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|--|---|--|-----------|
| 1. Report No. TX-98/2931-3 | 2. Government Accession No. | 3. Recipient's Catalog No. | |
| 4. Title and Subtitle HOUSTON ITS PRIORITY CORRIDOR PROGRAM PLAN-1996 UPDATE | | 5. Report Date May 1997 | |
| | | 6. Performing Organization Code | |
| 7. Author(s) Merrell E. Goolsby | | 8. Performing Organization Report No. Research Report 2931-3 | |
| 9. Performing Organization Name and Address Texas Transportation Institute The Texas A&M University System College Station, Texas 77843-3135 | | 10. Work Unit No. (TRAIS) | |
| | | 11. Contract or Grant No. Study No. 7-2931 | |
| 12. Sponsoring Agency Name and Address Texas Department of Transportation Research and Technology Transfer Office P. O. Box 5080 Austin, Texas 78763-5080 | | 13. Type of Report and Period Covered Interim: September 1995-December 1996 | |
| | | 14. Sponsoring Agency Code | |
| 15. Supplementary Notes Research performed in cooperation with the Texas Department of Transportation and the U.S. Department of Transportation, Federal Highway Administration. Research Study Title: Development of ITS Priority Corridor Program Plan | | | |
| 16. Abstract The Houston ITS Priority Corridor is one of four corridors selected by the U.S. Department of Transportation to showcase intelligent transportation systems (ITS) applications. The Texas Transportation Institute assisted the coalition of four local governments, comprised of the Texas Department of Transportation, Metropolitan Transit Authority (METRO), Harris County, and City of Houston, along with the Houston-Galveston Area Council (local MPO), in developing the Houston ITS Priority Corridor Program Plan (Report 2931-2, August 1995). This report updates the initial plan, reflecting additional funding authorizations, updated project development, and integration of Priority Corridor deployment projects into TranStar (Greater Houston Transportation and Emergency Management Center). The updated plan identifies a short-range component consisting of 31 deployment projects with an estimated cost of \$25,502,500. The total 10-year plan calls for 52 projects with an estimated cost of \$60,502,500. Implementation of the individual projects will be led by one of the four partnership transportation agencies or the Houston-Galveston Area Council. | | | |
| 17. Key Words Intelligent Transportation Systems, Traffic Management, Traveler Information Systems | | 18. Distribution Statement No restrictions. This document is available to the public through NTIS: National Technical Information Service 5285 Port Royal Road Springfield, Virginia 22161 | |
| 19. Security Classif.(of this report) Unclassified | 20. Security Classif.(of this page) Unclassified | 21. No. of Pages 86 | 22. Price |

**HOUSTON ITS PRIORITY CORRIDOR
PROGRAM PLAN-1996 UPDATE**

by

Merrell E. Goolsby, P.E.
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Research Report 2931-3
Research Study Number 7-2931
Research Study Title: Development of ITS Priority Corridor Program Plan

Sponsored by the
Texas Department of Transportation
in Cooperation with
U.S. Department of Transportation
Federal Highway Administration

May 1997

TEXAS TRANSPORTATION INSTITUTE
The Texas A&M University System
College Station, Texas 77843-3135

IMPLEMENTATION STATEMENT

This report documents the update of the Houston Intelligent Transportation Systems (ITS) Priority Corridor Plan (Research Report 2931-2) conducted in 1996. The plan is inherently “implementation oriented” and develops deployment projects in two implementation time frames: short range (1996-2000) and intermediate range (2001-2005). There are 52 individual deployment projects identified in the plan. These projects will be implemented under the leadership of one or more of the local transportation agencies (Texas Department of Transportation, Metropolitan Transit Authority of Harris County, Harris County, City of Houston) or the Houston-Galveston Area Council (local MPO). The Priority Corridor Technical Committee has developed an implementation process for project deployment with leadership on individual projects assumed by the lead agency for the project.

DISCLAIMER

The contents of this report reflect the views of the author who is responsible for the facts and the accuracy of the data presented herein. The contents do not necessarily reflect the official views or policies of the Texas Department of Transportation (TxDOT). This report does not constitute a standard, specification, or regulation. It is not intended for construction, bidding, or permit purposes. The engineer in charge of this project was Merrell E. Goolsby, P.E. #29551.

ACKNOWLEDGMENT

This report was developed as part of study 7-2931 “Development of ITS Corridor Program Plan” conducted by the Texas Transportation Institute (TTI) and sponsored by the Texas Department of Transportation (TxDOT) in cooperation with the U.S. Department of Transportation, Federal Highway Administration (FHWA).

Development of the plan represents a collaborative effort by the Houston ITS Priority Corridor Technical Committee, with assistance from TTI. Appreciation is extended to the committee, Dr. Douglas Wiersig, executive director of the multi-agency Houston TranStar Center and chair of the Technical Committee, and to Mr. John Gaynor, who serves as TxDOT’s project director for the Priority Corridor Program.

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1.0 INTRODUCTION

Passage of the Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA) introduced a new direction for surface transportation development and operation in the United States. With completion of the Interstate Highway System, ISTEA focuses on multimodal approaches to efficiently utilize existing and upgraded transportation resources to improve safety and reduce congestion. An important element of ISTEA is the creation of an Intelligent Transportation System (ITS) program which will contribute significantly to meeting the goals of ISTEA. ITS uses advanced communications, computer, surveillance, and control systems to address surface transportation needs.

The overriding concept of ITS is to increase transportation system performance, efficiency, and safety through application of advanced operational and technological applications. ITS applies advanced and emerging technologies to address the goals adopted for the ITS program as follows (1):

- Improve the safety of the Nation's surface transportation system;
- Increase the operational efficiency and capacity of the surface transportation system;
- Reduce energy and environmental costs associated with traffic congestion;
- Enhance present and future productivity;
- Enhance the personal mobility and the convenience and comfort of the surface transportation system; and
- Create an environment in which the development and deployment of ITS can flourish.

INTELLIGENT TRANSPORTATION INFRASTRUCTURE AND OPERATION TIMESAVER

FHWA considers implementation of an Intelligent Transportation Infrastructure (ITI) to be a necessary ingredient in deploying traffic management and traveler information services. The ITI establishes a foundation upon which ITS deployment by both the public and private sectors can proceed. Development of the ITI is a near-term (and evolutionary) deployment activity led by the

public sector. FHWA in its Operation TimeSaver (2) program has defined the ITI as having nine features:

- Regional Multimodal Traveler Information Center;
- Traffic Signal Control System(s);
- Freeway Management System(s);
- Transit Management System(s);
- Incident Management Program;
- Electronic Fare Payment System(s);
- Electronic Toll Collection System(s);
- Railroad Grade Crossing Controls; and
- Emergency Management Services.

It can be seen that development of the ITI directly addresses the six ITS goals established in the National Program Plan for ITS. In addition, deployment of the ITI in a “building block” approach provides a rational basis for continued progressive future ITS deployment.

On January 10, 1996, the U.S. Department of Transportation (USDOT) announced “Operation TimeSaver,” whose goal is to integrate/construct an ITI that saves time, increases safety, enhances mobility, and improves quality of life. The program’s goal is to deploy ITI in the 75 largest U.S. metropolitan areas in the next 10 years, and establishes travel time reductions of 15 percent as the operational target for the program.

The Houston area has made significant process in putting an ITS infrastructure in place. A significant portion of the Computerized Transportation Management Systems (freeway management systems) is in place, including the Houston TranStar Center. In addition, TranStar agencies are implementing other ITS infrastructure, including a regional computerized traffic signal system, automatic vehicle identification systems on area freeways, and “smart” buses for the Metropolitan Transit Authority’s (METRO) transit system.

HOUSTON ITS PRIORITY CORRIDOR

USDOT selected Houston to be one of four Intelligent Transportation Systems (ITS) Priority Corridors. These four corridors will showcase ITS concepts and technologies through implementation and evaluation of ITS projects directed at improving transportation systems operation.

The four U.S. priority corridors are:

- Northeast (IH-95) Corridor—Includes a corridor from Maryland to Connecticut, with numerous transportation agencies involved.
- Midwest Corridor—Includes the corridor from Gary, Indiana, through Chicago to Milwaukee, Wisconsin.
- Southern California Corridor—Includes IH-10/IH-5 from Los Angeles to San Diego.
- Houston, Texas Corridor—Includes the area surrounding IH-45 and IH-10, essentially including urbanized Greater Houston.

The Federal Highway Administration and the Texas Department of Transportation officially created the Houston Priority Corridor in an ITS Partnership Agreement dated September 8, 1993. The Agreement established initial funding (\$3,105,000 from FHWA and \$776,250 from TxDOT), defined a “work order” process for individual project authorization and established other contractual requirements. The ITS Partnership has been amended three times to supplement initial funding. Amendment 1 increased FHWA funding by \$2.00 million; Amendment 2 added \$2.25 million; and Amendment 3 added \$6.207 million. This FHWA funding represents Houston’s share of Priority Corridor Program support through Fiscal Year 1996 appropriations. The ITS Partnership Agreement and Amendments are provided in Appendix A.

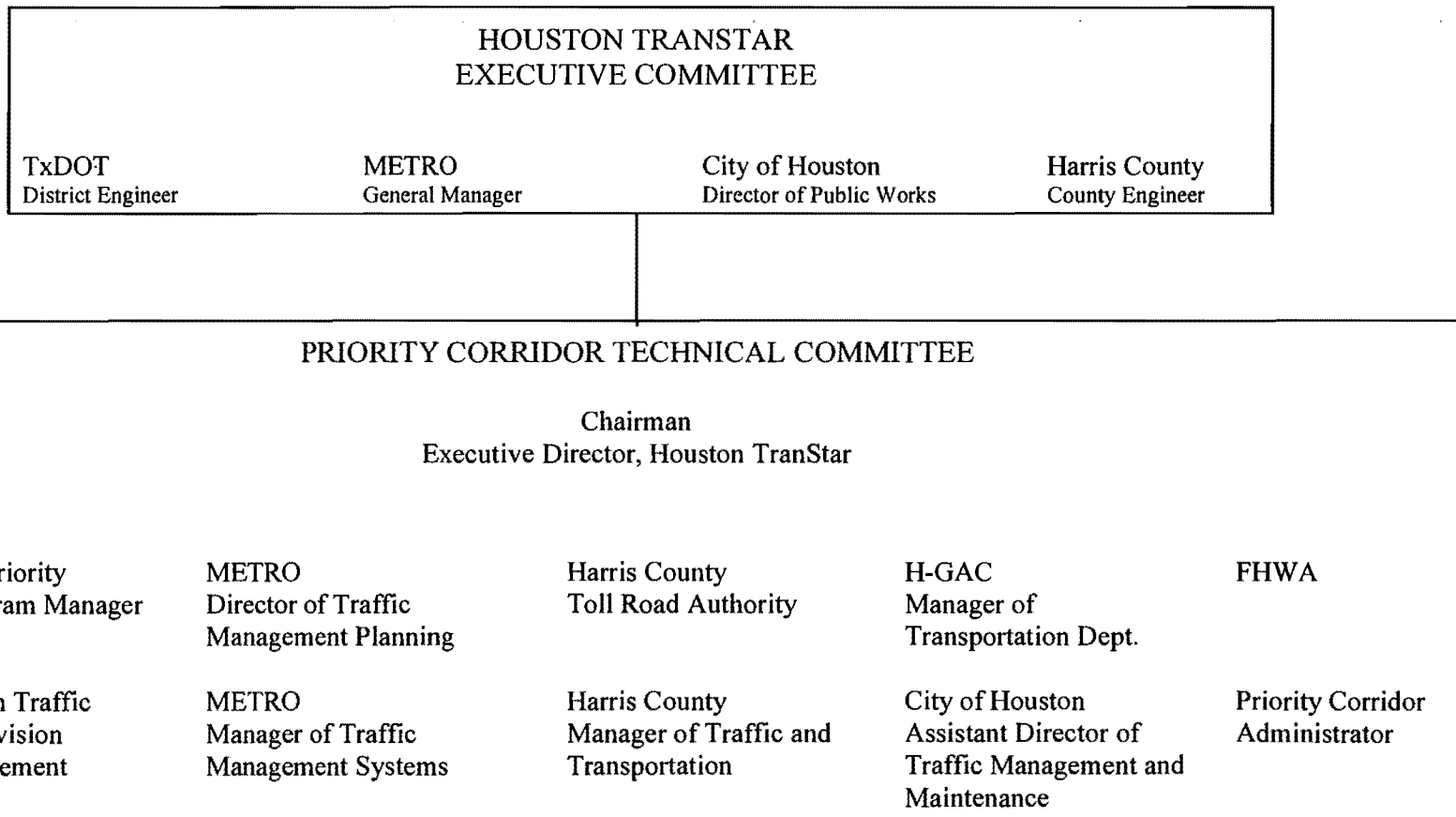
CORRIDOR ORGANIZATION

The FHWA/TxDOT Partnership Agreement establishes the framework for program development funding and administration. The agreement also recognizes the importance of

involvement of other local implementing transportation agencies in the area. TxDOT, Harris County, City of Houston, and METRO entered into a Memorandum of Understanding to manage and deploy the Houston ITS Priority Corridor Plan. The extensive prior ITS deployment in the area, the development of Houston TranStar, and the joint Priority Corridor approach demonstrate the commitment of area agencies to ITS deployment in the Houston area.

The organizational structure for the Houston ITS Priority Corridor Coalition is shown in Figure 1. Top management members of the four coalition agencies comprise the Executive Committee. This committee has overall management and coordination responsibility for the corridor program and its implementation, as well as directing the TranStar Center. The Technical Committee is composed of agency representatives and the Houston-Galveston Area Council, which is the Metropolitan Planning Organization for the eight-county area that includes Houston and Harris County. The Technical Committee is responsible for the technical direction, development, administration, coordination, and implementation of the corridor program.

Figure 1. Organization of Houston ITS Priority Corridor Coalition



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2.0 DEVELOPMENT OF THE PLAN UPDATE

Each of the four Priority Corridors is required to develop and maintain a plan which identifies proposed projects, priorities, schedules, costs, and responsibilities. Initial development of the Houston Plan was completed in 1995. The plan included an Immediate Action Program (3), outlining highest priority projects and a Program Plan (4) which identified specific projects for short range (five year) and intermediate range (10 year) project deployments.

PLAN CONTEXT AND VISION

ITS development in the Houston area began a number of years ago and actually predated ISTEA and the USDOT program for ITS and the Priority Corridor Program. The Priority Corridor Program has overlaid an on-going ITS development program with a multi-agency institutional structure. Table 1 contains a summary of the status of Intelligent Transportation Infrastructure (ITI) in the Houston area.

Because of the extensive existing and planned deployment of ITI by Corridor Coalition agencies, the Priority Corridor Program Plan builds upon and supplements this ITI. The Houston area ITS foundation upon which Priority Corridor projects will build includes:

- Computerized Transportation Management System (freeway, HOV, communications);
- Motorist Assistance Program;
- Automatic Vehicle Identification (AVI) System;
- METRO Smart Bus;
- Regional Computerized Traffic Signal System; and
- Houston TranStar Center.

The vision for the Houston ITS Priority Corridor is to continue to build upon the institutional and ITS deployment foundation, expanding ITS on an incremental basis as successful Priority Corridor operational tests are deployed on a larger scale. This vision entails:

| Table 1. Current Intelligent Transportation Infrastructure Deployment | | |
|--|---|----------|
| ITI Initiative | Existing and Operational in 1997 | |
| Traveler Information/Control Center | TranStar Center (Transportation Management and Information Center) | Existing |
| | AVI for Vehicle Probe Travel Speed Information | Existing |
| | • US 290 (NW), IH 45 (N), IH 10 (Katy), US 59 (SW), IH 610 (Loop) | Existing |
| | • AVI Expansion to Complete System | 1997 |
| | Real-Time Traveler Information on Internet | Existing |
| | Smart Commuter-IH 45 Personal Digital Assistant Information System | Existing |
| | Shadow Traffic and Metro Traffic in TranStar Center | Existing |
| Traffic Signal Control Systems | Real-Time Information Kiosks (PCorr) | 1997 |
| | Highway Advisory Radio-Mobile Unit | Existing |
| Freeway Management Systems | Changeable Lane Assignment System (CLAS) on Frontage Road (PCorr) | Existing |
| | Advanced Traffic Signal Systems | Existing |
| | • Closed Loop Arterial Signal Systems – 32 systems with 590 signals | Existing |
| | Traffic Signal Operations Integrated in TranStar Center | Existing |
| Transit Management Systems | Regional Computerized Traffic Signal System (RCTSS)-Partial Deployment | 1997 |
| | Computerized Freeway Traffic Management System (CTMS) | Existing |
| | • IH 45 (N), IH 45 (Gulf), IH 10 (Katy), US 290 (NW) | Existing |
| | • IH 610 (Loop), US 59 (SW), SH 225, SH 288, IH 10 (E) | 1997 |
| | Freeway Flow Signals-Partial Deployment | Existing |
| | Changeable Message Signs: Various Houston Freeway Locations | Existing |
| | Changeable Message Signs: Galveston Causeway (IH 45) | Existing |
| Truck Monitoring/Warning System for Freeway to Freeway Connections (PCorr) | 1997 | |
| Incident Management Programs | Integrated Corridor Transportation Management and Traveler Info System (PCorr) | 1997 |
| | Monitoring Traffic/Transit Conditions and Freeway Incident Detection with Automatic Vehicle Identification Technology (PCorr) | 1997 |
| | HOV Reversible Lanes and Control Systems | Existing |
| | • IH 10 (Katy), US 59 (SW), IH 45 (Gulf), IH 45 (N), US 290 (NW) | Existing |
| Electronic Fare Payment Systems | • Extensions: IH 45 (Gulf), IH 45 (N), US 59 (SW) | 1997 |
| | • Priority Pricing on IH 10 (Katy) HOV | 1997 |
| | HOV Park-and-Ride Lots | Existing |
| | Smart Bus: Communication System, Fleet Management, Passenger Information | 1997 |
| Electronic Toll Collection Systems | METROLift AVL for Scheduling and Routing | Existing |
| | Motorist Assistance Program (with AVL) | Existing |
| Railroad Grade Crossings | Special Event (Astrodome Area) Transportation Management (PCorr) | Existing |
| | Automatic Vehicle Locator for Incident Management (PCorr) | 1997 |
| Emergency Response | Transit Fare Card Payment System | Existing |
| | AVI/Automatic Toll Collection (HCTRA) | Existing |
| TranStar Integration | High Speed Lane Toll Collection with AVI | 1997 |
| | Railroad Grade Crossing Monitoring System (PCorr) | 1997 |
| | Fire Truck and EMS Signal Pre-Emption (City of Houston) | Existing |
| TranStar Integration | Houston and Harris County Office of Emergency Management (OEM) | Existing |
| | Integrated in TranStar Center | Existing |
| | METRO Police and Houston Police Department Integrated in TranStar Center | Existing |
| TranStar Integration | Monitoring and Information System for Environmental Conditions (PCorr) | 1997 |
| | TranStar Initial Systems Integration (CCTV, VMS, LCS, MAP, GIS, Incident Logs, and Databases) | Existing |

- Building on previous ITS deployment;
- Deploying ITS through the established multi-agency TranStar/Priority Corridor/Coalition; and
- With a focus on deployment of multi-modal transportation management and traveler information systems.

CORRIDOR PROGRAM PLAN 1996 UPDATE PROCESS

The Corridor Program Plan calls for an annual review and update. This annual update reflects the status of project deployments, latest funding commitments, and a review and update of the plan based on current needs and resources. The plan update also includes development of scope, schedule, and estimated cost of new or revised projects.

This report documents the 1996 update of the Program Plan. The Houston ITS Priority Corridor Technical Committee conducted this update, with the assistance of the Texas Transportation Institute. The Technical Committee conducted bi-weekly working meetings during the period of August-December 1996 to develop the 1996 update. This process considered:

- Status of current project deployments and project interrelationships;
- Review and update of agency needs, resources, and priorities; and
- Updated funding commitments (FHWA funding through FY 96).

The product of these efforts is an updated Priority Corridor Program Plan which reflects current conditions, needs, priorities, and agency programs.

RECOMMENDED 1996 PROGRAM PLAN UPDATE

The recommended updated plan, covering the ten-year short and intermediate range periods, is comprised of 52 projects with an estimated cost of \$60,502,500. Table 2 lists the updated plan projects grouped by ITI category. Brief project descriptions for the updated plan are provided in Appendix B.

| Table 2. Program of Projects Grouped by Intelligent Transportation Infrastructure Category | | |
|--|---------------------------|-----------------------|
| Category/Project | Lead Agency | Estimated Cost |
| 0. <u>Administrative/Planning</u> | | |
| 0-1 Development of ITS Priority Corridor Program Plan | TxDOT | \$ 400,000 |
| 0-2 Public Information/Program Administration | TxDOT | 200,000 |
| 0-3 Program Administration/Public Information/Project Development (2 Years) | TxDOT/METRO | 590,000 |
| 0-4 ITS Technology for Data Collection and Transportation Planning | H-GAC | 300,000 |
| 0-5 Integration of Priority Corridor Projects into TranStar | TxDOT | 247,500 |
| 0-6 System Integration for FY 1997 Funded Projects | TxDOT | 550,000 |
| 0-7 Program Administration/Public Information/Project Development (2 Years) | TxDOT/METRO | 500,000 |
| 0-8 System Integration of Intermediate Range Projects into TranStar | TxDOT | 1,400,000 |
| 0-9 Program Administration/Public Information/Project Development (3 Years) | TxDOT/METRO | 600,000 |
| 1. <u>Regional Multimodal Traveler Information Center</u> | | |
| 1-1 Real-Time Information Kiosks | TxDOT | 750,000 |
| 1-2 On-Vehicle Navigation/Information Applications | TxDOT | 400,000 |
| 1-3 Monitoring and Information Systems for Environmental Conditions | TxDOT | 500,000 |
| 1-4 Dissemination of Traveler Information | TxDOT | 483,750 |
| 1-5 Condition Responsive Uptown Traveler Information System | City of Houston | 937,500 |
| 1-6 Using ITS Technology for Parking Management and Airport Area Traffic Management/Traveler Information | TxDOT/ City of Houston | 2,500,000 |
| 1-7 Expansion of Traveler Information Kiosks | TxDOT/METRO | 1,300,000 |
| 1-8 Using AVI Technology for Best Route Selection in Clear Lake City | City of Houston | 1,600,000 |
| 1-9 Using Advanced AVI Technology for In-Vehicle Traveler Information | TxDOT | 800,000 |
| 2. <u>Traffic Signal Control Systems</u> | | |
| 2-1 Changeable Lane Assignment System (CLAS) on Frontage Roads | TxDOT | 750,000 |

Table 2. Program of Projects Grouped by Intelligent Transportation Infrastructure Category (cont.)

| Category/Project | | Lead Agency | Estimated Cost |
|------------------|--|-----------------------------------|------------------------|
| 2-2 | Changeable Lane Assignment System (CLAS) at Arterial Intersections | Harris County | 250,000 |
| 2-3 | Providing ITS Core Infrastructure in North and Northwest Growth Corridors | Harris County | 2,400,000 |
| 2-4 | Expansion of CLAS Applications and Operations Integration | TxDOT | 2,000,000 |
| 2-5 | Arterial Street Traffic Management System Enhancements | Harris County/ City of Houston | 2,200,000 |
| 2-6 | AVI Monitoring of Arterial Street Traffic Operations | TxDOT/ City of Houston | 3,100,000 |
| 3. | <u>Freeway Management Systems</u> | | |
| 3-1 | Monitoring Traffic and Transit Conditions and Incident Detection with AVI (Phase 4) | TxDOT | 1,831,250 |
| 3-2 | Truck Monitoring and Warning Systems for Freeway to Freeway Connections | TxDOT | 220,000 ⁽¹⁾ |
| 3-3 | Integrated Corridor Transportation Management and Traveler Information System | TxDOT/METRO | 1,862,500 |
| 3-4 | Coordinated Ramp Metering and Intersection Traffic Signal Control | TxDOT | 362,500 |
| 3-5 | Air Quality Monitoring to Evaluate Traffic/Air Characteristics | TxDOT/H-GAC | 660,000 |
| 3-6 | AVI System Expansion | TxDOT | 1,760,000 |
| 3-7 | Freeway Lane Control/Advisory Speed System | TxDOT | 900,000 |
| 3-8 | Freeway/Arterial Corridor Management | TxDOT/METRO | 2,800,000 |
| 3-9 | Traffic Monitoring System Using Unique CCTV Platforms | METRO | 1,700,000 |
| 3-10 | Operation of Smart Vehicles for Traffic Management | TxDOT | 2,800,000 |
| 4. | <u>Transit Management Systems</u> | | |
| 4-1 | En-Route Transit Information System | METRO | 712,500 |
| 4-2 | Public Travel Security Infrastructure and Integrating Transit into Houston TranStar Center | METRO | 3,080,000 |
| 4-3 | ITS-Based Scheduling, Reservation, Dispatching of Personalized Public Transit | METRO | 5,100,000 |
| 5. | <u>Incident Management Program</u> | | |
| 5-1 | CCTV Surveillance System Lease for Astrodome Area | TxDOT | 480,000 |
| 5-2 | Automatic Vehicle Locator System for Incident Management | TxDOT | 100,000 |
| 5-3 | Washburn Tunnel Traffic Management and Information System | Harris County | 950,000 |

| Table 2. Program of Projects Grouped by Intelligent Transportation Infrastructure Category (cont.) | | | |
|---|---|--------------------|-----------------------|
| Category/Project | | Lead Agency | Estimated Cost |
| 5-4 | Traffic Management and Traveler Information for Critical Roadway Links | TxDOT | 1,325,000 |
| 5-5 | ITS Enhanced Incident Management | TxDOT/METRO | 387,500 |
| 5-6 | Automatic Traffic Management in Flood Prone Areas Through Use of ITS Technologies | Harris County | 1,200,000 |
| 5-7 | Automated Incident Management Strategies and Support Systems | TxDOT | 750,000 |
| 5-8 | North Freeway/Hardy Toll Road Incident Management Through Toll Adjustment | TxDOT/HCTRA | 1,000,000 |
| 5-9 | Development of Enhanced Incident Management Plan | METRO | 300,000 |
| 5-10 | AVI Traffic Monitoring for Incidents | TxDOT | 2,100,000 |
| 6. | <u>Electronic Fare Payment (no projects)</u> | | |
| 7. | <u>Electronic Toll Collection</u> | | |
| 7-1 | Priority Lane Pricing Using AVI | METRO/TxDOT | 462,500 |
| 7-2 | Toll Plaza Monitoring and Remote Toll Collection | HCTRA/TxDOT | 700,000 |
| 8. | <u>Railroad Grade Crossing Controls</u> | | |
| 8-1 | Railroad Grade Crossing Monitoring System | TxDOT | 500,000 |
| 9. | <u>Emergency Management Services</u> | | |
| 9-1 | Hazardous Materials Truck Monitoring and Routing | Harris County | 1,000,000 |
| 9-2 | Remote Incident Monitoring/Emergency Response Agencies | TxDOT | 700,000 |
| Estimated Program Cost | | | \$60,502,500 |

⁽¹⁾ Estimated cost does not include private sector participation of \$80,000.

SHORT RANGE PLAN (1996-2000)

The short range plan covers the period for which ISTEA/ITS funding is currently authorized (through FY 97). Implementation is underway for projects funded by FY 93-FY 95 FHWA Priority Corridor allocations. In addition to these 14 projects, called the Intermediate Action Program, the 1996 Update refined FY 96 funded projects in the Short Range Plan to reflect actual FHWA funding allocations for the priority corridors.

The updated Short Range Program is summarized in Table 3. Those short range projects whose location has been determined are shown in Figure 2. Table 3 also lists estimated project costs and funding requirements by funding fiscal year. Total estimated cost to implement the 31 projects of the Short Range Plan is \$25,502,500. This is a reduction from the \$27.5 million of the original plan and reflects the most current information and ITS funding availability.

INTERMEDIATE RANGE PLAN (2001-2005)

Projects and estimated cost of the Intermediate Range Plan are summarized in Table 4. The Intermediate Range Plan contains 21 projects, with an estimated total cost of \$35,000,000. This represents a significant increase in the number of projects and the extent of ITS development envisioned in the intermediate range period. Projects in this time frame are considered more flexible in terms of scope, cost, and schedule. The annual update process for the priority corridor plan will more firmly define these projects as the time for their implementation approaches. The Technical Committee can add projects or revise currently planned projects as ITS deployment experience and technology advance.

PROGRAM FUNDING RESOURCES AND NEEDS

The ten-year program of projects contained in the Short and Intermediate Range Plans will require a total estimated investment of over \$60.5 million. Table 5 lists estimated costs, funding authorizations, and additional funding needs.

| Table 3. Updated Short Range Program (1996-2000) and Funding Requirements Houston ITS Priority Corridor | | | | | |
|--|--|------------|-------------|-------------|-------|
| Project | Estimated Cost by Funding Fiscal Year ⁽¹⁾ | | | | |
| | FY 93 | FY 94 | FY 95 | FY 96 | FY 97 |
| 5-1 CCTV Surveillance System Lease for Astrodome Area ⁽²⁾ -Work Order #1 | \$ 480,000 | | | | |
| 0-1 Development of ITS Priority Corridor Program Plan ⁽²⁾ -Work Order #2 | 400,000 | | | | |
| 3-1 Monitoring Traffic and Transit Conditions and Incident Detection with AVI Technology (Phase 4) ⁽²⁾ -Work Order #3 | 1,831,250 | | | | |
| 2-1 Changeable Lane Assignment System (CLAS) on Frontage Roads ⁽²⁾ -Work Order #4 | 750,000 | | | | |
| 0-2 Public Information/Program Administration (3 years) ⁽²⁾ -Work Order #5 | 200,000 | | | | |
| 3-2 Truck Monitoring and Warning Systems for Freeway to Freeway Connections ⁽²⁾ -Work Order #6 | 220,000 | | | | |
| 1-1 Real-Time Information Kiosks ⁽²⁾ -Work Order #7 | | \$ 750,000 | | | |
| 8-1 Railroad Grade Crossing Monitoring System ⁽²⁾ -Work Order #8 | | 500,000 | | | |
| 5-2 Automatic Vehicle Locator System for Incident Management ⁽²⁾ -Work Order #9 | | 100,000 | | | |
| 1-2 On-Vehicle Navigation/Information Applications ⁽²⁾ -Work Order #10 | | 400,000 | | | |
| 1-3 Monitoring and Information System for Environmental Conditions ⁽²⁾ -Work Order #11 | | 500,000 | | | |
| 2-2 Changeable Lane Assignment System (CLAS) at Selected Arterial Intersections ⁽²⁾ -Work Order #12 | | 250,000 | | | |
| 3-3 Integrated Corridor Transportation Management and Traveler Information System ⁽²⁾ -Work Order #13 | | | \$1,862,500 | | |
| 5-3 Washburn Tunnel Traffic Management and Information System ⁽²⁾ -Work Order #14 | | | 950,000 | | |
| 5-4 Traffic Management and Traveler Information for Critical Roadway Links | | | | \$1,325,000 | |
| 0-4 ITS Technology for Data Collection and Transportation Planning | | | | 300,000 | |
| 7-1 Priority Lane Pricing Using AVI | | | | 462,500 | |
| 0-3 Program Administration/Public Information/Project Development (2 years) | | | | 590,000 | |

⁽¹⁾ Project cost is listed for the funding fiscal year.

⁽²⁾ These projects are included in Immediate Action Program.

**Table 3. Updated Short Range Program (1996-2000) and Funding Requirements
Houston ITS Priority Corridor (continued)**

| Project | Estimated Cost by Funding Fiscal Year ⁽¹⁾ | | | | |
|--|--|-------------|-------------|-------------|-------------|
| | FY 93 | FY 94 | FY 95 | FY 96 | FY 97 |
| 4-1 En-Route Transit Information System | | | | 712,500 | |
| 5-5 ITS Enhanced Incident Management | | | | 387,500 | |
| 5-6 Automatic Traffic Management in Flood Prone Areas Through Use of ITS Technologies | | | | 1,200,000 | |
| 1-4 Dissemination of Traveler Information | | | | 483,750 | |
| 3-4 Coordinated Ramp Metering and Intersection Traffic Signal Control | | | | 362,500 | |
| 1-5 Condition Responsive Uptown Traveler Information System | | | | 937,500 | |
| 5-7 Automated Incident Management Strategies and Support Systems | | | | 750,000 | |
| 0-5 Integration of Priority Corridor Projects into TranStar | | | | 247,500 | |
| 0-6 System Integration of FY 97 Funded Projects into TranStar | | | | | \$ 550,000 |
| 1-6 Using ITS Technology for Parking Management and Airport Area Traffic Management/Traveler Information | | | | | 2,500,000 |
| 4-2 Public Travel Security Infrastructure and Integrating Transit into Houston TranStar Center | | | | | 3,080,000 |
| 3-6 AVI System Expansion | | | | | 1,760,000 |
| 3-5 Air Quality Monitoring to Evaluate Traffic/Air Characteristics | | | | | 660,000 |
| Annual Total Cost | \$3,881,250 | \$2,500,000 | \$2,812,500 | \$7,758,750 | \$8,550,000 |
| Estimated USDOT Share | \$3,105,000 | \$2,000,000 | \$2,250,000 | \$6,207,000 | \$6,840,000 |
| Estimated State/Local Share | \$ 776,250 | \$ 500,000 | \$ 562,500 | \$1,551,750 | \$1,710,000 |
| Short Range Program Total Cost | \$25,502,500 | | | | |

⁽¹⁾ Project cost is listed for the funding fiscal year.

⁽²⁾ These projects are included in Immediate Action Program.

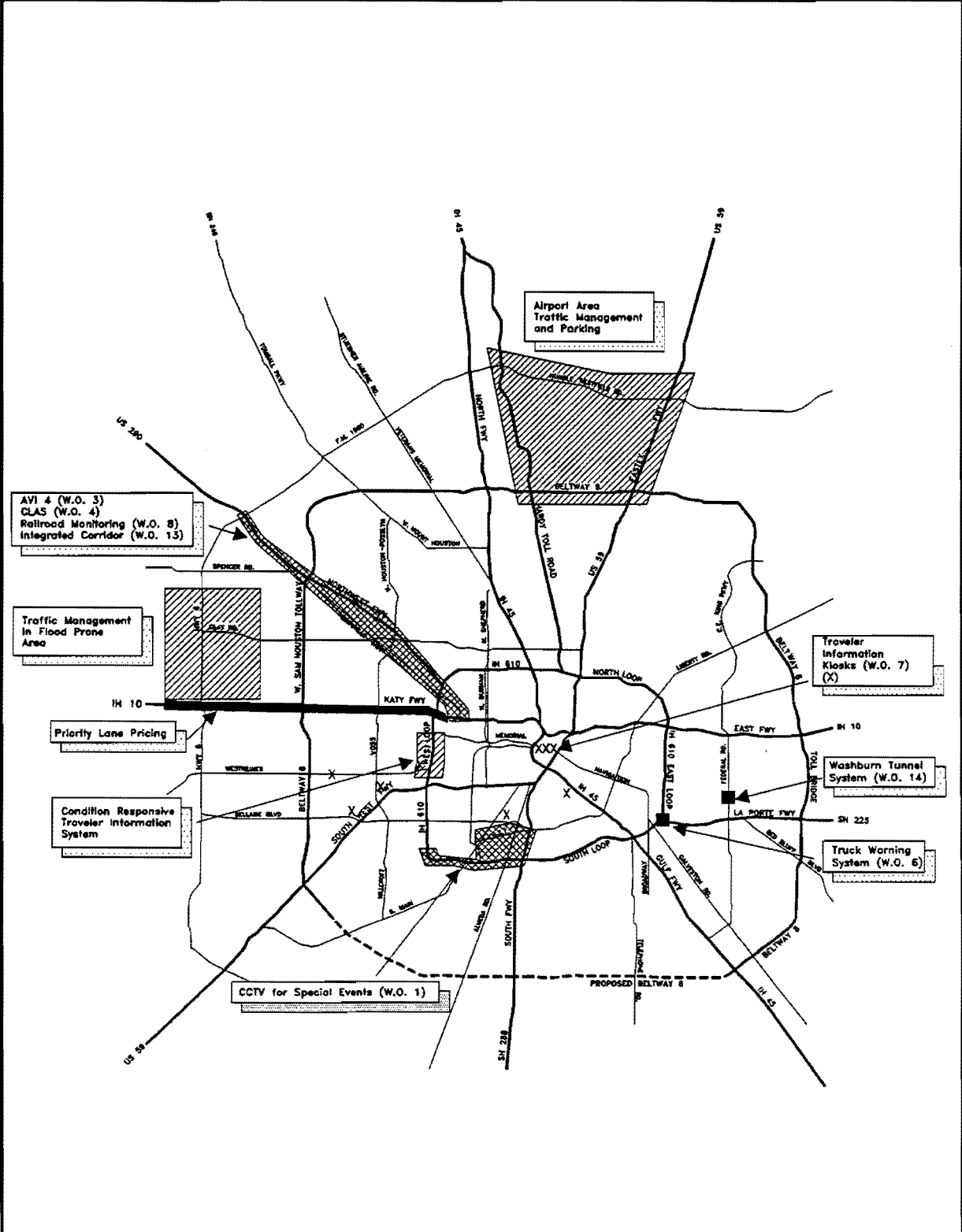


Figure 2. Location of Selected Short Range Program Projects

**Table 4. Updated Intermediate Range Program (2001-2005) and Funding Requirements
Houston ITS Priority Corridor**

| Project | Estimated Cost by Funding Fiscal Year | | | | |
|--|---------------------------------------|--------------------|--------------------|--------------------|--------------------|
| | FY 98 | FY 99 | FY 00 | FY 01 | FY 02 |
| 2-3 Providing ITS Core Infrastructures in North and Northwest Growth Corridors | \$2,400,000 | | | | |
| 4-3 ITS-Based Scheduling, Reservation, Dispatching, or Personalized Public Transit | 5,100,000 | | | | |
| 0-7 Program/Administration/Public Information/Project Development (2 years) | 500,000 | | | | |
| 5-8 North Freeway/Hardy Toll Road Incident Management Through Toll Adjustment | | \$1,000,000 | | | |
| 1-7 Expansion of Traveler Information Kiosks | | 1,300,000 | | | |
| 2-4 Expansion of CLAS Applications and Operations Integration | | 2,000,000 | | | |
| 0-8 System Integration of Intermediate Range Projects into TranStar | | 1,400,000 | | | |
| 3-7 Freeway Lane Control Signal/Advisory Speed System | | 900,000 | | | |
| 9-1 Hazardous Materials Truck Monitoring and Routing | | 1,000,000 | | | |
| 0-9 Program Administration/Public Information/Project Development (3 years) | | | \$ 600,000 | | |
| 1-8 Using AVI Technology for Best Route Selection in Clear Lake City | | | 1,600,000 | | |
| 1-9 Using Advanced AVI Technology for In-Vehicle Traveler Information | | | 800,000 | | |
| 3-8 Freeway/Arterial Corridor Management | | | 2,800,000 | | |
| 3-9 Traffic Monitoring System Using Unique CCTV Platforms | | | 1,700,000 | | |
| 9-2 Remote Incident Monitoring/Emergency Response Agencies | | | | \$ 700,000 | |
| 7-2 Toll Plaza Monitoring and Remote Toll Collection | | | | 700,000 | |
| 5-9 Development of Enhanced Incident Management Plan | | | | 300,000 | |
| 2-5 Arterial Street Traffic Management System Enhancements | | | | 2,200,000 | |
| 5-10 AVI Traffic Monitoring for Incidents | | | | 2,100,000 | |
| 2-6 AVI Monitoring of Arterial Street Traffic Operations | | | | | \$3,100,000 |
| 3-10 Operation of Smart Vehicles for Traffic Management | | | | | 2,800,000 |
| Annual Total Cost | \$8,000,000 | \$7,600,000 | \$7,500,000 | \$6,000,000 | \$5,900,000 |
| Estimated USDOT Share | \$6,400,000 | \$6,080,000 | \$6,000,000 | \$4,800,000 | \$4,720,000 |
| Estimated State/Local Share | \$1,600,000 | \$1,520,000 | \$1,500,000 | \$1,200,000 | \$1,180,000 |
| Intermediate Range Program Cost | \$35,000,000 | | | | |

| Table 5. Summary of Funding Needs | | | |
|--|-------------------|--------------------|-------------------|
| | USDOT | State/Local | Total |
| <u>Estimated Ten Year Program Costs</u> | | | |
| Short Range Plan | | | |
| Immediate Action Program (14 Projects) | | | \$ 9,193,750 |
| Other Short Range Projects | | | 16,308,750 |
| Intermediate Range Plan | | | <u>35,000,000</u> |
| Total Program Cost | | | \$60,502,500 |
| <u>Current Funding Authorizations</u> | | | |
| FY 1993 | \$ 3,105,000 | \$ 776,250 | \$ 3,881,250 |
| FY 1994 | 2,000,000 | 500,000 | 2,500,000 |
| FY 1995 | 2,250,000 | 562,500 | 2,812,500 |
| FY 1996 | <u>6,207,000</u> | <u>1,551,700</u> | <u>7,758,750</u> |
| Total Authorized | \$13,562,000 | \$3,390,450 | \$16,952,500 |
| <u>Estimated Additional Funding Needs</u> | | | |
| FY 1997 | \$ 6,840,000 | \$1,710,000 | \$ 8,550,000 |
| FY 1998 and Beyond | <u>28,000,000</u> | <u>7,000,000</u> | <u>35,000,000</u> |
| Total Additional Funding Needed | \$34,840,000 | \$8,710,000 | \$43,550,000 |

Current funding authorizations total \$16,952,500 (\$13,562,000 from USDOT and \$3,390,450 from local agencies). This funding includes USDOT funding for the Houston ITS Priority Corridor for Fiscal Years 1993-1996. Estimated required additional USDOT funding is \$6,840,000 for FY 97 to complete the funding estimates of the Short Range Plan and complete the original ISTEA/ITS program. The Intermediate Range Program is anticipated to receive financial assistance under anticipated 1997 legislation which would extend ISTEA/ITS programs.

3.0 IMPLEMENTATION OF THE PLAN

The plan represents the current consensus and desired direction for ITS project deployment in the Corridor. Implementation of these projects, particularly those in the Short Range Program, should proceed quickly in order to respond to the National ITS goals and program schedule.

Involved local agencies and FHWA consider the plan to be a “living document” which is subject to periodic update and revision. Some projects will be modified or even eliminated as further study and detailed project development proceeds. ITS technologies are expected to continue to advance over time, providing additional project deployment opportunities. Therefore, the plan is considered flexible in terms of project makeup, scope, cost, and schedule.

PROJECT DEPLOYMENT

The action elements of the plan are a series of projects which extend or test intelligent transportation infrastructure. The interrelationships of many of the projects fosters a building block approach to the incremental development of transportation management and traveler information systems. However, from the standpoint of deployment, each project is developed and implemented separately. Table 6 shows the estimated project deployment schedule for the Short Range Program.

Staffing of the Houston Priority Corridor Program includes a program manager and a program administrator who are responsible for overall management of the program. They will coordinate program development with the Priority Corridor Technical and Executive Committees. At the individual project level, a “lead agency” (currently one of the four operating agencies or H-GAC) will be responsible for project management and (typically) providing the local funding match. Deployment of projects will be undertaken by the designated lead agency and its project manager. Although there will be a lead agency, other local agencies, as well as private sector partners, will often be involved on a specific project.

Although each project will have its own unique characteristics, most will track the four following steps.

| Table 6. Short Range Program (1996-1999) and Deployment Schedule | | | | |
|---|---|------|------|------|
| Project | Year of Project Initiation ⁽¹⁾ | | | |
| | 1996 | 1997 | 1998 | 1999 |
| 5-1 CCTV Surveillance System Lease for Astrodome Area ⁽²⁾ –Work Order #1 | X ⁽³⁾ | | | |
| 0-1 Development of ITS Priority Corridor Program Plan ⁽²⁾ –Work Order #2 | X ⁽³⁾ | | | |
| 3-1 Monitoring Traffic and Transit Conditions and Incident Detection with AVI (Phase 4) ⁽²⁾ –Work Order #3 | X | | | |
| 2-1 Changeable Lane Assignment System (CLAS) on Frontage Roads ⁽²⁾ –Work Order #4 | X | | | |
| 0-2 Public Information/Program Administration (3 Years) ⁽²⁾ –Work Order #5 | X | | | |
| 3-2 Truck Monitoring and Warning Systems for Freeway to Freeway Connections ² –Work Order #6 | X | | | |
| 1-1 Real-Time Information Kiosks ⁽²⁾ –Work Order #7 | X | | | |
| 8-1 Railroad Grade Crossing Monitoring System ⁽²⁾ –Work Order #8 | X | | | |
| 5-2 Automatic Vehicle Locator System for Incident Management ⁽²⁾ –Work Order #9 | X | | | |
| 1-2 On-Vehicle Navigation/Information Applications ⁽²⁾ –Work Order #10 | X | | | |
| 1-3 Monitoring and Information System for Environmental Conditions ⁽²⁾ –Work Order #11 | X | | | |
| 2-2 Changeable Lane Assignment System (CLAS) at Selected Arterial Intersections ⁽²⁾ –Work Order #12 | | X | | |
| 3-3 Integrated Corridor Transportation Management and Traveler Information System ⁽²⁾ –Work Order #13 | | X | | |
| 5-3 Washburn Tunnel Traffic Management and Information System ⁽²⁾ –Work Order #14 | | X | | |
| 5-4 Traffic Management and Traveler Information for Critical Roadway Links | | X | | |
| 0-4 ITS Technology for Data Collection and Transportation Planning–Work Order #16 | | X | | |
| 7-1 Priority Lane Pricing Using AVI | | X | | |
| 0-3 Program Administration/Public Information/Project Development (2 Years) | | X | | |
| 4-1 En-Route Transit Information System | | X | | |
| 5-5 ITS Enhanced Incident Management | | X | | |
| 5-6 Automatic Traffic Management in Flood Prone Areas Through Use of ITS Technologies | | X | | |
| 1-4 Dissemination of Traveler Information | | X | | |
| 3-4 Coordinated Ramp Metering and Intersection Traffic Signal Control | | X | | |
| 1-5 Condition Responsive Uptown Traveler Information System | | | X | |
| 5-7 Automated Incident Management Strategies and Support Systems | | | X | |
| 0-5 Integration of Priority Corridor Projects into TranStar | | | X | |
| 0-6 System Integration of FY 97 Funded Projects into TranStar | | | X | |
| 1-6 Using ITS Technology for Parking Management and Airport Area Traffic Management and Traveler Information | | | X | |
| 4-2 Public Travel Security Infrastructure and Integrating Transit into Houston TranStar Center | | | | X |
| 3-6 AVI System Expansion | | | | X |
| 3-5 Air Quality Monitoring to Evaluate Traffic/Air Characteristics | | | | X |

⁽¹⁾ Year listed is the estimated fiscal year of initial deployment. Most project durations are multi-year.

⁽²⁾ These projects are included in the Immediate Action Program and have approved work orders.

⁽³⁾ Project begun prior to FY 1996.

Project Approval and Funding

Each project will need to have the necessary administrative processing, approvals, and funding commitments before proceeding with detailed planning, design, and implementation. Approvals will typically include the lead agency, TxDOT, and FHWA, with typical local funding by the lead agency. The initial step will be development and approval of the project work order, which supplements the ITS Partnership Agreement between FHWA and TxDOT. Each work order describes the project scope, estimated cost and schedule, and financial assistance by FHWA.

Project Development and Design

Additional planning and preliminary engineering will be necessary to define the project sufficiently for design and construction. This plan has developed projects only to the concept level, and further study and refinement will be needed. This refinement leads directly to project design and development of construction plans and specifications and/or system development specifications.

Deployment

Project deployment includes several steps, depending upon the nature of the project, i.e., implementation (construction and/or systems development), system integration, public information, and operations/maintenance. Typically, the construction or installation of necessary hardware or facilities will follow the lead agency's bidding/contracting procedures with the lead agency responsible for contract administration and project acceptance. However, all federal regulations for procurement must be followed, including record-keeping and audit requirements. Many of the projects have components which will be integrated with the TranStar Center and/or other systems. If system integration is not a part of the construction/installation scope for a specific project, it may be necessary to contract with an independent systems firm to integrate the project into the Houston TranStar Center.

A public information component will be necessary on many of the projects in order to inform travelers of the project's objectives and how the public can utilize or respond to the deployed project (which often involves transportation management or traveler information). The lead agency will typically develop a public information program specifically for each deployed project.

Deployment activities should not overlook operation and maintenance needs of developed ITS infrastructure, as these have been recognized as potential weak links in the ITS program. These activities will be the responsibility of the local agencies, and sufficient staffing and funding should be provided to assure the continuing functionality of the ITS systems deployed. Actual performance of operation and maintenance activities can be in-house or through contracts with qualified private firms. Lead agencies may structure projects to utilize lease systems with a private supplier responsible for all operations and maintenance.

Project Evaluation

The FHWA requires that each project undergo an evaluation study. These evaluation studies will provide the documentation and independent assessment needed for technology sharing with the worldwide ITS community. These evaluation studies should be contracted with qualified research organizations or consultants. Evaluation studies should generally include assessing the achievement of project objectives, quantitative evaluation of measures of effectiveness, and the potential for widespread future deployment.

FUNDING OF PRIORITY CORRIDOR PROJECTS

Title VI (Research) of the ISTEA provides federal funding for ITS programs. ISTEA designates a portion of the ITS funds for Priority Corridors (approximately \$43 million per year). Although Houston must compete nationwide for general ITS funding, the competition for Priority Corridor funding is among only the four designated corridors. ITS funding provided for each corridor will not be automatic, but based on the site's ITS Corridor Program Plan and USDOT funding decisions. The maximum federal funding for priority corridor projects is 80 percent of project costs, with minimum local funding of 20 percent required.

The FHWA has approved a total of \$13,562,000 in combined FY 93-FY 96 Priority Corridor funding for the Houston Priority Corridor. This funding is sufficient to support a program of \$16,952,500 (including local matching funds), which represents 66 percent of the Short Range Program Plan.

The recommended Short Range Plan for the Houston Priority Corridor has an estimated cost of \$25,502,500, which indicates a need for federal Priority Corridor funding at a higher rate than that which has previously been authorized. In addition, the Intermediate Range Program is estimated to cost approximately \$35,000,000 for which FHWA assistance is anticipated to be provided in the 1997 legislation reauthorizing ISTEA/ITS. If this funding is not sufficient, it will be necessary to find other funding (local, state, or other federal program funding), delay, or eliminate deployment of a portion of the plan.

CONTINUING PLANNING ACTIVITIES

The plan was developed as a living document which should be monitored on a continuing basis and updated annually. In addition, the plan should be coordinated with other agencies and areawide transportation planning activities.

The planning for the Houston Priority Corridor is a continuing process with this initial update of the plan, an example of this process. The Technical Committee should monitor progress of the plan as projects are undertaken and the plan updated annually. Feedback from early project deployments will provide input for development of later projects. Texas Transportation Institute will assist in these activities as part of its contract for development of the program plan. Recommended planning activities include:

- Project deployment planning and coordination, including regular Technical Committee meetings to review and assess status of project development.
- Monitoring of national ITS activities and other Priority Corridors.

- Annual assessment and update of plan:
 - meetings with agencies and Technical Committee;
 - assess status of project deployments;
 - review needs and resources;
 - develop new/revised projects; and
 - develop scope, schedule, and cost for projects.
- Documentation of recommended plan revisions in an annual update report.

4.0 CONCLUSION

This report documents the initial review and update of the ten-year plan and vision for ITS development in the Houston Priority Corridor. This plan is unique and builds on previous and in-process Intelligent Transportation Infrastructure development by TxDOT, USDOT, and local transportation agencies. The plan and this 1996 update were developed by the Technical Committee of the multi-agency consortium comprised of TxDOT, METRO, City of Houston, Harris County, and the Houston-Galveston Area Council, which are currently implementing this plan.

5.0 REFERENCES

1. *National Program Plan for Intelligent Transportation Systems*, Final Draft, U.S. Department of Transportation, 1995.
2. *Operation TimeSaver*, Press Kit, U.S. Department of Transportation, January 1996.
3. Goolsby, Merrell E. and William R. McCasland, *Immediate Action Program, Houston ITS Priority Corridor Program Plan*, Research Report 2931-1, Texas Transportation Institute, 1995.
4. Goolsby, Merrell E. and William R. McCasland, *Houston ITS Priority Corridor Program Plan*, Research Report 2931-2, Texas Transportation Institute, 1995.

APPENDIX A. ITS PARTNERSHIP AGREEMENT

HOUSTON, TEXAS PRIORITY IVHS CORRIDOR

IVHS Partnership Agreement

between

The Federal Highway Administration

and

The Texas Department of Transportation

Project No. IVH-9348(305)

The purpose of this Agreement is to award a grant of Federal assistance to the State of Texas (State) for certain specific Intelligent Vehicle Highway System (IVHS) activities relating to the Houston IVHS Priority Corridor, and to maximize the involvement of the State and other project participants in the IVHS program, as authorized by P. L. 102-240, Sections 6053(a), 6055(d), and 6056(a) (23 USC 307 note). The parties to this Agreement are independent contracting parties, and nothing in this Agreement shall be deemed to create a business partnership for purposes of sharing profits and losses.

1. Estimated Cost

The State shall be reimbursed for allowable costs incurred in the performance of work under this IVHS Partnership Agreement in an amount not to exceed \$3,105,000 in Federal IVHS funds. This amount shall be matched at an 80/20 (Federal/non-Federal) ratio, resulting in a matching share valued at not less than \$776,250. Reimbursement for costs incurred will follow regular Federal-aid billing and payment procedures.

2. Responsibilities of the State

In conformance with approved Work Orders (see paragraph 3 below), the State shall perform, or cause to be performed, the following:

a. Development and Maintenance of the Houston IVHS Priority Corridor Program Plan

Management of the Houston IVHS Priority Corridor is envisioned as the responsibility of key State and local officials (principally TxDOT, the City of Houston, Houston METRO, Harris County, and the Houston-Galveston Area Council) in cooperation with US DOT participants. These parties have been working together over a number of years to develop a full-featured

transportation management concept which will serve needs such as provision of traveller information, public transportation and ridesharing, and commercial vehicle-oriented elements. The IVHS Priority Corridor Program Plan will document the comprehensive vision for IVHS applications within the Corridor, specifically addressing what IVHS elements will be showcased. Projects, schedules, priorities, and estimated funding needs should be identified. The Priority Corridor Program Plan should break the IVHS vision for the area into realizable segments or incremental capability levels for implementation, each building on the previous segment or capability level. An extended series of projects/tests should be described in the Priority Corridor Program Plan, which would make the Corridor an IVHS test bed and showcase, with sustained deployment of IVHS services and technologies as they become available. The Priority Corridor Program Plan should be closely coordinated with the needs of the national IVHS program as defined in the US DOT Strategic Plan and the National IVHS Program Plan.

Eligible activities included under this item are expected to include overall project management, coordination, and public information / public relations efforts associated with the IVHS Priority Corridor in Houston. In addition, establishment of a systems integration function is envisioned. This would provide for oversight and technical assistance for coordination, communications, and integration of the various IVHS-related projects in the Corridor.

b. Development and Implementation of Selected High-Priority IVHS Operational Tests

The Houston IVHS Priority Corridor officials have identified several IVHS operational test projects having early implementation opportunities. The IVHS Priority Corridor Program Plan discussed above will identify additional opportunities. Specific work tasks, schedules, budget, evaluation goals, and responsibilities will be defined in Work Orders proposed by the State and approved by the FHWA. Beyond currently anticipated opportunities, additional high-priority operational test proposals may be proposed and approved under this IVHS Partnership Agreement, as funding limitations allow.

3. Work Orders

Individual activities agreed to be performed by the State or caused to be performed by the State shall be incorporated in Work Orders. Each Work Order will specify the work and goals to be accomplished and the type and amount of assistance to be provided by the FHWA. Each Work Order must include a description of the work (addressing clearly the technical, institutional, and evaluation goals and objectives to

be included), completion dates for the work, and the signatures of the FHWA Division Administrator and an authorized representative of the State indicating acceptance of the Work Order prior to initiation of any work described therein. Issuance of a Work Order does not constitute a promise, either expressed or implied, that the FHWA will issue further Work Orders or provide additional assistance pursuant to this IVHS Partnership Agreement.

4. Period of Performance, Modifications, and Project Completion

The period of performance and completion date for each task or activity is as stated in the Work Orders. It is expected that this IVHS Partnership Agreement will remain in effect at least through fiscal year 1997, which is the last year of IVHS funding authority currently provided to FHWA under P. L. 102-240 (the Intermodal Surface Transportation Assistance Act [ISTEA] of 1991). Modifications of this Agreement may be made, but no promise, either expressed or implied, is made at this time that FHWA will provide additional funding beyond that specified in paragraph 1. The US DOT will make decisions regarding additional funds under this Agreement (per Section 6056 of the ISTEA; "IVHS Corridors Program") based upon the overall quality of the Corridor's technical and institutional program and the degree to which the proposed activities contribute to achieving the National IVHS Program Plan.

A final project evaluation report shall be delivered within six months from the date of completion of the final Work Order and shall constitute completion of the project. The evaluation report is to include a review of the work completed and a discussion of the technical and institutional issues encountered in completing the project.

5. US DOT Participation

The FHWA and the Federal Transit Administration (FTA) shall be considered full participants in the project. As such, these agencies shall be a voting member of appropriate project management committees as they develop. The FHWA and the FTA shall be provided the opportunity for membership on all sub-committees, working groups, task forces, and other such groups related to the project. The FHWA and the FTA will provide names, addresses, and phone numbers of committee representatives to the State Program Manager as required.

6. Project Documentation and Reporting Requirements

Copies of all project reports, correspondence, meeting announcements, and other documents shall be supplied directly to the FHWA. In addition, brief monthly progress statements and quarterly reports summarizing work performed, significant events, expenditures, and progress of work shall be supplied to the FHWA. The FHWA will provide names and addresses of specific contacts to receive these documents.

7. Evaluation Work Plans

The funding provided by this IVHS Partnership Agreement for individual operational test efforts shall include an appropriate amount for a comprehensive evaluation. An evaluation work plan for each operational test shall be developed and submitted for FHWA approval, normally within eight (8) weeks after the approval of the Work Order which initiates the test. Each evaluation plan shall discuss the scope and method of evaluation for each funded activity. The plan(s) should also assess the opportunity to collect data that can answer questions of both local and national significance. The FHWA will participate in the evaluation of the work performed. As appropriate, the final report for each evaluation shall include a section prepared by legal counsel reporting and analyzing the disposition of significant legal issues, including contract, liability, privacy, regulatory and intellectual property issues. In addition, analysis of all significant institutional issues which are addressed during the project, along with discussion of how they were resolved, shall be part of the evaluation report.

8. Programmatic Changes

The State must obtain the prior approval of the FHWA whenever any significant change is anticipated. These include, but are not limited to:

- a. Any revision of the scope, goals or objectives of the consultant contract or related activities (regardless of whether there is an associated budget revision requiring prior approval); and
- b. Changes in key personnel, program manager, or prime contractor.

9. Intellectual Property

Intellectual property consists of copyrights, patents, and any other form of intellectual property rights covering any data bases, software, inventions, training manuals, systems design or other proprietary information in any form or medium.

Copyrights. The FHWA reserves a royalty-free, nonexclusive and irrevocable license to reproduce, publish or otherwise use, and to authorize others to use, for Federal Government purposes:

- (a) The copyright in any works developed under this Agreement, or under a subgrant or contract under this Agreement; and
- (b) Any rights of copyright to which the State, its subgrantee or contractor purchases ownership with Federal financial assistance provided by this Agreement.

Patents. Rights to inventions made under this Agreement shall be determined in accordance with 37 C.F.R. Part 401. The standard patent rights clause at 37 C.F.R. §401.14, as modified below, is hereby incorporated by reference.

- (a) The terms "to be performed by a small business firm or domestic non-profit organization" shall be deleted from paragraph (g)(1) of the clause;
- (b) Paragraphs (g)(2) and (g)(3) of the clause shall be deleted; and
- (c) paragraph (1) of the clause, entitled "Communications" shall read as follows:
"(1) Communications. All notifications required by this clause shall be submitted to the FHWA Division office.

10. Costs

The State shall limit its progress claims and final claims to those costs incurred in accordance with this IVHS Partnership Agreement, and shall submit its final claim within 90 days after the project is completed.

11. Additional Requirements

The State shall comply with all applicable laws, regulations and FHWA requirements, including but not limited to 49 C.F.R. Parts 18, 20, 21, 27, and 29, and the assurances in OMB SF 424B attached hereto as Appendix A.

12. Certification Regarding Lobbying

The State makes the certification regarding lobbying which is attached hereto as Appendix B.

13. Termination

The State shall notify FHWA immediately of any intent to terminate this IVHS Partnership Agreement.

14. Effective Date

This IVHS Partnership Agreement is effective upon execution by both parties.

Texas Department of Transportation

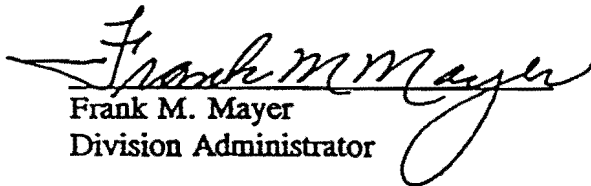
Executed for the Executive Director and approved by the Texas Transportation Commission under the authority of Minute Order No. 82513 and Administration Order 15-88, for the purpose and effect of activating and/or carrying out the orders, established policies or work programs heretofore approved by the Texas Transportation Commission under the authority of Minute Order No. 100002.



Roger B. Welsch
Associate Executive Director, Field Operations

Date 9-7-93

Federal Highway Administration



Frank M. Mayer
Division Administrator

Date 9/8/93

ATTACHMENT 1

Houston, Texas, IVHS Priority Corridor

Amendment 1 to the

IVHS Partnership Agreement
between

The Federal Highway Administration
and

The Texas Department of Transportation

Project No. IVH-9348(305)

The Federal Highway Administration (FHWA) hereby provides the State of Texas Department of Transportation (State) with additional Federal assistance funding to support the activities being undertaken as part of the Houston, Texas, Priority IVHS Corridor Program pursuant to 23 USC 307. This document hereby amends sections 1 and 2 of the Intelligent Vehicle Highway Systems (IVHS) Partnership Agreement signed between FHWA and the State on May 11, 1993. All other sections of the original IVHS Partnership Agreement remain in full force.

1. Estimated Cost. The State shall be reimbursed for allowable costs incurred in the performance of work under this IVHS Partnership Agreement in an amount not to exceed \$2,000,000 in Federal IVHS funds. Funding under this Partnership Agreement is available as follows:

| | |
|-------|---|
| | \$ 3,105,000 - FY 1993 |
| | \$ 2,000,000 - FY 1994 (This Amendment) |
| Total | \$ 5,105,000 |

This total amount shall be matched at a minimum 80/20 (Federal/non-Federal) ratio, resulting in a minimum matching share valued at \$ 1,276,250. Reimbursement for costs incurred will follow regular Federal-aid billing and payment procedures.

2. Responsibilities of the State. In conformance with approved Work Orders (see paragraph 3), the State shall perform, or cause to be performed the activities described in the February 23, 1994 letter from Mr. Gary K. Trietsch to FHWA Technology Assistance Engineer C. L. Chambers. In addition to on-going IVHS activities initiated utilizing funds provided in FY 1993, efforts planned by the State and tentatively supported by this Agreement for FY 1994 include projects concerning:

- a. Advanced Traveler Information for Commercial Vehicles
- b. Dynamic Lane Assignment Controls on Frontage Roads (A System for Traffic Diversion Within the Priority Corridor)

- c. Automatic Vehicle Locator (AVL) System for Incident Management
- d. On-Vehicle Navigation/Information Applications
- e. Monitoring and Information Systems for Environmental Conditions

This amendment is effective upon execution by both parties.

Texas Department
of Transportation

Federal Highway Administration



Division Administrator

Title: Assistant Executive Director
Field Operations

Date July 1, 1994

Date _____

Houston, Texas, ITS Priority Corridor
 Amendment 2 to the
 ITS Partnership Agreement
 between
 The Federal Highway Administration
 and
 The Texas Department of Transportation
 Project No. IVH-9348(305)

The Federal Highway Administration (FHWA) hereby provides the State of Texas Department of Transportation (State) with additional Federal assistance funding to support the activities being undertaken as part of the Houston, Texas, Priority Intelligent Transportation Systems (ITS) Corridor Program pursuant to 23 U.S.C. 307. This document hereby replaces section 1 and amends section 2 of the ITS Partnership Agreement executed between FHWA and the State on May 11, 1993, and amended on July 6, 1994. All other sections of the original ITS Partnership Agreement and Amendment 1 remain in full force.

Section 1 is replaced in its entirety by the following:

1. Estimated Cost. The State shall be reimbursed for allowable costs incurred in the performance of work under this IVHS Partnership Agreement in an amount not to exceed \$7,355,000 in Federal IVHS funds. Funding under this Partnership Agreement is available as follows:

| | |
|-------|---|
| | \$3,105,000 - FY 1993 |
| | \$2,000,000 - FY 1994 (Amendment 1) |
| | <u>\$2,250,000</u> - FY 1995 (This Amendment) |
| Total | \$7,355,000 |

This total amount shall be matched at a minimum 80/20 (Federal/non-Federal) ratio, resulting in a minimum matching share valued at \$1,838,750. Reimbursement for costs incurred will follow regular Federal-aid billing and payment procedures.

Section 2 is amended by the following:

2. Responsibilities of the State. In conformance with approved Work Orders (see paragraph 3), the State shall perform, or cause to be performed, the activities described in the February 13 letter from Mr. Edward G. Schroeder to FHWA Division Traffic Operations Engineer, Mark D. Olson. In addition to on-going ITS activities that were initiated with funds provided in fiscal

years 1993 and 1994, efforts planned by the State and tentatively supported by this Agreement for FY 1995 include projects concerning:

- a. Integrated Corridor Transportation Management and Traveler Information System; and
- b. Washburn Tunnel Traffic Management and Information System.

This amendment is effective upon execution by both parties.

Texas Department
of Transportation

Federal Highway Administration

Robert Chiles

Francis M. Wagner

Assistant Executive Director
for Field Operations

Division Administrator

Date 6-16-95

Date 6/27/95

HOUSTON ITS PRIORITY CORRIDOR

**Amendment Number 3
to the
ITS Partnership Agreement
between
The Federal Highway Administration
and
The State of Texas Department of Transportation**

Project No. IVH-9348(305)

The purpose of this amendment is to award a grant of Federal assistance to the Texas Department of Transportation (State) for specific Intelligent Transportation Systems (ITS) activities being undertaken as part of the Houston, Texas ITS Priority Corridor Program pursuant to 23 U.S.C. 307. This document hereby replaces section 1 and amends section 2 of the ITS Partnership Agreement executed between FHWA and the State on May 11, 1993 and amended on July 6, 1994 and June 27, 1995. All other sections of the original ITS Partnership Agreement and Amendments 1 and 2 remain in full force.

Section 1 is replaced in its entirety by the following:

1. Estimated Cost. The State shall be reimbursed for allowable costs incurred in the performance of work under this ITS Partnership Agreement in an amount not to exceed \$13,612,000 in Federal ITS funds.

| | |
|------------------|-----------------------------------|
| \$ 3,105,000 | FY 93 (original Agreement) |
| 2,000,000 | FY 94 (Amendment Number 1) |
| 2,250,000 | FY 95 (Amendment Number 2) |
| <u>6,207,000</u> | FY 96 (Amendment Number 3) |

Total \$13,562,000

This amount shall be matched at an 80/20 (Federal/non-Federal) ratio, resulting in a matching share valued at not less than \$3,390,500. Reimbursement for costs incurred will follow regular Federal-aid billing and payment procedures.


Section 2 is amended by the following:

2. Responsibilities of the State. In conformance with approved Work Orders (see paragraph 3 of the original Agreement), the State shall perform, or cause to be performed, the activities described in the Houston ITS Priority Corridor Program Plan. Efforts planned by the State and tentatively supported by this Agreement for FY96 include the following:
 - a. Incident Management and Traveler Information for Critical Roadway Links
 - b. ITS Technology for Data Collection and Transportation Planning
 - c. Integrating Transit into TranStar
 - d. Automatic Traffic Management in High Water Areas through Use of ITS Technologies
 - e. Public Information/Project Management

In addition, an effort to evaluate and/or develop an expert system or preplanned traffic management scenarios which change appropriate traffic control devices in response to freeway incidents may be initiated with these FY96 funds.

This amendment is effective upon execution by both parties.

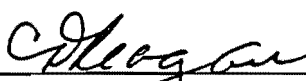
Texas Department
of Transportation



B.F. Templeton, P.E.
Assistant Executive Director,
Field Operations

Date June 10, 1996

Federal Highway Administration



C.D. Reagan
Division Administrator

Date 6/28/96

Executed for the Executive Director
and approved by the Texas Transportation
Commission under the authority of Minute
Order 100002 and Stand Alone Manual Notice
96-3, for the purpose and effect of activating
and/or carrying out the orders, established
policies or work programs heretofore approved
by the Texas Transportation Commission

**APPENDIX B. PROJECT DESCRIPTIONS
LISTED BY INTELLIGENT TRANSPORTATION
INFRASTRUCTURE CATEGORY**

**APPENDIX B. PROJECT DESCRIPTIONS
LISTED BY INTELLIGENT TRANSPORTATION
INFRASTRUCTURE CATEGORY**

0. ADMINISTRATIVE/PLANNING

- 0-1 Development of ITS Priority Corridor Program Plan
- 0-2 Public Information/Program Administration
- 0-3 Program Administration/Public Information/Project Development (2 Years)
- 0-4 ITS Technology for Data Collection and Transportation Planning
- 0-5 Integration of Priority Corridor Projects into TranStar
- 0-6 System Integration for FY 1997 Funded Projects
- 0-7 Program Administration/Public Information/Project Development (2 Years)
- 0-8 System Integration of Intermediate Range Projects into TranStar
- 0-9 Program Administration/Public Information/Project Development (3 Years)

1. REGIONAL MULTIMODAL TRAVELER INFORMATION CENTER

- 1-1 Real-Time Information Kiosks
- 1-2 On-Vehicle Navigation/Information Applications
- 1-3 Monitoring and Information Systems for Environmental Conditions
- 1-4 Dissemination of Traveler Information
- 1-5 Condition Responsive Uptown Traveler Information System
- 1-6 Using ITS Technology for Parking Management and Airport Area Traffic Management/Traveler Information
- 1-7 Expansion of Traveler Information Kiosks
- 1-8 Using AVI Technology for Best Route Selection in Clear Lake City
- 1-9 Using Advanced AVI Technology for In-Vehicle Traveler Information

2. TRAFFIC SIGNAL CONTROL SYSTEMS

- 2-1 Changeable Lane Assignment System (CLAS) on Frontage Roads
- 2-2 Changeable Lane Assignment System (CLAS) at Selected Intersections
- 2-3 Providing ITS Core Infrastructure in North and Northwest Growth Corridors
- 2-4 Expansion of CLAS Applications and Operations Integration
- 2-5 Arterial Street Traffic Management System Enhancements
- 2-6 AVI Monitoring of Arterial Street Traffic Operations

3. FREEWAY MANAGEMENT SYSTEMS

- 3-1 Monitoring Traffic and Transit Conditions and Incident Detection with AVI Technology (Phase 4)
- 3-2 Truck Monitoring and Warning Systems for Freeway to Freeway Connections
- 3-3 Integrated Corridor Transportation Management and Traveler Information System

- 3-4 Coordinated Ramp Metering and Intersection Traffic Signal Control
 - 3-5 Air Quality Monitoring to Evaluate Traffic/Air Characteristics
 - 3-6 AVI System Expansion
 - 3-7 Freeway Lane Control/Advisory Speed System
 - 3-8 Freeway/Arterial Corridor Management
 - 3-9 Traffic Monitoring System Using Unique CCTV Platforms
 - 3-10 Operation of Smart Vehicles for Traffic Management
4. TRANSIT MANAGEMENT SYSTEMS
- 4-1 En-Route Transit Information System
 - 4-2 Public Travel Security Infrastructure and Integrating Transit into Houston TranStar Center
 - 4-3 ITS-Based Scheduling, Reservation, and Dispatching of Personalized Public Transit
5. INCIDENT MANAGEMENT PROGRAM
- 5-1 Closed Circuit Television Surveillance System Lease for Astrodome Area
 - 5-2 Automatic Vehicle Locator System for Incident Management
 - 5-3 Washburn Tunnel Traffic Management and Information System
 - 5-4 Traffic Management and Traveler Information for Critical Roadway Links
 - 5-5 ITS Enhanced Incident Management
 - 5-6 Automatic Traffic Management in Flood Prone Areas Through the Use of ITS Technologies
 - 5-7 Automated Incident Management Strategies and Support Systems
 - 5-8 North Freeway/Hardy Toll Road Incident Management Through Toll Adjustment
 - 5-9 Development of Enhanced Incident Management Plan
 - 5-10 AVI Traffic Monitoring for Incidents
6. ELECTRONIC FARE PAYMENT (no projects)
7. ELECTRONIC TOLL COLLECTION
- 7-1 Priority Lane Pricing Using AVI
 - 7-2 Toll Plaza Monitoring and Remote Toll Collection
8. RAILROAD GRADE CROSSING CONTROLS
- 8-1 Railroad Grade Crossing Monitoring System
9. EMERGENCY MANAGEMENT SERVICES
- 9-1 Hazardous Materials Truck Monitoring and Routing
 - 9-2 Remote Incident Monitoring/Emergency Response Agencies

0. ADMINISTRATIVE/PLANNING

0-1 Development of ITS Priority Corridor Program Plan

Problem: The USDOT requires each Priority Corridor to develop a plan which provides a 20-year ITS vision and identification of deployment projects, schedules, and estimated costs. A plan is needed to guide funding and project implementation decisions.

Description: The objective of this study is to develop the Corridor Program Plan for the Houston ITS Priority Corridor. The study is a multi-year planning effort through 1998. The initial activity and the major effort will be the initial development of the plan, which will be completed in the first year. Annual updates of the plan will occur as deployment activities progress, new applications occur, and schedule revisions are made. This annual review and update is important in maintaining a viable Priority Corridor Program Plan.

Development of the Priority Corridor Program Plan will result from a cooperative effort of local governmental organizations, the private sector, and the Texas Transportation Institute. The Priority Corridor Program Plan is envisioned as a "living document," which will be periodically reassessed and updated based on experience with deployed projects and the evolving state-of-the-art of ITS.

Lead Agency: TxDOT

Estimated Cost: \$400,000

0-2 Public Information/Program Administration

Problem: Administrative support is needed to manage the multi-year Priority Corridor Program with its many individual projects. Similarly, a public information program will be needed to foster understanding and acceptance of the program and individual projects.

Description: In conjunction with the planning and deployment of ITS Priority Corridor projects, there is a need for an ongoing program administration and continuing public information effort by TxDOT. A Priority Corridor Program Office will be established with a project coordinator.

The coordinator will be responsible for providing support for the various ITS deployments, informing the participating agencies and sponsors of the progress of the Priority Corridors Program, and working with the news media to provide information to the general public. The coordinator will also be responsible for coordinating proposals for the continued efforts in the Priority Corridors Program.

Lead Agency: TxDOT

Estimated Cost: \$200,000

0-3 Program Administration/Public Information/Project Development (2 Years)

Problem: Administrative support is needed to manage the multi-year Priority Corridor Program with its many individual projects. Similarly, a public information program will be needed to foster understanding and acceptance of the program and individual projects. Pre-engineering support is also needed to refine individual projects into work orders and definitive project concepts.

Description: In conjunction with the planning and deployment of ITS Priority Corridor projects, there is a need for an ongoing program administration and continuing public information effort by TxDOT. A Priority Corridor Program Office has been established with a project coordinator. The coordinator is responsible for providing support for the various ITS deployments, informing the participating agencies and sponsors of the progress of the Priority Corridors Program, and working with the news media to provide information to the general public. The coordinator will also be responsible for coordinating proposals for the continued efforts in the Priority Corridors Program.

Project development activities will be supported as part of this project. It is expected that the agencies will contract for project refinement/pre-engineering services which would lead to project deployment (design and implementation).

Lead Agency: TxDOT/METRO

Estimated Cost: \$590,000

0-4 ITS Technology for Data Collection and Transportation Planning

Problem: The regional transportation planning process, coordinated by H-GAC, requires extensive traffic data to define travel characteristics and system performance. With the introduction of ISTEA's management systems, effective methods to capture and collect data at random sites with flexible methods are needed for monitoring and evaluation of the transportation infrastructure and to determine the effects of transportation control measures within the region. Data sources available through Houston TranStar Center will be useful to H-GAC's continuing planning, evaluation, and monitoring process.

Description: This project will develop a computer system to facilitate use of the database at the Houston TranStar in planning efforts. Data assembly and analysis could include historical trends in traffic characteristics, traffic sampling for special studies, summaries of operational measures, and before and after data for performance verification. This project would also equip vehicles with GPS, AVL, and AVI on-board technology to collect real-time traffic data for seamless access into a Geographical Information Systems (GIS) utilized by the MPO and other local agencies.

Lead Agency: H-GAC

Estimated Cost: \$300,000

0-5 Integration of Priority Corridor Projects Into TranStar

Problem: Development of the TranStar Center has created a unique operational facility upon which to overlay the Priority Corridor deployment efforts: TranStar permits coordinated operation and maintenance of ITS facilities by the four local transportation agencies from this common location. Concurrent with most priority corridor project deployment is the need to integrate them with TranStar systems.

Description: This project, and similar later integration projects, will assure that Priority Corridor deployments are designed and integrated to assure compatibility, inter-connectivity, and operational efficiency. TranStar's "principal integrator" will be responsible for the overall development of Houston TranStar computer systems and will coordinate TranStar integration and system development performed by others to ensure that all systems can function within the standards, guidelines, and established architecture.

Lead Agency: TxDOT

Estimated Cost: \$247,500

0-6 System Integration For FY 1997 Funded Projects

Problem: Most individual Priority Corridor Project deployments are to be operated from the multiagency TranStar Center. This creates the need for these projects to be integrated into the TranStar computer system to assure operational effectiveness.

Description: This project continues the systems support of Priority Corridor projects. TranStar's principal integrator will coordinate and support project integration efforts of others to ensure that system additions can function within TranStar standards, guidelines, and established architecture.

Lead Agency: TxDOT

Estimated Cost: \$550,000

0-7 Program Administration/Public Information/Project Development (2 years)

Problem: Project management and public information are needed to manage and deploy individual projects as the Intermediate Range Plan is implemented. In addition, a significant effort is also needed to refine project scope and conduct preliminary engineering tasks for individual tasks.

Description: In conjunction with the planning and deployment of the Priority Corridor projects, the Priority Corridor Program Office will continue to provide project management, public information, and coordination. In addition, project development activities, including development of work orders and the conduct of preliminary engineering, will be undertaken, leading to project design and deployment.

Lead Agency: TxDOT/METRO

Estimated Cost: \$500,000

0-8 System Integration of Intermediate Range Projects into TranStar

Problem: As the ITS system in the Houston area expands, there will be the concurrent need for systems integration efforts to provide effective operational support at TranStar and its appropriate operating agencies.

Description: This project will provide the continuing system integration support during the Intermediate Range period needed to coordinate and develop TranStar-based ITS projects. TranStar's "principal integrator" will be responsible for the overall systems development and integration of individual deployment projects to ensure that all systems can function within the standards, guidelines, and established architecture.

Lead Agency: TxDOT

Estimated Cost: \$1,400,000

0-9 Program Administration/Public Information/Project Development (3 years)

Problem: Project management and related support activities will be needed during the final three years of the Intermediate Range program.

Description: This project will provide the project administration, public information, and project development support of individual project deployment. These activities are a continuing support task of the Priority Corridor Program Office.

Lead Agency: TxDOT/METRO

Estimated Cost: \$600,000

1. REGIONAL MULTIMODAL TRAVELER INFORMATION CENTER

1-1 Real-Time Information Kiosks

Problem: ITS surveillance and communications systems will assemble active databases of information that would be valuable to travelers. Various traveler information delivery systems, including information kiosks, should be used to make real-time information available to travelers. Kiosks provide an excellent means to provide traveler information at the non-home end of a trip.

Description: Real-time traffic information (average speed, travel time) is available through the AVI system in the Houston TranStar Center. In addition, incident status information and transit schedule status will also be available from the TranStar Center. A primary purpose of this system is to provide real-time information on traffic conditions to commuters, travelers, and commercial operators. METRO will be implementing an automatic vehicle location (AVL) system with their regular route bus system in the near future. This will provide the opportunity for bus passengers and potential riders to obtain real-time information on the status of buses. The potential exists to greatly expand and enhance the availability of real-time traffic and transit information to a wide range of

users, allowing them to make more informed travel choices. Further, the real-time transit information could be provided in both visual and passenger activated audio formats to enhance the ability of visually impaired or disabled individuals to use public transit.

This project will focus on expanding the availability of real-time traffic and transit information to commuters, travelers, and commercial operators in the Priority Corridor area. Specifically, the project will deploy and test the use of real-time information kiosks at activity centers, provided to allow travelers and commuters to make more informed travel decisions. Thus, the demonstration will provide improved information to transit and roadway system users to help them select the best travel mode, travel route, and time of travel based on current traffic conditions and transit options. These kiosks will be located at ten major activity centers, such as transit centers, shopping centers, truck terminals, major office buildings, and other employment centers. Three different kiosk applications will be deployed, tailored to each location and traveler need.

Lead Agency: TxDOT

Estimated Cost: \$750,000

1-2 On-Vehicle Navigation/Information Applications

Problem: One of the most promising benefits of ITS is the ability to provide route guidance and real-time traveler information in vehicles. The Houston TranStar Center will be the focal point for databases on travel conditions and incidents in the Priority Corridor, and their information (particularly AVI-based freeway travel speeds) can be valuable for contemporaneous route decisions.

Description: One of the objectives of the ITS program is to provide current information on travel conditions to travelers at all stages of their trip. Operational tests relating to in-vehicle information systems are being conducted in other major cities, and the intent of this proposed program is to extend these concepts to the Houston Priority Corridor. TxDOT proposes to examine the results of national and international studies on in-vehicle information systems and the resultant products that are available and develop an operational test that will address a particular group of travelers within the Priority Corridor, the travelers that use the Houston Intercontinental Airport (IAH).

TxDOT will seek the support and participation of public and private industry in the development and operation of this project. An automobile manufacturer and a rental car agency have indicated an interest in developing a project in Houston that would extend the in-vehicle concepts developed for the TravTek project in Orlando. It is the intent of this project to provide support for the planning and coordination of a major demonstration project that may develop in the Houston area under the leadership of private sector providers.

Lead Agency: TxDOT

Estimated Cost: \$400,000

1-3 Monitoring and Information Systems for Environmental Conditions

Problem: The Houston area is subject to unpredictable and severe weather conditions that can result in extensive roadway flooding during periods of intense rainfall. Several freeways, frontage roads, and major arterials have a history of being closed due to flooding conditions during severe storms. The technology is currently available to provide real-time monitoring of these conditions to the TranStar Center, and this information could be used by TranStar Center personnel to make control decisions and distribute traveler information.

Description: A system will be implemented which monitors water levels at roadway locations which historically experience roadway flooding and the status of pumps which are automatically activated to pump low roadway areas (typically underpasses) which cannot be drained through gravity flow systems. Harris County Flood Control District has 80 stream-level and rainfall gages which are continuously monitored and could be integrated into the TranStar Center's database, as well as correlated with flooding at critical roadway locations. In addition to monitoring roadway and waterway conditions, the availability of real-time weather radar and National Weather Service alerts would provide for advanced warning of severe conditions that may impact roadways. Because unpredictable and variable weather conditions occur at all times of the year, the implementation of such a system could be a useful component of an Advanced Traveler Information System.

This project will integrate the electronic data stream from an existing Harris County Flood Control District network of stream-level and rainfall gages with a proposed system of devices which monitor roadway environmental conditions and the operational status of TxDOT's storm water pumping facilities.

Using these sources of real-time information on the status of general weather conditions and location-specific data, ATIS services will assist motorists in both pre-trip planning, as well as en-route response to advisory information on flooding.

Lead Agency: TxDOT

Estimated Cost: \$500,000

1-4 Dissemination of Traveler Information

Problem: Houston TranStar has initiated a variety of programs that produce data and information which can support traveler information systems. This information includes travel speed, incident locations, construction activities, and flooding locations. Information regarding each element is produced in real time which can be integrated into the TranStar system and then distributed to users in a variety of user compatible forms including graphics, text, and video.

Description: Distribution of several information types and delivery modes is envisioned for the project, and traveler information would be provided to private sector, as well as public sector organizations. Typical information processing/delivery systems envisioned include:

- Freeway Travel Speed Map–TranStar currently produces an RGB (computer-type) map, but a system will be developed to convert the map information into a format compatible with television equipment for use by the media (including the Municipal Channel).
- Text Information–Travel speed, incident, and construction information would be provided in text scroll bar format, which will provide more detailed information than can be provided in graphic formats.
- Flood Control Map–Harris County Flood Control District operates a real time monitoring system of rain gages and stream flow meters. This “Alert System” is now located in TranStar and will be integrated into TranStar computer and traveler information systems.
- Internet Site Enhancement–TranStar has an Internet site which posts real time data and travel time information. The information will be supplemented, and other improvements in the site will be made.

Lead Agency: TxDOT

Estimated Cost: \$483,750

1-5 Condition Responsive Uptown Traveler Information System

Problem: The Uptown area of Houston is the largest suburban business center in the United States. The resulting travel to and through Uptown now significantly influences the traffic operations of freeways and arterials in the area. Existing freeway and arterial traffic control and information signs do not provide the ability to fully manage traffic conditions and mobility in the Uptown area. The development and implementation of improved signing and information systems could enhance Uptown mobility and traffic operations by identifying and communicating the most advantageous routes.

Description: This joint public/private sector project will develop improved wayfinding systems to enhance the mobility and convenience of traveling for workers, shoppers, and visitors. Uptown’s private sector would develop and participate in the implementation of this system. The City of Houston has identified the need to better inform motorists and the Texas Department of Transportation in working to increase the effective utilization of the freeway network.

This project will include ITS applications, surveillance, and other components which can be integrated into TranStar. It ranges from static (traffic, transit, pedestrian) signing to real time travel information kiosks which communicate with TranStar. The project’s purpose is to: 1) inform travelers of the quickest available routes or facilities; 2) provide transit schedules and stop locations; and 3) communicate travel conditions and facilitate mobility by effective usage of available transportation facilities and services. Project boundaries would generally be Memorial Drive, the Southern Pacific Railroad tracks, Gulfton, and Chimney Rock. Infrastructure components could include static signing, CCTV surveillance, variable message signing, traveler information kiosks, cellular phone hotline, highway advisory radio (HAR), and traveler information via Internet.

Lead Agency: City of Houston

Estimated Cost: \$937,500

1-6 Using ITS Technology for Parking Management and Airport Area Traffic Management/Traveler Information

Problem: The high traffic and parking demands placed on major trip generators such as the Houston CBD and Houston Intercontinental Airport have traditionally required special planning, development, and operational approaches to accommodate this high demand. ITS technologies provide opportunities for increasing the efficiency of parking facilities and traffic operations in the vicinity of these two important areas.

Description: This project would apply the concepts of traffic management/traveler information systems specifically to Houston Intercontinental Airport (IAH) as a major traffic generator and intermodal transportation hub. This deployment would be a logical extension of core infrastructure deployment now underway in the Greater Houston area. Supplemental core infrastructure would include JFK Boulevard, Will Clayton Parkway, adjacent freeway connections, and other area arterial roadways. The key element of the system is the traffic management/information system. This function is viewed as an extension of the areawide ITS system, with the TranStar Center serving as a focal point. In addition, this project will test evolving ITS technologies for use in parking management at IAH and/or the Houston CBD. These technologies could include use of coinless payment systems (e.g., stored value cards, parking vouchers, in-car electronics, smart cards) and space occupancy detection for more efficient and cost effective parking system management.

Lead Agency: City of Houston

Estimated Cost: \$2,500,000

1-7 Expansion of Traveler Information Kiosks

Problem: The placement of traveler information kiosks in areas of high activity offers a promising means of delivering traveler information. Providing kiosks at locations where the information is most needed (i.e., office buildings, shopping malls, hospitals, truck terminals) can enable travelers to make mode, route, or departure time decisions. This project will build on the experience of Project 1-1, deploying additional kiosks at locations of greatest effectiveness.

Description: The Immediate Action Program (Project 1-1) will deploy ten kiosks. These kiosks will be deployed in various location types with varied information provided (e.g., traffic, transit). Experience gained with Project 1-1 will provide a basis for refinement and expansion of the kiosk approach to providing traveler information. It is anticipated that up to 50 additional kiosks will be deployed for displaying transit and/or traffic information. Private sector involvement is also expected and joint public/private development may increase the number of kiosks deployed.

Lead Agency: TxDOT/METRO

Estimated Cost: \$1,300,000

1-8 Using AVI Technology for Best Route Selection in Clear Lake City

Problem: Suburban centers, such as the Clear Lake City area of Houston, are a microcosm of the City's existing transportation system control and traveler information systems and needs. Clear Lake City is both a major residential community and a major employment center (NASA and related aerospace contractors). The arterial street system of Clear Lake City is not sufficient to accommodate the peak period traffic demands and could benefit from deployment of AVI and traveler information technology to better utilize the roadway system and serve traveler information needs.

Description: This project would utilize existing AVI technology to sample vehicle speeds on major arterials in the Clear Lake City area. In addition, train movements along the MKT railroad track parallel to State Highway 3 would be monitored, using AVI technology. This information would be processed and displayed in an easily understood format on Changeable Message Signs (e.g., direction of train travel and current location, speed on arterials, speed on arteries, speed on major arteries into and out of Houston CBD). The placement of the signs would be in strategic locations to allow the motorist to make informed route decisions, particularly during congested periods.

Lead Agency: City of Houston

Estimated Cost: \$1,600,000

1-9 Using Advanced AVI Technology for In-Vehicle Traveler Information

Problem: The most effective driver information system would deliver information specific to the vehicle's location and deliver it into the vehicle at, or near, a location where a route decision would need to be made.

Description: New developments in AVI technology (read/write) now provide for two-way communication with the added ability to provide communication from the roadside to within the vehicle. This project would investigate the effectiveness of providing information to selected persons using the AVI equipment. This would be comparable to similar information that could be displayed to all motorists on roadside changeable message signs and broadcast to all persons tuned in on either commercial radio or low-powered roadside highway advisory radio, except that this information will be location specific (to the site of the reader/transmitter).

Lead Agency: TxDOT

Estimated Cost: \$800,000

2. TRAFFIC SIGNAL CONTROL SYSTEMS

2-1 Changeable Lane Assignment System (CLAS) on Frontage Roads

Problem: Frontage roads are an essential element of design and operation on urban freeways in Texas. Because of high interchanging traffic demands, double turns from the frontage road are often

permitted. However, turning traffic demands are often highly variable throughout the day. In addition, freeway incidents often create high frontage road demands, as traffic diversion occurs from the mainlanes to the frontage roads.

Description: The objective of this project is to design, install, and evaluate 11 changeable lane assignment control systems that can alter the permissive double turns at frontage road intersections based on traffic demands. TTI developed a Changeable Lane Assignment System (CLAS) concept which used fiber optic lane use signing. These changeable (dynamic) lane use signs permit double turns when needed and then change to indicate normal lane use (turns permitted only from outer lanes) when appropriate. TxDOT installed a prototype CLAS system in Houston on the inbound frontage road of I-10 at Bingle/Voss. This CLAS installation provided reliable, effective control, and it is this lane use control system with certain improvements proposed for implementation on U.S. 290, as well as for replacement of the prototype installed on I-10. The proposed locations for the installations are 10 outbound intersections on U.S. 290 Northwest Freeway and one intersection on I-10 Katy Freeway. The system will operate in both pre-timed and responsive control modes with monitoring and control from the TranStar Center.

Lead Agency: TxDOT

Estimated Cost: \$750,000

2-2 Changeable Lane Assignment System (CLAS) at Selected Intersections

Problem: In the system of urban highway transportation facilities, the arterial street network is the backbone of the regional transportation infrastructure. Operation of an arterial's signalized intersections directly affects the capacity of an arterial street and the level of traffic service offered to its users. Development of an advanced traffic control technology will allow the signalized arterial street intersections to dynamically respond to the changing demand of turning traffic existing at these locations.

Description: A priority corridor project has been proposed to deploy CLAS at arterial/arterial street intersections in Harris County. It is also the objective of this project to expand the deployment strategy to include traffic responsive operation of the traffic signal control system as well as the CLAS. Harris County will select two or three intersections to test CLAS deployment in operational treatments not included in the earlier CLAS deployment along freeway frontage roads. There are four potential CLAS applications which may be tested in this project: arterial/arterial intersections; interior approaches of arterial streets with wide median separations; arterial network to provide capability of dynamic traffic diversion as an incident traffic management alternative; and to explore the possibility of developing traffic responsive algorithm and guidelines for real-time integrated CLAS and signal control system.

Lead Agency: Harris County

Estimated Cost: \$250,000

2-3 Providing ITS Core Infrastructure in North and Northwest Growth Corridors

Problem: The data communications system is one of the key elements of ITS core infrastructure. Fiber optic cable is being deployed extensively in the Corridor to support CTMS, RCTSS, and other ITS systems. There is a need to extend the fiber optic cable system in to the north/northwest area to provide expanded coverage and to close the redundant ring communication infrastructure.

Description: This project will extend the communications infrastructure now under development by local agencies to support the CTMS, RCTSS, and other ITS applications. The project will connect the I-45 North and U.S. 290 single mode fiber optic cable systems to both extend communications into the County and provide the redundant loop needed for contingent systems operations. Extension of this cable system will enable extension of the RCTSS and other ITS technologies to serve the congested areas of north and northwest Houston and connect to the TranStar Center.

Lead Agency: Harris County

Estimated Cost: \$2,400,000

2-4 Expansion of CLAS Applications and Operations Integration

Problem: Two projects of the Immediate Action Program will utilize Changeable Lane Assignment Systems (CLAS) for control of freeway frontage road intersections and arterial street intersections, respectively. If findings from these two projects are promising, then further deployment and extension to other applications should be undertaken.

Description: This proposed project would provide for wider deployment of CLAS, as well as expansion of the capabilities of CLAS. It is envisioned that the U.S. 290 CLAS would be enhanced to include automatic traffic responsive operation (e.g., phasing and timing) to complement freeway incident detection and incident management. This project would also deploy CLAS at freeway interchanges and arterials with unique geometric and operational characteristics.

Lead Agency: TxDOT

Estimated Cost: \$2,000,000

2-5 Arterial Traffic Management System Enhancements

Problem: Freeway management systems in the Houston area have the capability to monitor freeway traffic conditions and freeway incidents and to make control and traveler information decisions. These actions could result in diversion to the arterial system and the need for coordinated control between freeway and arterial streets. Local transportation agencies are deploying the RCTSS which will provide significant flexibility in arterial street traffic control. However, the RCTSS will not have the surveillance and traveler information capability which is comparable to the freeway management systems to which they will be related.

Description: This project would extend the concepts of areawide traffic management, incident management, and traveler information systems to the arterial street network. The RCTSS would serve as the control and communications backbone, but would be enhanced by the use of CCTV,

variable message signs, and changeable lane assignment signs for incident and recurrent congestion management. A suburban area would be identified for deployment of an arterial traffic management system.

Lead Agency: Harris County or City of Houston

Estimated Cost: \$2,200,000

2-6 AVI Monitoring of Arterial Street Traffic Operations

Problem: Automatic vehicle identification (AVI) systems have been deployed extensively on the Houston area freeway systems, providing a comprehensive real-time picture of traffic conditions. The AVI system has been expanded to also include monitoring of METRO HOV lane operations and park and ride facilities. Other Priority Corridor projects will evaluate AVI capability to detect freeway incidents and to monitor arterial street traffic (Hempstead Road).

Description: Previous deployments and their operational evaluations will provide the foundation for this project, which will deploy AVI technology for monitoring traffic operations on the arterial street system. Deployment will focus on selected major arterial facilities. Evaluations will be conducted to assess the effectiveness of this traffic monitoring system and its potential applications in an areawide traffic management/traveler information system.

Lead Agency: TxDOT/City of Houston

Estimated Cost: \$3,100,000

3. FREEWAY MANAGEMENT SYSTEMS

3-1 Monitoring Traffic and Transit Conditions and Incident Detection with AVI Technology (Phase 4)

Problem: The Houston Priority Corridor has been instrumented with Automated Vehicle Identification (AVI) Systems designed to measure travel times and average speeds on the freeway (mainlanes) and HOV lanes. The monitoring stations have an average spacing of 4.8 kilometers (3 miles) and do not provide sufficiently detailed travel time information for use in automatic incident detection/management. In addition, there is a need for the AVI system to monitor transit activity at major transit facilities.

Description: This project proposes to provide a traffic monitoring system using AVI technology to monitor the following applications: transit vehicle schedules from High Occupancy Vehicle (HOV) lanes' access points to Park and Ride Facilities and from transit terminal facilities for shuttle bus operations; traffic conditions on arterial streets that serve as alternate routes to the freeway system; and freeway incident detection for traffic incidents that block one or more lanes.

The traffic data collected from the ramps and roadways with the expanded AVI coverage will enhance the travel time information used to advise motorists of alternate routes, assist emergency

response agencies in incident management procedures, and inform transit agencies and HOV lane users of travel conditions.

Lead Agency: TxDOT

Estimated Cost: \$1,831,250

3-2 Truck Monitoring and Warning Systems for Freeway to Freeway Connections

Problem: Direct connections in freeway to freeway interchanges are a major source of traffic congestion and safety concerns. Because the design speeds on these connections are usually lower than the design speeds on the mainlane roadways and approaches, traffic tends to enter the connection curves at higher than desired speeds. High speed vehicles, particularly trucks, can lose control or turn over in these connections. An active detection/warning system could serve to reduce the occurrence of truck accidents on freeway to freeway connections.

Description: The project proposes to apply speed measurement and vehicle classification technologies on the approaches to and within freeway to freeway connectors that have sections with low design speeds. These monitoring systems will detect large trucks and determine their spot speeds. A data processor will identify trucks and determine if the conditions are critical for maintaining control of the vehicle through the connection. If the spot speed is too high for conditions, warning systems are activated to advise the driver to reduce his speed. The warning systems proposed would be dynamic to increase the target value and the compliance to what will be an advisory speed limit. New techniques for displaying messages on roadsides may be enhanced by also exploring methods of communicating to the driver within the vehicle.

Lead Agency: TxDOT

Estimated Cost: \$220,000

3-3 Integrated Corridor Transportation Management and Traveler Information System

Problem: The Houston Priority Corridor program has proposed a number of deployment projects in the Integrated Corridor Project area (Northwest Corridor). There is an opportunity and a need to integrate these projects and build upon them with additional system deployment to provide an “integrated” approach to multimodal transportation operations, incident management, and traveler information in a single geographic corridor (U.S. 290/Hempstead Road). The operational concept of the Integrated Corridor Project is to focus within one geographic corridor, a number of ITS concepts and technologies, most of which are complementary and synergistic. The core infrastructure developed in the Integrated Corridor will provide the ability to monitor traffic conditions, operate traffic control systems, and communicate current operational conditions to travelers.

Description: The project proposes to deploy, operate, and evaluate various traffic and transit monitoring, transportation management, and traveler information systems on: U.S. 290 Northwest Freeway mainlanes, HOV lanes, and frontage roads; the parallel Hempstead Road; and other arterial streets in the Northwest Corridor from FM 1960 to I-610 West Loop.

The proposed integrated corridor approach will apply ITS technologies and applications individually and on a system basis. These technologies include: CCTV, AVL, vehicle and railroad monitoring with AVI, variable message signs, highway advisory radio, and in-vehicle communications.

Lead Agency: TxDOT/METRO

Estimated Cost: \$1,862,500

3-4 Coordinated Ramp Metering and Intersection Traffic Signal Control

Problem: Ramp metering is soon to be implemented along the Houston freeway corridors as part of the Computerized Traffic Management System (CTMS), becoming an integral part of the Freeway Traffic Management Systems (FTMS). Currently, signalized intersections, including the frontage road signals, and the ramp meter signals are not coordinated. This lack of coordination between the systems does not provide for the efficient management of traffic during the peak periods or in the event of an incident that would require the metering of traffic entering the freeway.

Description: This project would deploy and evaluate concepts and strategies for interrelating traffic signal and ramp metering signal operations. Operational concepts would include routine operating conditions and incident management conditions. The “Smart Diamond” controller being developed by TTI would be considered for deployment on this project. Coordinated control created between the frontage road traffic signals and the ramp meter signals, as well as possible coordination between ramp meter signals, will add functional and more efficient metering control to the system that exists today. This project will develop, deploy, and evaluate a coordinated control of a Houston area freeway on a selected section. The evaluation will include a comparison of the existing system to the coordinated system.

Lead Agency: TxDOT

Estimated Cost: \$362,500

3-5 Air Quality Monitoring to Evaluate Traffic/Air Characteristics

Problem: One of the criteria for selection of priority corridors was that the area have unacceptable air quality conditions. There is a need to be able to relate transportation operational conditions to air quality and to integrate this information into transportation management and traveler information systems. For example, some urban areas declare “ozone alerts” based on prediction of areawide air quality conditions. Typically, such alerts are intended to lead to trip reductions through areawide mode shifts to carpooling or transit.

Description: This project will investigate and apply state-of-the-art air quality sensing technologies to determine the characteristics and interrelationships of air quality and traffic operations, potentially on both a large and small area basis. These characteristics and relationships could be utilized in a real-time air quality monitoring program which could be used in making transportation management decisions.

Lead Agency: TxDOT/H-GAC

Estimated Cost: \$660,000

3-6 AVI System Expansion

Problem: The current multi-stage development of Automatic Vehicle Identification (AVI) will provide basic coverage of the freeway system in the Priority Corridor. This system provides travel time/speed data for use in traffic management and traveler information systems. However, it is anticipated that additional AVI reader stations will be needed as experience is gained with use of the AVI system and with analyses conducted on AVI reader data.

Description: It is proposed to install additional AVI readers and transponders in areas with high proportions of interchanging traffic (e.g., freeways near CBD, freeway/freeway interchanges), and at other locations. In addition, readers would be added at locations where more intensive data needs exist (e.g., areas of recurrent congestion, high accident locations). This AVI expansion will provide more specific information on traffic conditions by reducing the distance between successive reader locations, as well as intensifying coverage in areas of indicated need.

Lead Agency: TxDOT

Estimated Cost: \$1,760,000

3-7 Freeway Lane Control Signal/Advisory Speed System

Problem: Throughout the country, the use of freeway lane control signals is becoming a popular technique to warn motorists of downstream lane blockage and congested areas. Primary objectives of their use are to reduce the amount of forced merging, the arrival rate of vehicles at the back of the queue, and secondary accidents caused by the congested areas. The use of the lane control signals can be enhanced with the use of CCTV, variable message signs, and traffic reports provided over broadcast and highway advisory radio. A coordinated program of these technologies, coupled with a public information program, may effectively alter driver behavior and better manage congested areas that are caused by both specific incidents and recurring bottlenecks. Varying combinations of technology can be used to determine which are most effective in producing changes in driver behavior and what level of information and education is necessary to produce these changes.

Description: Lane control signals will be deployed on a selected freeway section to assess their effectiveness and acceptance on Houston freeways. In addition to the standard lane control signals that display green, yellow, and red indications, variable advisory travel speed could be posted upstream of a bottleneck and result in vehicles arriving at the back of queues more slowly and maintaining a more even flow through the congested area. This technique has been successfully implemented in Europe and resulted in reduced delays and secondary accidents. The variable advisory speeds will be evaluated to determine the acceptability of this information by drivers and the resultant changes in speeds.

Lead Agency: TxDOT

Estimated Cost: \$900,000

3-8 Freeway/Arterial Corridor Management

Problem: Under current deployment plans, METRO will install the RCTSS system for the I-45 North Freeway Corridor. Signal system monitoring and control capabilities will allow engineers the flexibility to divert traffic from the freeways onto arterials either manually or automatically in response to volume/occupancy changes on the arterials. This will provide the opportunity to integrate the monitoring of the freeway, frontage road, and arterial systems in the I-45 North Freeway Corridor for both incident and recurrent conditions using Shepherd Drive and Airline Drive as alternate routes.

Description: This project will develop traffic monitoring, information, and control systems in the North Corridor which will permit optimization of traffic in the corridor under incident and recurring congestion conditions.

By installing reliable, accurate, cost-effective detection systems, we can measure volumes and derive capacity estimates for the arterials. Understanding capacity on potential alternate routes will help the public choose alternate routes during incidents, construction, or special events. The detection systems also allow pre-defined traffic signal timing pattern adjustments in response to changes in volume and/or occupancy.

Integrating the signal system with the freeway management system will automate the coordination of system changes in case of incidents or planned events. An incident management and public information delivery plan developed for those corridors will include use of appropriately sized variable message signs guiding travelers on the arterial street network. A network of closed circuit television cameras placed at strategic locations will assist in verification of problems.

A similar concept for incident management on arterials will be developed as has been developed for the freeways. Whether the incident takes place on the freeway or on the street, the same tools and strategies will be used to move people around problems effectively.

Lead Agency: TxDOT/METRO

Estimated Cost: \$2,800,000

3-9 Traffic Monitoring System Using Unique CCTV Platforms

Problem: Closed circuit television has proven to be a valuable tool for freeway surveillance and freeway traffic management and is a key element of the TranStar Center. However, the TranStar CCTV coverage does not include all freeway segments and has other limitations due to physical restrictions. In addition, the system has limited capability in monitoring arterial streets by utilizing freeway cameras to view arterial cross streets.

Description: This public/private sector project will extend visual observation of transportation systems by strategically placing CCTV cameras on high-rise buildings and on mobile airborne units. Cameras would be placed on high rise buildings in urban activity centers such as the CBD, Galleria area, Greenway Plaza, and Texas Medical Center. Private sector support could provide local infrastructure deployment (i.e., cameras and communication links) which would be tied to the

TxDOT freeway fiber optic cable system. Use of CCTV on mobile airborne units would allow coverage of areas where freeway CCTV coverage is poor or non-existent. Airborne CCTV could be particularly useful in managing major incidents and providing timely traveler information. A partnership would be established in which the public sector would assist with capital costs of CCTV and communications with the private sector providing the mobile airborne unit.

Lead Agency: METRO

Estimated Cost: \$1,700,000

3-10 Operation of Smart Vehicles for Traffic Management

Problem: Communications between a central dispatch or control center (such as TranStar) and vehicles in the field is an important element in timely and effective traffic management. Voice communication is the primary means for providing information to and from these vehicles; thus the amount of information and its timeliness is significantly restricted. In addition to a need for expanded information exchange, emergency vehicles and transportation agency response vehicles could benefit from in-vehicle information such as real-time traffic condition/incident information and navigation aids.

Description: This project would develop extensive in-vehicle communication and information systems for local transportation and emergency response agencies. Other proposed Priority Corridor projects include expanding communications and information dissemination to emergency response agency operations centers and incident command vehicles. This proposed project will provide deployment for emergency vehicles and traffic management vehicles of TxDOT, City of Houston, and Harris County. These "smart cars" could also include instrumentation needed to better perform routine functions of the transportation agencies, such as automatic vehicle location, travel time data collection, and on-board computer for signal timing analysis, reprogramming, and downloading of signal pattern changes.

Lead Agency: TxDOT

Estimated Cost: \$2,800,000

4. TRANSIT MANAGEMENT SYSTEMS

4-1 En-Route Transit Information System

Problem: The National Program Plan for ITS has established a need for providing travel related information on traffic, transit, and roadway conditions by wayside communication's infrastructure. While the technology exists in component pieces, no experience from a full implementation on a transit fleet exists.

Description: This project will provide an infrastructure capable of identifying a moving transit vehicle by a roadside transponder and using the vehicle's identity to trigger an appropriate bi-directional exchange of transit rider information and vehicle data with the roadside device. The

service would include real-time information on traffic, transit, and roadway conditions by this device. The system could include traveler information for riders, next bus arrival kiosks at selected bus stops and transit centers, and transit fleet management information.

Lead Agency: METRO

Estimated Cost: \$712,500

4-2 Public Travel Security Infrastructure and Integrating Transit into Houston TranStar Center

Problem: This project addresses two needs of public transportation operations in the Houston Priority Corridor: passenger travel security and overall operational efficiency of METRO transit service. Personal safety and the feeling of security are important factors which affect transit ridership. A high level of security should be provided at boarding points and other passenger facilities in order to reduce crime and increase riders' sense of personal safety. In addition, transit operations should capitalize on the potential operational improvements the TranStar Center can provide.

Description: The goal of the Public Travel Security element of the project is to develop, implement, and evaluate the effectiveness of providing automated security at transit boarding points such as bus stops, transit centers, and park and ride lots. The objectives are to use currently available advanced technologies to respond to security needs at transit boarding points. The project will include deployment of CCTV cameras and call boxes at selected park and ride lots, transit centers, CBD transit streets, and in the Texas Medical Center. The fiber optic cable system now being implemented by TxDOT and METRO will provide the communications link with the CCTV and call boxes.

The second element of this project will integrate transit operations into the TranStar Center. The project will develop data and functional integration of transit information systems into TranStar, which collects freeway travel time, incident, and construction information. METRO is developing an Advanced Technology Program (ATP) server which collects all static bus information such as bus routes and schedules and is exploring other advanced technologies such as AVL. There will be a potential benefit in integrating data collected by each of these systems. Transit and traffic operations can have data and functional integration without physical integration. Transit and traffic operations do not need to be co-located to have effective and real-time communication between each other.

Lead Agency: METRO

Estimated Cost: \$3,080,000

4-3 ITS-Based Scheduling, Reservation, and Dispatching of Personalized Public Transit

Problem: Evolving ITS technologies yielded promising capabilities to manage and operate real-time systems for personalized transit service. Today's demand responsive systems (e.g., elderly and disabled persons) could be more effectively scheduled and dispatched by utilizing these advanced communications, computer, and operational hardware and software.

Description: This project will develop and test real-time scheduling, reservation, and dispatching systems utilizing state-of-the-art communications, computer, and automatic vehicle locator (AVL) systems. Systems will be assessed, developed, and integrated to provide an AVL-based demand responsive transit delivery system. Automated reservation systems and real-time scheduling and dispatching, together with AVL systems, offer the potential to better allocate vehicle resources and serve transit riders by continuously optimizing vehicle routing and maximizing the use of available capacity. This project will incorporate all the elements into a personalized public transit demonstration project which will be implemented and evaluated in a selected area.

Lead Agency: METRO

Estimated Cost: \$5,100,000

5. INCIDENT MANAGEMENT PROGRAM

5-1 Closed Circuit Television Surveillance System Lease for Astrodome Area

Problem: Transportation agencies traditionally install their own communications medium for transmission of video signals from Closed Circuit Television (CCTV) cameras located in the field. The installation of such systems require lengthy design periods, tedious approval processes, extensive field testing, and software development. As a result, the minimum construction period for such projects is two years. There is a need to find expedient approaches to development, operation, maintenance, and use of CCTV.

Description: The objective of this project is to expeditiously lease a turnkey CCTV system from a private organization utilizing existing communications media installed by the organization for other purposes. A survey of three potential bidders determined that a minimum lease of five years is required for such an arrangement to be feasible relative to public sector costs and private industry needs. The project will include the lease of a ten-camera CCTV in the Astrodome area to be used for transportation management of special events. An evaluation will be made of procedures used to secure the leased fiber optic system and services.

Lead Agency: TxDOT

Estimated Cost: \$480,000

5-2 Automatic Vehicle Locator System for Incident Management

Problem: TxDOT and Harris County, through the Motorist Assistance Program (MAP), currently operate a fleet of vans to patrol freeways and respond to incidents and disabled vehicles. The application of a fleet management system is essential for coordinated and effective operation. Quick response and effective dispatching of these units can reduce the time for emergency response and the time needed to restore normal traffic operations. The objective of this project is to increase the effectiveness of incident management by implementation of an Automatic Vehicle Locator (AVL) system which identifies vehicles and locations on a real-time basis.

Description: The project proposes to implement one of a number of available automatic vehicle locator systems that would provide the management information needed for vehicle dispatch, patrol assignments, and automatic information collection and storage. The project will increase the effectiveness of the program by providing dispatchers in the Transportation Management Center with continuous and accurate vehicle location information. With this information, dispatchers can quickly access availability and location of the nearest MAP vehicle, as well as being able to provide guidance on the best route to use when responding to an incident. The use of the AVL information as a traffic monitoring source will also be tested.

Lead Agency: TxDOT

Estimated Cost: \$100,000

5-3 Washburn Tunnel Traffic Management and Information System

Problem: The Washburn Tunnel was constructed under the Houston Ship Channel in 1950 to connect the cities of Pasadena and Galena Park and provides access to area industries as well as important linkage between major employers and the residential areas on both sides of the Ship Channel. Weekday traffic volumes through the tunnel are approximately 30,000 vehicles per day with directional (one lane) peak hour volumes of 1,400 vehicles per hour. These peak period traffic volumes approach capacity for the 6.7 meters (22-foot) wide roadway. The tunnel is approximately 1,220 meters (4,000 feet) long and has a maximum grade of six percent. An estimated 20 percent of the tunnel traffic consists of trucks, even though those carrying hazardous materials are prohibited. When incidents occur in the tunnel or its approaches, severe congestion results, and diversion to alternate routes is severely limited. The objective of this project is to implement automatic incident detection and closure systems for the tunnel and develop traveler information services to advise travelers of conditions at the tunnel.

Description: The proposed integrated, areawide traffic management and traveler information systems would extend over a large area in order to minimize the user impacts of tunnel closures. The project will include four implementation components: an incident detection system, automatic tunnel closure, areawide traveler information, and an AVI-based CVO permitting process. It is anticipated that visual imaging technology, such as the Mobilizer Advanced Tracking System, will be used for incident detection at three detection locations in the tunnel. Automatic gates would replace manually operated gates at the tunnel entrances.

Lead Agency: Harris County

Estimated Cost: \$950,000

5-4 Traffic Management and Traveler Information for Critical Roadway Links

Problem: There are some roadway system links in the Greater Houston and surrounding areas which, when road closures or capacity reductions occur, result in significant motorist delay and inconvenience. Typically, these critical links have no reasonable alternative routes, and diversion routes may be long and create extensive travel delays to the motorist. Many of the critical links in the area serve as evacuation routes in the event of a hurricane that approaches the Texas Gulf coast.

Description: This project will focus ITS technologies on critical roadway system links (e.g., Baytown Bridge, IH 45/SH 146 Interchange, SH 6, Galveston Causeway, IH 10 at the San Jacinto River Bridge, and US 59 South) where incidents and construction can have a severe impact on the traveling public. Each potential critical link serves as an evacuation route for hurricane evacuation, and incidents during evacuations can severely impact that process. These critical links would be equipped with CCTV, vehicle detection, changeable message signs, AVI, and HAR. In addition to the permanent ITS technology implemented in the field, a portable ITS Freeway Traffic Management System (FTMS) would be used for evacuation, major incidents, and during construction as a temporary FTMS. The portable FTMS would include CCTV, CMSs, video vehicle detection, and a portable HAR. By implementing some new infrastructure and a portable FTMS, traffic management through these critical roadway links will provide a safer and more efficient system to the traveling public.

Lead Agency: TxDOT

Estimated Cost: \$1,325,000

5-5 ITS Enhanced Incident Management

Problem: Accidents, stalled vehicles, and other incidents create a significant amount of vehicle and passenger delay on freeways. Effective management of these freeway incidents could significantly reduce delays and restore the freeway to normal operation sooner. Management systems could include rapid notification and deployment of special personnel and equipment needed for incident removal. Accident investigation and reporting are a routine part of incident management, yet the process has changed little in the last 50 years. The accuracy of information and reducing the time to complete accident investigations can be improved by using ITS technologies.

Description: This project will develop incident response, clearance, and traffic management strategies and the automated systems to support them. A communication system would be developed to transmit real-time data collected system-wide at the Traffic Management Center to TxDOT traffic operations and maintenance personnel, law enforcement agencies, fire departments, and emergency medical services (EMS) that may be responsible for managing or responding to an incident that impacts a regional arterial or freeway. These responsible agencies/persons would receive needed information (e.g., CCTV, AVI, traffic data) in their office or home (if on quick response team) to permit fast decisions and response to major incidents. Innovative driver communications, such as truck/trailer mounted CMS, CCTV camera, HAR, and traffic signals, would be deployed as a mobile unit for on-site incident management.

On-site incident management for major incidents would utilize a mobile command vehicle. This vehicle would allow for all the decision makers from the various agencies to assemble at a technical focal point. ITS technology, such as Highway Advisory Radio (HAR) for public traffic information and real time video, would be incorporated for instantaneous communication with TranStar.

In addition, advanced ITS equipped police vehicles would be deployed for the accurate and timely collection and dissemination of traffic accident information. Using AVL, investigating officers could transmit accurate accident location information directly to the TranStar Center. Pen-based notebook computers with wireless communication capability would be used to record and transmit

the accident report. This real-time accident reporting with accurate location information could be valuable in traffic management decisions by TranStar Center staff.

Lead Agency: TxDOT/METRO
Estimated Cost: \$387,500

5-6 Automatic Traffic Management in Flood Prone Areas through Use of ITS Technologies

Problem: The coastal areas of Texas are flat lands at low elevations and receive 138-150 centimeters (55-60 inches) of rain per annum. During these rain storms, Houston and Harris County areas become a parking lot of stalled cars in high water and commuters trying to find passable routes. Freeway underpasses are especially plagued by these problems. The objective of this project would be to significantly reduce major congestion problems in the Houston and Harris County area, when major arterials are blocked by high water, by using ITS technologies.

Description: It is anticipated that all of the intersections at major reroute nodes (15) would be updated to spread spectrum radios, microwave video with cameras, advanced traffic controllers (ATC) and (CLAS) in one electronic backplane. Existing and new water level detectors, operated by the Harris County flood control district, would be integrated with the Traffic Management Center. These devices would need to be interconnected with wireless radio equipment to fit the Traffic Operations Center (TOC). The water level detectors on the reservoir and upstream would signal when the arterials are submerged. The video surveillance system that is existing on the I-10 corridor would confirm these alarms. The traffic control operator could then initiate the contingency plan for the area affected.

Lead Agency: Harris County
Estimated Cost: \$1,200,000

5-7 Automated Incident Management Strategies and Support Systems

Problem: Freeway Management Systems (FMS) are operational or planned on essentially the entire Houston area urban freeway system. These systems include CCTV, vehicle detection, ramp metering, HOV lane control signals, and variable message signs. In addition, automatic vehicle identification (AVI) systems monitor travel time/speed information for freeway segments. FMS are monitored and operated from the Houston TranStar Center, which became operational in April 1996. The primary mission of TranStar is the detection, management, and removal of freeway incidents.

Incident detection and management currently rely primarily on operators and traffic engineers in the Center. There is a need to develop automated monitoring and traffic management tools which can guide and assist TranStar operating staff in managing incidents in the safest, fastest, and most efficient manner.

Description: This project will develop incident response, clearance, and traffic management strategies and automated systems to support them. This project will pre-plan "response scenarios" for a wide range of incident types, locations, and traffic conditions which occur on the freeway system. These scenarios, tailored for specific incident types and locations, would identify at-site

traffic control, ramp/lane closures, messages for variable signs, ramp metering strategies, and adjustment to frontage road traffic signals. By having these pre-planned “response scenarios,” TranStar staff can provide quicker, more accurate, and responsive incident management.

Lead Agency: TxDOT

Estimated Cost: \$750,000

5-8 North Freeway/Hardy Toll Road Incident Management through Toll Adjustment

Problem: The Hardy Toll Road and I-45 North (North Freeway) are generally parallel facilities in North Houston and converge near the Harris/Montgomery County lines. They are parallel for approximately 32 kilometers (20 miles) between their convergence and the I-610 North Loop. Changeable message signs presently are in place at the interchanges at both ends of this section. The physical proximity of the two facilities in an essentially common travel corridor provides an opportunity to coordinate their operation when major incidents occur, particularly on the North Freeway.

Description: The proposed project would develop operational and administrative approaches to encouraging diversion to the Hardy Toll Road when major incidents with significant capacity reductions occur on the North Freeway. It is conceivable that tolls on the Hardy Toll Road would be reduced during these incidents, with reimbursements (if revenues are reduced) made to the HCTRA from project funding. Guidelines would be developed for implementing “encouraged diversion,” and the impacts and benefits would be evaluated.

Lead Agency: TxDOT/Harris County Toll Road Authority

Estimated Cost: \$1,000,000

5-9 Development of Enhanced Incident Management Plan

Problem: METRO is developing a master plan for detecting, locating, and responding to traffic incidents. Another Priority Corridor Project will develop significant corridor ITS infrastructure in the I-45 North Freeway Corridor (including Shepherd and Airline Drive) for use in optimizing corridor traffic service. With the infrastructure in place (e.g., CCTV, RCTSS, vehicle detectors, and variable message signs), there will be a need to develop incident response plans unique to the North Freeway Corridor.

Description: This project proposes to develop and deploy a plan for the North Freeway utilizing the ITI systems that are in place and adding capabilities for alternate route diversion. Integration of the arterial signal system and addition of CCTV and VMS on the arterial network will assist in these efforts. Enhanced plans must take these new components into consideration.

The project will focus on improved incident-detection methods for arterials, quicker response by emergency vehicles by providing route assistance, and quicker clearance of accident scenes by approval and implementation of Houston TranStar's rapid removal policy. The goal of this project is to reduce incident clearance times by 50 percent.

Lead Agency: METRO

Estimated Cost: \$300,000

5-10 AVI Traffic Monitoring for Incidents

Problem: A pilot installation of AVI for use in incident detection is being implemented on US 290 as part of Priority Corridor Work Order 3. This system is to be evaluated in 1997 and 1998. If this pilot installation finds AVI to be a promising incident detection tool, this project could be used to expand freeway AVI and "integrated corridor" systems in the US 290 and I-45 North corridors, as well as supporting incident management on these freeways.

Description: The AVI systems on US 290 and I-45 North Freeways would be augmented for incident detection. The spacing of AVI reader stations and finalizing of the incident detection algorithm to be used would be based on findings of the evaluation study included in Work Order 3, as well as being consistent with corridor management systems in the I-45 North/Shepherd and US 290/Hempstead Road corridors.

Lead Agency: TxDOT

Estimated Cost: \$2,100,000

6. ELECTRONIC FARE PAYMENT (no projects)

7. ELECTRONIC TOLL COLLECTION

7-1 Priority Lane Pricing Using AVI

Problem: One of the criticisms of HOV lane operations and an inherent inefficiency is that unused capacity often exists, particularly under the 3+ persons per vehicle regime. One of the means of gaining higher usage of HOV lanes is the tolling or congestion pricing of the unused available capacity. Through congestion pricing, the tolls could be set to optimize usage of the HOV (priority) lanes.

Description: Priority Pricing is the selling of available capacity on a priority lane during the restricted hours of operation. The technology proposed is the AVI transponder system similar to that used to measure travel times on the freeways and HOVs. Special traffic monitoring software would be provided that would identify the authorized vehicles in the field so METRO Police could be

notified of a non-conforming vehicle using the HOV lane. The project would investigate the operational effectiveness of providing selective use of the HOV lane by pre-approved, non-conforming carpools, or single occupancy vehicles.

Lead Agency: METRO/TxDOT

Estimated Cost: \$462,500

7-2 Toll Plaza Monitoring and Remote Toll Collection

Problem: The Harris County Toll Road Authority (HCTRA) is modifying its mainlane toll collection facilities for high speed passage of toll tag vehicles. The typical toll plaza configuration will include two high-speed lanes, two stop-control lanes for manual toll collection, and three or more lanes for correct change collection.

Description: This project proposes to install advanced vehicle sensing and tracking systems on the approaches to the toll plazas to monitor and analyze in real-time the impact of the toll collection procedures. The monitoring system is important because of the high traffic volumes that urban toll roads must accommodate. Also, the new configuration, although increasing the capacity of the high-speed lanes, eliminates the opportunity for reversing lanes to gain capacity in the peak direction. Therefore, it is important that the available lanes are operated at peak efficiency to meet existing demands. The monitoring system will provide information to the toll plaza manager that can be used to make changes in the collection procedure to increase or decrease the vehicular capacity of the plaza.

The monitoring system will also be used to analyze and develop driver information and control systems to minimize the problems of high differential speeds in the transition area approaching the plaza and the high volume and high speeds that will result in the transition area leaving the plaza.

Lead Agency: HCTRA/TxDOT

Estimated Cost: \$700,000

8. RAILROAD GRADE CROSSING CONTROLS

8-1 Railroad Grade Crossing Monitoring System

Problem: Railroad grade crossings represent a major source of delay in Houston. There are numerous at-grade crossings that can affect traffic flow and safety on the arterial street system. The objective of this project is to examine how information systems and traffic control systems can be used to monitor the movements of trains and to adjust traffic patterns and advise emergency vehicles in the corridor to reduce delays at railroad at-grade crossings. On major bus routes and on routes frequently used by emergency vehicles, the additional travel times can be critical to their operations.

Description: This project proposes to monitor railroad train movements along one or more of these corridors: the Union Pacific rail line that parallels I-10 Katy Freeway and the Southern Pacific rail lines that parallel the I-610 West Loop Freeway and the US 290 Freeway/Hempstead Road. The monitoring systems will use AVI readers at selected locations to determine the position and identification of the train and to measure the travel times of trains moving along the lines. Advanced warning/information systems would be developed and implemented on approaches to selected intersections.

Lead Agency: TxDOT

Estimated Cost: \$500,000

9. EMERGENCY MANAGEMENT SERVICES

9-1 Hazardous Materials Truck Monitoring and Routing

Problem: Trucks traveling in the Houston-Galveston area require real-time information to determine traffic bottleneck points and to establish alternate routes where possible. While some of this information is available through radio broadcasts and automated signage, a more sophisticated method is needed to provide truck drivers with alternate route information. Because these trucks often transport hazardous materials, it is also desirable to monitor these movements to increase safety and emergency response efficiency.

Description: The objective of this project is to improve traffic management and enhance safety with existing ITS technology. Trucks selected to participate in this project will be linked electronically to Houston TranStar which will serve as the operations center. TranStar will provide truck drivers with real-time traffic information and alternate route information, and monitor hazardous material movements. The proposed test corridor is SH 255 between Beltway 8 and East Loop 610.

This project will enable truck drivers to use the transportation system more effectively which can ultimately reduce transportation costs and provide TranStar with a means to locate hazardous material incidents and to identify these materials before emergency responders arrive on the scene.

Lead Agency: Harris County

Estimated Cost: \$1,000,000

9-2 Remote Incident Monitoring/Emergency Response Agencies

Problem: Fire, police, and emergency medical services perform in a “time-critical” environment in which traffic information can be valuable in routing vehicles and operating at emergency scenes. TranStar has extensive real-time information systems (e.g., CCTV, MAP, vehicle detectors, environmental sensors, AVI travel time data), which are being further expanded and enhanced. This information can be important to emergency response agencies in performing their normal agency functions.

Description: This project will provide remote units and communications systems in the control (dispatch) centers of the City of Houston and Harris County emergency response agencies tied to the TranStar Center. This linkage can provide video, audio, traffic condition status, and incident information. In addition, the linkage of emergency agencies and TranStar can enhance response to major incidents, such as damaging storms or hurricanes, hazardous spills or releases, major traffic incidents, train derailments, or major fires.

Lead Agency: TxDOT

Estimated Cost: \$700,000

