

Project No. 9
Coordinated VMS/HAR Strategies

FINAL REPORT

Prepared by

I-95 Northeast Consultants

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I-95 Corridor Coalition

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Coordinated VMS/HAR Strategies

PART I
EXECUTIVE SUMMARY



I-95 Corridor Coalition

EXECUTIVE SUMMARY

While Variable Message Signs (VMS) and Highway Advisory Radios (HAR) are the two primary devices used to disseminate traffic information in the I-95 Corridor, there is little coordination among member agencies on the use of these devices. During incidents of Corridor significance, VMS and HAR are not always effectively deployed and fail to provide motorists with timely and accurate information. As a result, these devices have lost credibility with the public. Project 9, Coordinated VMS/HAR Strategies, of the I-95 Corridor Coalition Business Plan Elements, was therefore charged with the responsibility of developing a structure and deployment strategy for the overall coordination of VMS/HAR devices in the Corridor to meet the information dissemination needs of member agencies. This Final Report, prepared for the I-95 Corridor Coalition, documents the activities and findings of Project 9.

The main objective of Project 9 was to provide a consistent pattern for the use of VMS and HAR by Coalition member agencies. Motorists throughout the Corridor could then be provided with real-time, continuous, and consistent information on incidents of Corridor significance. This would enhance the use of VMS/HAR in the Corridor and increase motorist confidence in these devices.

This project is closely interrelated to Project 1, *Information Exchange Network (IEN)*, and Project 2, *Incident Management - Detection, Response, and Operations*. This interrelationship is illustrated in Figure 1. Motorist information (VMS and HAR) is one of the incident management issues that is addressed by Project 2. VMS and HAR are also an integral part of Project 1, the IEN. The procedures developed in Project 9 will be incorporated into Project 2. The data from Project 9 will be distributed on the IEN.

REVIEW OF ACTIVITIES

In developing a VMS/HAR deployment strategy, the initial responsibility of Project 9 was the collection of information on existing and planned VMS/HAR within the I-95 Corridor. Information collected on existing VMS and HAR operating policies, procedures, and practices for each Coalition agency was reviewed to determine areas of common practice and significant difference among member agencies. Information on the locations of existing and proposed HARs, VMSs, and TOCs were presented graphically on maps of the I-95 Corridor and are shown in the appendix to this report. All information obtained during the information collection process was

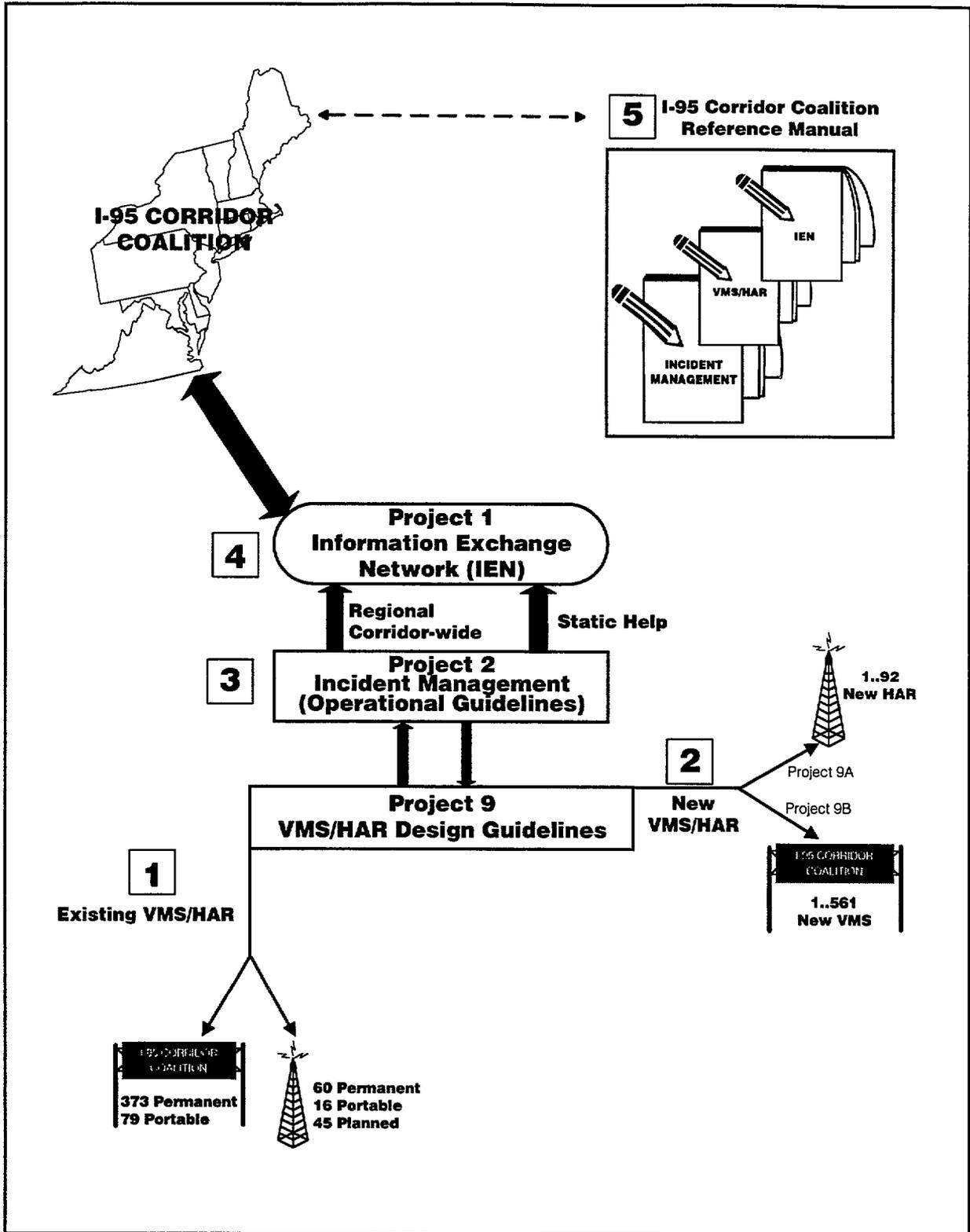


Figure I. Context diagram showing the interrelation among Projects 1, 2, and 9.

documented in the Operations, Policies, and Practices Coordination Workshop¹ notebook. The VMS/HAR information base provided the framework for developing a coordinated strategy for the operation of VMS/HAR within the Corridor. The main goal of the coordinated strategy was the development of recommendations for consistent application guidelines and messages.

A review and discussion of the information collected from member agencies took place at a one-day workshop that focused on the similarities and differences in VMS/HAR operations, policies, and practices within the Corridor. The workshop used an open forum to encourage discussion from participants on the issues listed below:

- Strategies for the effective utilization of VMS and HAR in the Corridor
- The control of Coalition financed VMS/HAR devices
- The importance of using VMS and HAR in tandem
- Strategies for improving the credibility of VMS/HAR
- The use of a common HAR frequency
- Standardized and filler messages
- Establishing an 800 Corridor telephone number

Based on the discussion at the workshop, an issues list identifying areas of consensus as well as areas where consensus could not be reached was prepared. The issues list served as a guiding document for the remainder of the project.

One of the focal points of Project 9 was the development of the manual titled VMS/HAR Operations Guidelines and Recommended Practices.² The manual provided a basic set of guidelines to assist the Coalition in achieving their aim of a coordinated VMS/HAR strategy in the Corridor. In addition, procedures for amending and/or adding to the manual was provided.

Application guidelines for VMS/HAR were provided on the following:

- Inter-agency coordination
- Deployment of messages
- Development of VMS/HAR messages
- The operation and field installation of VMS/HAR

1. *I-95 Northeast Consultants, Operations, Policies, and Practices Coordination Workshop, September 15, 1994 Report No: I-95 CC 9-94-01*

2. *I-95 Northeast Consultants. VMS/HAR Operations Guidelines and Recommended Practice June 1995. Report No: I-95 CC 9-95-09.*

Procedures for evaluating the need and location for additional VMS/HAR devices in the Corridor were developed and presented in Coalition VMS/HAR Implementation Policy.^{3,4} Using these procedures, the location of additional VMS/HAR in the Corridor were identified. An implementation plan and schedule⁴ covering a ten year period was then developed for the additional VMS/HAR devices identified. Further, a multiple step process for deploying VMS/HAR to ensure correct installation of VMS/HAR acquired by Corridor agencies was outlined. The implementation program was divided into five phases and extended from Year 4 through Year 13 of the I-95 Corridor Coalition Business Plan as follows:

- Phase 1: Year 4 - 6 (1996-1998)
- Phase 2: Year 7 - 8 (1999 - 2000)
- Phase 3: Year 9 - 10 (2001 - 2002)
- Phase 4: Year 11 - 12 (2003 - 2004)
- Phase 5: Year 13 (2005)

To ensure consistency in the acquisition of VMS/HAR hardware, generic and performance-based specifications^{5,6} were developed. The specifications were written to accommodate new technologies as they become available. Also, a common protocol that could be used in all specifications for VMS and HAR procurement was explored. The main development of the National Transportation Control/ITS Communication Protocol (NTCIP) – a Federal effort to develop an ITS protocol which would encompass all ITS devices – has focused on traffic signal controllers. This focus has been broadened however, through our efforts to include VMS and HAR. Through this project, the NTCIP development provided feasible addressing schemes for devices and a preliminary list of command definitions for VMS signs.⁷

3. *I-95 Northeast Consultants. Coordinated VMS/HAR Implementation Policy. April 1995 Report NO: I-95 CC 9-95-06*
4. *I-95 Northeast Consultants, Comprehensive VMS and HAT System Development and Implementation, May 1995 Report No: I-95 CC 9-95-07.*
5. *I-95 Northeast Consultants. I-95 Corridor Coalition Special Provision for Variable Message Signs (ryMS)February I-95. Report No: I-95 CC 9-95-03.*
6. *1995 Northeast Consultants. I-95 Corridor Coalition Special Provision for Highway Advisory Radio (HAR)February 1995. Report No: I-95 CC 9-95-04.*
7. *I-95 Northeast Consultants. Application of the NTCIP to VMS/HAR. May 1995. Report No: I-95 CC 9-95-08.*

FINALIZED REPORTS

A number of reports have been completed and submitted to the I-95 Corridor Coalition as part of this project. A listing of all finalized reports follow. Brief descriptions of these reports can be found in Chapter 1 on pages 4 - 5.

PIN NUMBER	TITLE	DATE
I-95 CC 9-94-01	States' Policies, Guidelines and Procedures for VMS/HAR Systems	August 1994
I-95 CC 9-94-02	Operations, Policies, and Practices Coordination Workshop Notebook	September 1994
I-95 CC 9-95-03	I-95 Corridor Coalition Special Provision for Variable Message Signs (VMS)	February 1995
I-95 CC 9-95-04	I-95 Corridor Coalition Special Provision for Highway Advisory Radio (HAR)	February 1995
I-95 CC 9-95-06	Coalition VMS/HAR Implementation Policy	April 1995
I-95 CC 9-95-07	Comprehensive VMS/HAR Expansion System Development and Implementation	May 1995
I-95 CC 9-95-08	Application of the National Transportation Control/ITS Communications Protocol (NTCIP) to VMS/HAR	May 1995
I-95 CC 9-95-09	VMS/HAR Guidelines and Recommended Practices	June 1995
I-95 CC 9-95-11	Project 9 Final Report	July 1995

RECOMMENDATIONS

This project has assembled a coordinated plan to enhance the reliability and credibility of VMS and HAR. The next step to fulfilling this mission is to implement this plan by conducting operational tests. Based on the findings of Project 9, the I-95 NEC recommends that the Coalition do the following:

- *Provide training programs for personnel*

To ensure that the procedures and knowledge developed in this study are thoroughly disseminated to the correct personnel in the Corridor, training should be

provided to inform those directly involved in VMS and HAR. One way of ensuring that everyone will have a chance to participate in this training would be to develop a series of videos to teach the issues covered in the documents. An effort is needed to determine what information should be included in these videos followed by the production of the videos. The videos must present information in a way that makes it easy to follow, understand, and remember. To increase familiarity with the document, the videos should follow the format of the document and use it as a reference. An evaluation of these training videos should be performed following their completion to determine their effectiveness.

- *Use the procedures and recommended practices presented in the reports listed in Chapter 1 of this report*

In order for this project to be a success each agency should begin using the operations guidelines. Each agency may begin using the documents immediately in their TOC and in planning for operational changes. Some agencies may need to evaluate their existing agency's procedures and revise them, if necessary, to combine them with the I-95 Corridor Coalition's guidelines. Pages of the operations guidelines, which are used daily, may be copied and kept with other quick reference material in the TOC. The following pages should be copied for quick reference: VMS/HAR Operations Guidelines and Recommended Practices - pages 2-5,9,12,14; 3-3,7,8,15,23; 4-2,10,15,16,31,40,41,42,43; 5-6. The standard message format, which is developed to provide the information in a manner that is easy to comprehend, should be followed. The list of acceptable and unacceptable abbreviations should be available to all personnel involved, and it should be utilized. This page should be copied and kept near the equipment. The reports are intended to be used as guides and should be kept available as a reference for the people using the equipment. Memorandums of understanding should be developed to define the responsibilities to be executed by individual parties.

- *Staff level personnel should make a conscientious effort to address the credibility issues of VMS/HAR*

This item may seem somewhat ambiguous; however, it is likely the most important recommendation from this document. Training will help to solidify ways in which HAR and VMS operators can ensure that credibility is maximized. This matter should therefore be addressed in the training videos. Any information placed on VMS or HAR should be verified before being presented, and then updated frequently. Maintaining good coordination and communications with the incident agency will also help to improve credibility through the good experiences of the public. An

immediate goal of all agencies is for all VMS and HAR to be updated at least every 30 minutes.

- *Encourage Steering Committee level personnel to active/y promote the enhanced credibility of VMS and HAR within their agency*

This will accomplish the most dramatic increase in the credibility of VMS and HAR. There should also be an emphasis from the upper level people in the agency on the importance of using these guidelines on a daily basis.

- *Compare equipment specifications for the purchase of VMS/HAR devices*

The specifications developed in this project are provided as a baseline for agencies to use when developing a specification for new equipment. Each agency should compare their specifications with these and make adjustments as needed.

- *Incorporate the VMS/HAR expansion system into agency strategic planning and capital improvement projects*

The expansion sites were developed by the Coalition to fill the “gaps” in the current system and were intended to be incorporated into each agency’s plans. Each agency should compare the expansion system with their current plans and make adjustments as necessary. This effort will eliminate most gaps in the system. These locations were also selected to assist motorists with regional diversions. A seamless motorist information system will result in the Corridor if every Coalition agency adopts this plan.

- *Continue development of the NTCIP communication protocol for VMS and HAR*

Given the success that the Coalition has had already in expanding the focus of the NTCIP from traffic signals to VMS and HAR, the Coalition should stay actively involved in the VMS development and develop a NTCIP protocol for HAR. Use of the NTCIP will reduce expenditure on hardware needed to control systems from various manufacturers and will help with system maintenance. Therefore, the Corridor should allocate funding to continue involvement in the NTCIP development process. Coalition members should attend the national NTCIP meetings and include VMS and HAR vendors. The NTCIP should be incorporated into local agency specifications when available.

- *Update the reports produced in Project 9 as the Coalition’s knowledge base increases, particularly after the conclusion of Project 2, and develop a single operations manual for VMS/HAR incident management, and the IEN*

Because this project was completed before Projects 1 and 2, it did not have the benefit of the knowledge and refinements that will be worked out as a part of Project 2 (*Incident Management - Detection, Response, and Operations*) and Project 1

(information Exchange Network). As these projects progress they will have a direct impact on the coordination procedures and the alternate routing work that was done as a part of this project. These reports are living documents and new information should be shared at Coalition meetings and the reports updated accordingly. A single operations manual is also desirable for traffic operations personnel to eliminate the several manuals that will be produced as a result of the I-95 Corridor Coalition projects.

- *Begin a HAR Operational Test to evaluate the guidelines developed in this project*
This test should implement and test the guidelines and the implementation plan. The test should also determine whether the performance of HAR is improved by the use of digital technology. Further, as a part of this test, digital HAR should be tested to determine its compatibility with the NTCIP.

The recommendations of the I-95 NEC are summarized in Table I.

CONCLUSIONS

Project 9 has provided consistent application guidelines and messages developed along with the Coalition members, for the coordinated use of VMS/HAR in the Corridor. The guidelines address the deficiencies found in the Corridor and builds on the strengths. Coalition members must make a conscious effort to implement these guidelines and develop a VMS/HAR information dissemination system that motorists can depend on for real-time traffic information in the Corridor.

TABLE I

SUMMARY OF RECOMMENDED ACTIONS FOR THE I-95 CORRIDOR COALITION

ACTION:	RESPONSIBLE PARTY:	ACTION NEEDED BY:
Provide training program	Project 11 I-95 CC Technical Coordinator	August 1995
Use the procedures and recommended practices	HOGS	August 1995
Staff level personnel should make a conscientious effort to address the credibility issues of VMS/HAR	HOGS	Begin July 1995
Steering Committee level personnel should actively promote the enhanced credibility of VMS and HAR within their agency	Corridor Executive Board	Begin July 1995
Compare equipment specifications for the purchase of VMS/HAR devices.	FRAT I-95 CC Technical Coordinator	September 1995
Incorporate the VMSHAR expansion system into agency strategic planning and capital improvement projects	Steering Committee	May 1996
Continue development of the NTCIP communication protocol for VMS and HAR	FRAT I-95 CC Technical Coordinator	Ongoing
Update the reports produced in Project 9 as their knowledge base increases, develop a single operations manual for VMS/HAR, incident management, and the IEN	I-95 CC Technical Coordinator	Conclusion of Project 2 and Project 1
Begin HAR Operational Test to evaluate the guidelines developed in the project	Steering Committee I-95 CC Technical Coordinator	Ongoing

Project No. 9
Coordinated VMS/HAR Strategies

PART II
FINAL REPORT



I-95 Corridor Coalition

CHAPTER 1

INTRODUCTION

This report documents the activities and findings of Project 9, *Coordinated Variable Message Sign/Highway Advisory Radio Strategies*, of the I-95 Corridor Coalition Business Plan Elements. The main objective of this project was to provide a consistent pattern for the use of VMS and HAR by Coalition member agencies to furnish motorists throughout the Corridor with real-time, continuous, and consistent information. This would enhance the use of VMS/HAR in the Corridor and increase motorist confidence in these devices. This report has been prepared for the I-95 Corridor Coalition.

BACKGROUND

The I-95 Northeast Corridor defines an area of approximately (200 X 800) miles extending from Maine to Virginia. This corridor was designated by the U.S. Department of Transportation (USDOT) as a Priority Corridor on March 29, 1993. The I-95 Corridor Coalition, a coalition of state, toll, transit, and other transportation agencies, was charged with the responsibility of bringing a coordinated Intelligent Transportation Systems (ITS)⁸ program to the I-95 Corridor. While the Coalition uses the I-95 designation, it actually goes beyond I-95 to include all major free and toll highways that parallel I-95, the major routes that feed these north-south highways, and the various modes and facilities serving passengers and freight. To accomplish its responsibility, the I-95 Corridor Coalition set the following objectives:⁹

- To enhance the capabilities of transportation agencies within the Corridor to effectively handle non-recurring incidents.
- To cooperatively develop and assist in the operation of an interregional traffic and travel information network.
- To transform the I-95 Corridor into a showcase of ITS technologies.
- To foster cooperative relationships among all involved transportation organizations.
- To demonstrate to the public the benefits of ITS and a partnership approach.

⁸ Formerly Intelligent Vehicle Highway Systems (IVHS)

⁹ *The I-95 Corridor Coalition Business Plan. May 12, 1994.*

To provide administrative and technical support to the I-95 Coalition, the firms of Parsons Brinckerhoff/Farradyne Systems, Inc., and JHK & Associates (the I-95 Northeast Consultants - I-95 NEC) were retained in December 1992. The Scientex Corporation, a transportation engineering consulting firm with experience in research, evaluation, design and implementation projects, was retained as a sub-contractor for Project 9 in May 1994.

VMS and HAR are the primary devices used by transportation agencies of the I-95 Corridor Coalition to disseminate traffic information to motorists. However, these devices are not always effectively deployed, resulting in a failure to provide motorists with timely and accurate information. The information presented is not always current, often providing motorists with outdated and repetitive information; devices are sometimes non-operational for major portions of the day and even during significant events in the corridor; and, there is very little coordination among member agencies on the use of these devices. In many cases these devices have lost credibility with the public. Therefore, the purpose of Project 9 was to develop a structure and deployment strategy for the overall coordination of VMS/HAR devices in the Corridor and to promote the use of consistent application guidelines and messages. The project builds on the existing and planned VMS/HAR networks, and provides locations of additional devices where needed, to meet the information dissemination needs of member agencies as well as satisfying Coalition functions.

The primary objective of Project 9 was to develop strategies and procedures to furnish motorists with real-time, continuous, and consistent traveler information throughout the corridor. To accomplish this objective, Project 9 focused on the three main tasks of the pre-design elements:

- Task 1: Information Gathering
- Task 2: Developing Operating Policies and Guidelines
- Task 3: VMS/HAR Implementation Policy

This document summarizes the activities and findings from the main tasks. The main elements of Task 1 included the project initiation, literature review, agency interviews, field inspection, information summary, and coordination with the Transportation Operations Coordinating Committee (TRANSCOM). Task 2 included a review workshop, the development of an issues paper, the development of model specifications, and the development of operations policies and guidelines. Task 3 focused on the development of a Coalition implementation policy and program. The relationship among the various tasks of Project 9 is illustrated in Figure 1-1

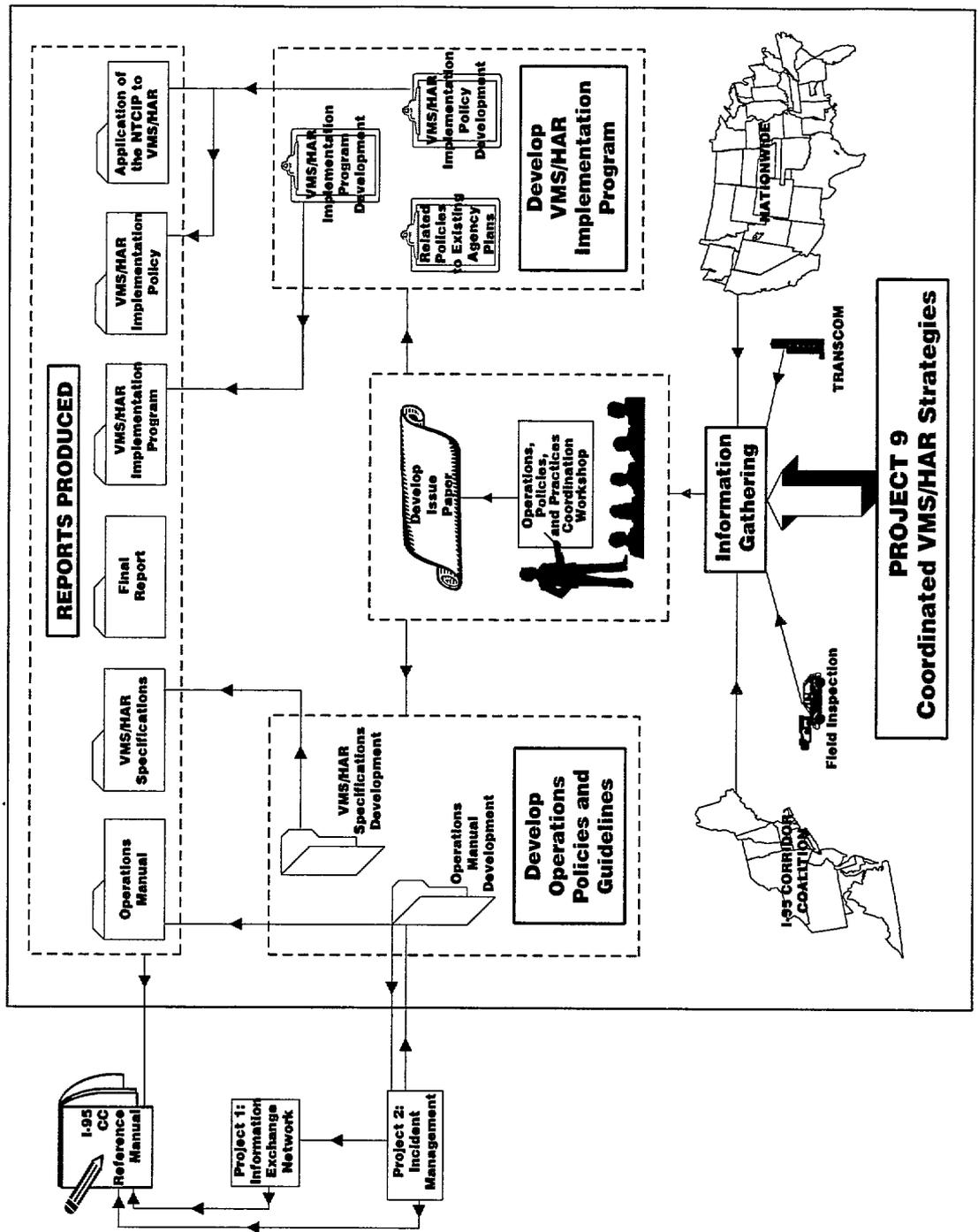


Figure 1-1. Relationship among the various tasks of Project 9

The following is a summary of the remaining chapters:

Chapter 2, Summary of Task Activities and Findings, provides an overview of the task activities and the findings of the main elements of each task.

Chapter 3, Findings and Conclusions, presents an overview of the main findings from the project. It also recommends steps to be implemented by the Coalition to integrate the coordinated strategies from Project 9 into their daily routines.

FINALIZED REPORTS

A number of reports have been completed and submitted to the I-95 Corridor Coalition as part of this project. A listing and summary of all finalized reports follow:

PIN NUMBER	TITLE	DATE
I-95 CC 9-94-01	<u>States' Policies, Guidelines and Procedures for VMS/HAR Systems</u> <i>Results from a representative sampling of the practices and policies of states outside the I-95 Northeast Corridor with respect to VMS/HAR operations.</i>	August 1994
I-95 CC 9-94-02	<u>Operations, Policies, and Practices Coordination Workshop Notebook</u> <i>A summary of information on VMS/HAR ownership, location, operating policies, practices and procedures in the I-95 Corridor Coalition.</i>	September 1994
I-95 CC 9-95-03	<u>I-95 Corridor Coalition Special Provision for Variable Message Signs (VMS)</u> <i>Generic and performance -based specifications for the acquisition of VMS within the Corridor.</i>	February 1995
I-95 CC 9-95-04	<u>I-95 Corridor Coalition Special Provision for Highway Advisory Radio (HAR)</u> <i>Generic and performance -based specifications for the acquisition of HAR within the Corridor.</i>	February 1995
I-95 CC 9-95-06	<u>Coalition VMS/HAR Implementation Policy</u> <i>Guidelines and policies for the implementation of VMS/HAR devices purchased by Coalition agencies.</i>	April 1995

PIN NUMBER	TITLE	DATE
I-95 CC 9-95-07	<u>Comprehensive VMS/HAR Expansion System Development and Implementation</u> <i>locations and implementation plan and schedule for additional VMS/HAR devices needed to complete the Corridor VMS/HAR network.</i>	May 1995
I-95 CC 9-95-08	<u>Application of the National Transportation Control/ITS Communications Protocol (NTCIP) to VMS/HAR</u> <i>Issues relating to the design of the NTCIP and its application to VMS/HAR are examined.</i>	May 1995
I-95 CC 9-95-09	<u>VMS/HAR Guidelines and Recommended Practices</u> <i>Guidelines and recommended practices for coordinated VMS/HAR operations.</i>	June 1995
I-95 CC 9-95-1 1	<u>Project 9 Final Report</u> <i>Review of the activities and findings of Project 9.</i>	July 1995

Reports I-95 CC 9-95-05 and I-95 CC 9-95-10 were draft reports.

RELATED PROJECTS

Project 9 is one of 21 projects identified in the Business Plan (at the time of this writing) to be undertaken by the I-95 Corridor Coalition. Table 1-1 indicates two subgroups of interrelated projects that were identified from the 21 Coalition projects.

Of the technical-related projects, Project 1, *Information Exchange Network (IEN)*, and Project 2, *incident Management - Detection, Response, and Operations*, are most closely related to Project 9.

TABLE 1-1¹⁰
INTERRELATED PROJECTS

TECHNICAL-RELATED PROJECTS	MARKET-SECTOR-RELATED PROJECTS
1. Information Exchange Network	4. Commercial Vehicle Operations
2. Incident Management	5. Public/Private Sector Outreach
3. Surveillance Requirements/Technology	6. User Needs and Marketability
8. Traveler Information Services	8. Traveler Information Services
9. Coordinated VMS/HAR Strategies	17. Long Range Strategic Plan
11. Technology Exchange and Training Program	

Project 1 involves the establishment of an electronic information exchange network that will become the I-95 information network. The system will tie each of the corridor agencies into a single dedicated information exchange network, allowing each agency to provide data to a central database location or to make direct entry of data to the database. Corridor-wide data collection and compilation will be displayed on a map based on a Geographical Information System (GIS) interface. The system will be able to display locations and characteristics of all ITS components such as VMS, closed circuit television (CCTV), HAR, traffic operation centers (TOC), etc.

Project 2 is responsible for providing guidelines to the Coalition on instituting predetermined, organized, and coordinated procedures, and responses for handling incidents. It is envisioned that through Project 2, effective coordination and compatibility of Incident Management procedures on an areawide basis will be achieved. The result will be significant benefits to motorists as they travel along the I-95 Corridor.

The interrelation between Projects 1, 2 and 9 is illustrated in Figure 1-2.

¹⁰ Adapted from "Wilmington, Delaware, was the Site of the Fourth Projects Coordination Meeting," Corridor Clipboard May 1995: 1

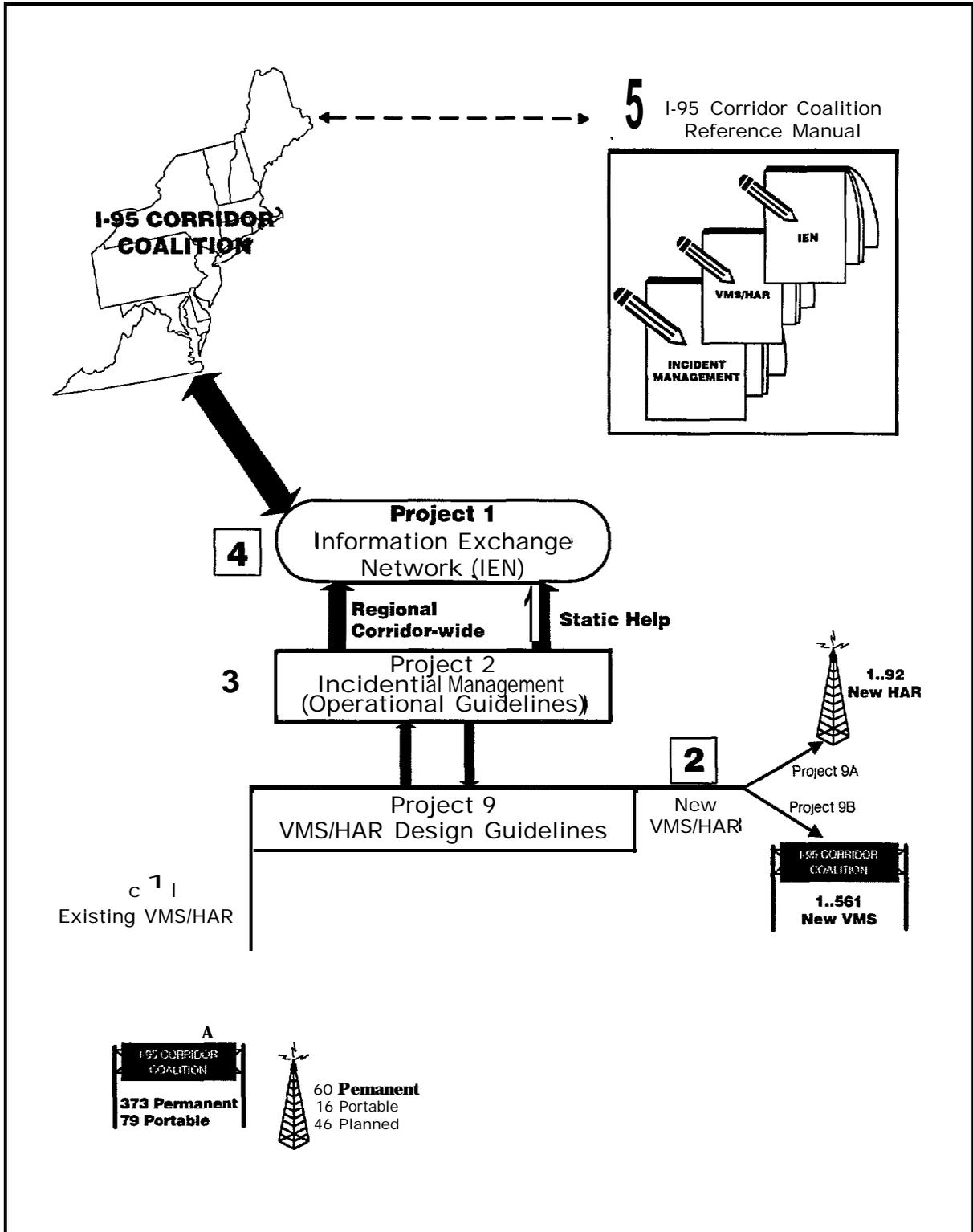


Figure 1-2. Interrelation between Projects 1, 2, and 9.

CHAPTER 2

SUMMARY OF TASK ACTIVITIES AND FINDINGS

This chapter describes the task activities and findings of Project 9. The primary purpose of this project was to develop guidelines for the consistent use of VMS/HAR in order to provide motorists with real-time, continuous, and consistent traveler information throughout the Corridor. The activities required to achieve this objective were categorized into three main tasks, Information Gathering, Developing VMS/HAR Operating Guidelines, and VMS/HAR Implementation Policy.

TASK 1: INFORMATION GATHERING

The primary purpose of Task 1 was to develop a databank of VMS/HAR information. This databank was necessary to develop plans for the effective coordination of VMS/HAR throughout the Corridor to supplement existing agency VMS/HAR plans. Task 1 activities included:

- Project Initiation
 - The development of a Work Plan
 - Schedule of Activities
 - The development of an Issues List
 - VMS/HAR Questionnaire
- Agency Interviews and Data Collection
- Literature Review
- Field Inspection
- Information Summary
- Coordination Summary

By employing various information gathering techniques, Task 1 was able to acquire information on VMS/HAR ownership, location, operating policies, practices and procedures within the I-95 Corridor, as well as outside of the Corridor. The information was summarized in tabular and graphical formats making it possible to visualize the strengths and weaknesses of VMS/HAR deployment in the Corridor. The I-95 NEC was able to use this information to identify the work to be accomplished to produce a coordinated VMS/HAR strategy for the I-95 Corridor. The main accomplishments of Task 1 were identified as follows:

1. An issues list concerning standardization, operation, and implementation to be addressed in the development of a Corridor standard for VMS/HAR was prepared.
2. An indication of the current coordination of VMS/HAR operating policies, procedures and practices existing within the Corridor was gathered.
3. A detailed overview of the existing system and identification of the gaps in the system where additional VMS/HAR hardware is needed to establish a comprehensive VMS/HAR network in the Corridor was obtained.

All existing VMS/HAR operating policies, procedures, and practices for each Coalition agency were summarized in the Operations, Policies, and Practices Coordination Workshop¹¹ notebook. The following section of this report discusses the main elements of Task 1.

Project Initiation

This element involved meeting with the Technical Review Committee (TRC) of the I-95 Corridor Coalition to present the following:

- Comprehensive draft work plan and schedule of activities
 - The work plan outlined the work to be undertaken by the I-95 NEC to achieve the objectives of this project. Each main task was divided into several sub-tasks, which were in turn further subdivided into more specific assignments. Throughout the project, the work plan acted as a guide to the work to be accomplished and the items to be delivered, to achieve the successful completion of each task.
 - A detailed schedule of activities outlined the projected execution and delivery dates for the work assignments and deliverable items identified in the work plan. Execution and delivery dates were identified for the following items:
 - Major deliverables,
 - Interviews,
 - Field trips,
 - Progress reports, and
 - Presentations.

¹¹ *I-95 Northeast Consultants. Operations, Policies, and Practices Coordination Workshop. September 1995 No. I-95 CC 9-94-02.*

- List of VMS/HAR issues to be addressed
 - An issues list outlining the issues to be addressed in the development of a Corridor standard for VMS/HAR was developed. Issues concerning standardization, operation, and implementation were addressed separately for VMS and HAR, and in addition, issues common to the operation and standardization of VMS/HAR systems were also identified. Some of the major issues presented to the TRC for consideration were as follows:
 - Due to the differences in application of portable and permanent VMS as well as the reduced message capacity of portable VMS, the development of separate standards for portable and permanent VMS should be considered.
 - To standardize the dissemination of information on VMS, it would be beneficial to use standard messages and abbreviations throughout the Corridor.
 - For the purposes of visibility and legibility, minimum character height and visibility distances should be implemented in the Corridor.
 - For uniformity and consistency, the development of consistent standards for the location and placement of portable and permanent signs would be beneficial.
 - A consistent type of HAR station should be used. Systems should all include 10 watt transmitters (which require FCC licensing). In addition, consideration should be given to whether HAR stations should be computer controlled with digital message downloading capabilities.
 - For effective dissemination of information, HAR should be a 24 hour operation. However, with continuous broadcasting, filler messages should be used for the periods when incident information is not being broadcasted. The nature of these filler messages has to be decided and a uniform mechanism for alerting motorists to emergency information, e.g., flashing lights, should be developed. Also, the use of standard message formats will enhance the credibility of HAR in the Corridor.
 - Consistent standards for the location of HAR stations and advance signing should be considered.
 - Promoting the use of HAR in the Corridor would be enhanced by the use of a standard I-95 Corridor frequency. Further, joint licensing applications to the FCC for that frequency would be desirable.
 - As a Coalition, the ownership and maintenance responsibility of any VMS/HAR equipment purchased with Coalition funds should be resolved.

Further, the issue of whether there is a need for a mechanism to ensure compliance with any standards developed should be addressed. Similarly, the manner in which litigation and liability issues will be handled must be clarified.

- Of equal importance is the need to determine whether the Coalition must continue to exist for the continuation of the coordinated dissemination of information, after the VMS/HAR coordinated strategies have been implemented.
- Draft questionnaire for agency interviews
 - As part of the information gathering process, a VMS/HAR questionnaire was developed for distribution to the agencies. The questionnaire was designed to develop an understanding of the VMS/HAR inventory, practices, and installation procedures within the Corridor. Through the questionnaire, information was gathered on the following:
 - Existing VMS/HAR equipment
 - Existing/planned/programmed VMS/HAR strategies
 - Agency permit requirements
 - Interagency communications/cooperation
 - Legal aspects of operation
 - VMS/HAR plans/specifications

The results from the VMS/HAR questionnaire provided some of the basic information required in order to develop standards and regulations for Corridor-wide coordination of VMS/HAR. The following data were obtained from the questionnaire:

VMS

- A total of 373 permanent and 79 portable VMS were identified.
- The primary VMS technology in the Corridor was flip-disk.
- A character height of 18 inches and a 5x7 pixel were predominant.
- The majority of VMS were blank during non-use periods.
- Three agencies had VMS with special graphics capability.
- Leased line was the most utilized type of communication.
- All VMS had message storage capacity.

HAR

- A total of 60 permanent, 16 portable and 45 proposed HAR stations were identified.
- All HAR broadcasted recorded messages.

- 530 and 1610 kHz were the most commonly used frequencies.
- Leased line was the most utilized type of communication medium.
- Reported broadcast range was from 2 to 20 miles.
- Not all HAR had message storage capacity.

The work plan outline, schedule of activities, issues list and the VMS/HAR questionnaire are presented in the Operations, Policies, and Practices Coordination Workshop¹² notebook.

Agency Interviews and Data Collection

To supplement the questionnaire, on-site interviews were scheduled and conducted with representatives from each member agency. Additional information was gathered on

- Plans of existing and planned systems,
- Areas where agencies expect additional coverage in the Corridor, and
- The criteria used by agencies for the placement of VMS/HAR.

The results from the on-site interviews, together with the information gathered from the VMS/HAR questionnaires, were used to identify various operational issues, existing practices, and policies associated with VMS/HAR systems in the Corridor. In addition, the results determined that model specifications for VMS/HAR equipment were required. The interviews revealed that

- The most extensive use of VMS and HAR was in the New York City and Washington Metropolitan areas;
- Less than half of the agencies interviewed had a written manual or guidelines for their VMS/HAR operations; and
- Less than half of the agencies used standardized VMS/HAR messages.

A summary of the agency interviews and data collection is available in the Operations, Policies, and Practices Coordination Workshop¹³ notebook.

¹² I-95 Northeast Consultants. Report No. I-95 CC 9-94-02.

¹³ I-95 Northeast Consultants. Report No. I-95 CC 9-94-02.

Literature Review

The purpose of the literature review was to provide a resource of VMS/HAR information to the Coalition agencies. The literature review involved an examination of policies, guidelines, and procedures of VMS/HAR users within the Coalition as well as around the country. Within the Coalition, a review and summary of the information gathered from the agency interviews and data collection process was carried out. Outside the I-95 Corridor, the remaining thirty-nine states were targeted for information gathering, with at least partial responses being received from twenty-six. In all, approximately one hundred state transportation officials, equipment manufacturers, and vendors from the twenty-six states participated. The complete results are included in a separate report, I-95 CC g-94-02, States' Policies, Guidelines and Procedures for VMS/HAR Systems.¹⁴ Some of the main findings from that report are as follows:

- VMS

- All states surveyed place permanent VMS on overhead structures to provide better visibility.
- The majority of states surveyed (18 of 25) have a policy to leave signs blank when not in use for traffic management.
- Most of the states do not have customized written policies regarding VMS operations beyond guidelines provided in the Manual of Uniform Traffic Control Devices (MUTCD).
- Most states prefer to restrict the number of phases used to display messages on both permanent and portable VMSs to two.

- HAR

- Only four of the 25 states surveyed have policies and/or guidelines for HAR operations beyond what is required by the Federal Highway Administration (FHWA) and Federal Communications Commission (FCC).
- Most of the states surveyed broadcast at both 530 and 1610 AM.
- The common message length limitation among the states is 2 minutes.

A comprehensive literature search of practices, standards, and policies for the operation and maintenance of VMS/HAR was carried out. A number of sources were explored in compiling this information:

¹⁴ I-95 Northeast Consultants. *States' Policies, Guidelines and Procedures for VMS/HAR Systems*. August 1994. Report No. I-95 CC 9-94-01.

- Transportation Research Information Services (TRIS) Database
- University of Virginia VMS/HAR Literature Review
- Transportation Research Board (TRB)
- United States Department of Transportation (USDOT) Library
- The Institute of Electrical and Electronics Engineers, Inc. (IEEE) Vehicular Technology Society

A search of the FCC database was carried out through their copy contractor, International Transcription Services, Inc. (ITS). For a given range of frequencies, ITS supplied the licensee, call sign, transmitter location, contact person, and telephone number for any radio license issued in the Corridor states. The listing included HARTIS stations of Coalition members, non-Coalition members and commercial radio stations. As a result, information was obtained on FCC licensees within the Corridor who could become potential system participants. Within the Coalition, a total of 146 licenses had been issued:

- 94 for 530 kHz
- 40 for 1610 kHz

The remaining 12 stations used six different frequencies between 590 and 1700 kHz.

Among the non-Coalition agencies, a total of 32 licenses had been issued:

- 16 for 530 kHz
- 10 for 1610 kHz

Four frequencies between 590 and 1700 kHz were used by the remaining six stations.

Results from the FCC search and the VMS/HAR questionnaire were cross-checked. The results of the literature review are in the Operations, Policies, and Practices Coordination Workshop¹⁵ notebook.

¹⁵ I-95 Northeast Consultants. Report No. I-95 CC 9-94-02.

Field Inspection

The field inspection involved a survey of existing VMS/HAR systems in the corridor. The purpose of the field inspection was to verify the information gathered from the agency interviews, and to evaluate the following aspects of VMS/HAR:

- Visibility/legibility of VMS
- Broadcast/reception quality of HAR
- Site location characteristics, mounting, and space requirements

The field study was conducted by driving through the Corridor and observing the above aspects of VMS/HAR installations. The results were summarized on a state by state basis and an organized set of slides of all the major installations in the corridor was prepared. A full report on the field inspection is available in the Operations, Policies, and Practices Coordination Workshop” notebook.

Information Summary

The information collected on the existing and proposed VMS/HAR devices in the Corridor were summarized in graphical and tabular format. A total of 452 permanent and portable VMSs and 121 permanent, portable, or proposed HAR stations were identified among Coalition states through the data collection process. All existing and proposed VMS and HAR devices were located on individual base maps of the I-95 corridor that included all major roadways, interchanges, commercial airports, and boundaries. These maps are shown in Appendix A. In addition, the locations of 33 existing/proposed TOCs obtained from Project 1, *Information Exchange Network*, were plotted on the HAR location map. Further, separate tabular summaries for existing and proposed VMS and HAR devices were developed. The tables included information such as, location, equipment type, etc.

A summary of existing operating policies, procedures, and practices for VMS/HAR was developed from agencies that had these policies in place. The summary gave an overall view of the areas of common practice and significant differences among those member agencies. Some of the areas looked at follow:

- General operational guidelines
- Message content
- Sign placement characteristics
- Communications
- Credibility
- Accuracy of information
- Site selection

These summaries, particularly the graphical summary, were used later in the project to determine the location of additional VMS and HAR for the completion of the Corridor network. The information summary is presented in the Operations, Policies, and Practices Coordination Workshop¹⁷ notebook.

Coordination with TRANSCOM

The purpose of this coordination was to gather information on the work done by TRANSCOM in implementing VMS and HAR devices among its members, and to coordinate and incorporate their efforts with the work being done for the I-95 Corridor Coalition.

TRANSCOM is a fifteen member coalition of traffic, transit and police agencies in the New York Metropolitan area, which is funded, staffed and governed by its members. They share incident information through a 24 hr/7 day Operations Information Center (OIC). In addition, TRANSCOM serves as a forum for incident management planning, construction coordination and for the shared testing and implementation of traffic and transportation management technologies.¹⁸ The TRANSCOM coalition is structured similar to the I-95 Corridor Coalition, although, on a smaller scale. Insight on the following strategies that were advantageous to the development of a coordinated I-95 Corridor Coalition VMS/HAR strategy was obtained from coordination with TRANSCOM:

- Agency inter-relationships
- Operational problems
- Coordination procedures

¹⁷ I-95 Northeast Consultants. Report No. I-95 CC 9-94-02.

¹⁸ Matt Edelman and Paul Einreinhofer. Institutional Issues in ITMS - TRANSCOM's Experience in NY and NJ.

Useful information on the inventory of devices of TRANSCOM member agencies was also obtained.

TASK 2: DEVELOPING VMS/HAR OPERATING GUIDELINES

Task 2 used the information gathered in Task 1 as the building block for developing a coordinated strategy. The coordinated strategy developed recommendations for consistent application guidelines and messages. The activities in Task 2 included the following:

- A one-day review workshop
- The preparation of an issues paper
- The development of an operations manual
- The development of VMS/HAR model specifications

The information collected in Task 1 was reviewed at a one-day workshop focusing on the similarities and differences in VMS/HAR operations, policies, and practices within the Corridor. From the workshop, an issues list identifying areas of consensus, as well as areas where consensus could not be reached, was prepared. The issues list served as a guiding document for the remainder of the project, opening an avenue for discussion on the issues that would culminate in consensus by the TRC. The main developments of Task 2 can be summarized as follows:

1. A list of areas of consensus and areas where consensus could not be reached was developed based on the workshop review of the material collected in Task 1.
 - The credibility of VMS and particularly HAR was a major concern expressed at the workshop. While the sentiment was expressed that possibly HAR credibility problems could not be improved, there was a general feeling that with the consistent application of some basic guidelines, the problems could be minimized. Some of the suggested guidelines follow:
 - HAR must be a 24 hour operation to give clear, accurate, and real-time information
 - VMS should be used to advise motorists to tune in to HAR
 - HAR must always provide a strong, clear, static free signal
 - A ratio of the number of VMS/HAR devices to the number of VMS/HAR operators should be determined
 - A TOC should be in constant contact with HAR devices

- A standard HAR advisory sign should be developed for use in the corridor
- A Corridor 800 telephone number should be included in the HAR message

It was clear from the workshop that the credibility of HAR and VMS was an issue of major concern. The full text of these suggestions and the other issues related to coordinated VMS/HAR strategies in the corridor are available in the issues paper (see page 22). The arguments associated with the credibility issues of VMS/HAR are presented here for emphasis as they are issues that must be addressed by the Coalition as they move into the operational tests.

2. Development of the VMS/HAR Operations Guidelines and Recommended Practices.

- Recognizing the concerns of Coalition members, a manual was developed that proposed consistent application guidelines for VMS/HAR in the Corridor. The manual proposed procedures for inter-agency coordination that could be utilized to effectively disseminate information to motorists. Guidelines for the deployment of messages, and a methodology for the development of VMS/HAR messages were proposed. The operation and field installation of VMS/HAR were discussed and guidelines presented. To ensure that the document remains current and can be readily revised, procedures for amending and/or adding to the document were developed.

The manual provides a basic set of guidelines for the Coalition to achieve their aim of a coordinated VMS/HAR strategy in the Corridor. It will be necessary for the Coalition to make a conscious effort to adopt these guidelines as part of their daily practices.

3. Development of generic and performance-based specifications for the acquisition of VMS and HAR within the corridor.

- These specifications were developed to assist Coalition members with purchasing VMS/HAR devices. Results from Task 1 indicated that this was necessary to ensure uniformity in hardware and software standards along the Corridor. It was also expected that the specifications would ensure that devices purchased within the Corridor would accommodate future technology growth. In particular, the I-95 Corridor Coalition has expressed its interest in adopting the NTCIP and in extending

it to apply to various ITS devices.¹⁹ New VMS/HAR devices purchased within the Corridor must be able to accommodate this protocol, if adopted. Diligent use of these specifications will ensure that the requirements for uniformity in hardware and software standards along the Corridor will be realized.

The following section of the report will discuss the main elements of Task 2.

Review Workshop

A one-day workshop was conducted to review and discuss the information collected in Task 1. The workshop focused on the similarities and differences in VMS/HAR operations, policies, and practices within the Corridor. The workshop presented an overview of the project status followed by a presentation of the material collected in Task 1, copies of which were available to participants in the workshop notebook.²⁰ The remainder of the workshop used an open forum to encourage discussion from participants on the following issues:

- Strategies for the effective utilization of VMS and HAR in the corridor
- The control of Coalition financed - VMS/HAR devices
- The importance of using VMS and HAR in tandem
- Strategies for improving the credibility of VMS/HAR
- The use of a common HAR frequency
- Standardized and filler messages
- Establishing an 800 Corridor telephone number

Discussion on these issues generated valuable insight on the following:

- Concerns of member agencies
- Importance of these issues in terms of Coalition operations
- Differences between member agencies
- Scope for unrestrained resolution of these differences

The findings of the workshop are discussed in greater detail in the next section, Develop Issues Paper.

¹⁹ I-95 Northeast Consultants. *An Addressing Scheme for the NTCIP, May 1995.*

²⁰ I-95 Northeast Consultants. *Report No. I-95 CC 9-94-02*

To determine the success of the workshop from the participants' viewpoint, a workshop evaluation was conducted. As part of the evaluation, several questions were directed at issues:

- Suggestions for improving the workshop format
- Additional subjects for discussion
- Areas of VMS/HAR that would most benefit from standard VMS/HAR guidelines

Of the 61 percent of the participants who responded to the evaluation, 58 percent assessed the workshop, the quality of the hand-out material, and the presentation of the material as either "good" or "very good." All respondents described the workshop as "useful" or "very useful," and 95 percent felt that it produced beneficial discussion. Further, 95 percent described the usefulness of the VMS/HAR discussion as either "excellent," "very good" or "good." In all, 90 percent of the respondents indicated that they either used, planned to use or would consider using information from the workshop in their daily routines. Some general responses received from participants included:

- "[The format of the presentation could have been improved by] a more structured format oriented toward discussion of the topics. A copy of the format sent out prior to the meeting."
- "More discussion on Coalition-wide 'phrase-ology' of messages [should have been discussed]."
- "[More discussion on] agency experience with HAR/VMS in regard to operation and maintenance (problems, successes, etc.)."
- "Design of HAR signs should be the same throughout the entire I-95 Corridor, there are too many dissimilar sign types, and this is confusing to the public."
- "[VMS/HAR would benefit from] standard abbreviations for VMS, standard phrases for VMS. HAR info sign guidelines."
- "Overall, the workshop was excellent. This is a good method for sharing experiences between agencies along Corridor (similar to HOGS meeting) and meeting face-to-face with people in other agencies doing the same thing. Periodic meeting (annual?) should continue even after project end!"

Develop Issues Paper

The results of the workshop were carefully reviewed and an Issues Paper summarizing the concerns and implications of member agencies with regards to VMS/HAR operations, practices, and policy differences in the Corridor, was prepared. Suggested actions for addressing these issues was also presented. The Issues Paper was to serve as a guiding document for the remainder of the project and identified areas of consensus and areas where consensus could not be reached as follows:

- Areas of consensus

- Agency coordination

- The level of coordination/control was discussed with the majority of agencies being opposed to any external agency operating their devices. However, successful examples between TRANSCOM and the New Jersey Highway Authority were used to demonstrate that a high level of coordination can be achieved without agencies having to give up control of the equipment. It was suggested that direct linkage of TOCs was required and that a Corridor operations center be used as a center for information coordination.

- Credibility of VMS/HAR

- One of the issues arousing the most concern at the workshop was the credibility of HAR and, to a lesser extent, VMS. While the potential of HAR was recognized, many at the workshop felt that credibility problems seriously hampered its effectiveness. Some participants recounted their own experiences with HAR which included broadcasting outdated information and the failure to provide information on current traffic conditions. Reservations were expressed about the ability of Corridor agencies to overcome these credibility problems. However, there was a general consensus that with proper application and a coordinated effort, the credibility of HAR, and VMS, could be greatly improved. Some suggested actions for addressing the credibility issue included the following:

- HAR must be a 24 hour operation to give clear, accurate, and real-time information
 - VMS should be used to advise motorists to tune in to HAR
 - HAR must always provide a strong, clear, static free signal
 - A ratio of the number of VMS/HAR devices to the number of VMS/HAR operators should be determined

- A TOC should be in constant contact with HAR devices
- A standard HAR advisory sign should be developed for use in the corridor
- The Corridor 800 telephone number should be included in the HAR message
- VMS filler messages

It was suggested that all Corridor agencies use a standard filler message that would indicate to motorists that the sign was operational. Suggestions for this standard message included the following:

 - Construction information (local or Corridor)
 - Time and date
 - Safety tips
- Library of standard VMS messages/contractions/abbreviations

There was general agreement on the need to develop a library of standard messages, contractions and abbreviations. To aid motorist interpretation, it was suggested that the standardized abbreviations could be handed out to motorists at toll booths, included in driver education course curriculums, and incorporated into the driver handbook.
- Standardized protocol

The use of a standard communications protocol was desired. This protocol should provide at least “read-only” access so that a central Coalition agency could see what was on an agency’s sign.
- Coalition equipment

Coalition equipment was defined as equipment used to display and/or provide Corridor-related messages. This is a broad definition which could include existing devices as well as devices purchased with Coalition funds. Discussion was also generated on the location of Coalition VMS/HAR. It was suggested that these devices be located between urban centers at locations that would facilitate diversion of traffic. The use of VMS/HAR in tandem was recognized and emphasized.
- Prioritization of Incidents

The need for a prioritization system to determine the order in which messages should be presented was recognized. It was felt that such a system should be developed based on the type of incident and distance to the incident. The general opinion was that local messages should override Corridor messages and that non-recurring incident messages were generally more important than recurring incident messages.

- Standardized operating procedures
 - To assist operators and to provide uniform operating strategies throughout the Corridor, it was felt that standardized operating procedures should be developed.
- Training
 - The view was expressed that additional training was required for more efficient use of VMWHAR equipment.
- Consensus could not be reached
 - Control of VMS/HAR devices by the Coalition
 - This was an issue of major concern to the participants. Opinion was strongly divided as some felt that the Coalition should have direct control of VMWHAR, while others felt that control of these devices should always remain with the operating agency. A possible resolution of this issue could be had by dealing with each agency on an individual basis. Those agencies that feel comfortable with handing over control could do so. However, regardless of an agency's preference, it was felt that under no circumstances should any Corridor message be placed on VMS or HAR without the permission of the operating agency.

Develop VMS/HAR Operations Guidelines Document

The main development of Task 2 was the document titled, VMS/HAR Operations Guidelines and Recommended Practices.²¹ This document was developed to provide the Coalition agencies with VMWHAR operating guidelines for their consistent use in the Corridor. In addition, specifications to ensure consistency in the acquisition of VMS/HAR hardware, were developed for the Corridor. Several issues were examined in developing these guidelines:

- Inter-agency coordination
- Message deployment
- Message development, standard message formats, and abbreviations

²¹ I-95 Northeast Consultants. Report No. I-95 CC 9-95-09.

- General VMS/HAR operations
- Uniform field installation guidelines
- Amendment procedures

Each issue was dealt with separately and combined into a final report titled, VMS/HAR Operations Guidelines and Recommended Practices.²² A summary of each issue is provided in the following sections.

Inter-Agency Coordination

The purpose of this section was to provide guidelines for sharing accurate information between agencies on incidents in the Corridor in a timely manner. This involved the development of inter-agency coordination guidelines for implementation during incidents of significant magnitude in the Corridor. These guidelines assumed that an Interim Corridor Communications Center (Interim CCC), would be responsible for disseminating information to member agencies, thus freeing the agency with the incident to focus on the local incident.

The general role of every agency, the information to be transmitted, and the expected responses during any incident requiring a corridor-wide response was defined. Since the response to incidents can vary depending on the type of incident, specific incident conditions were examined and the expected actions by each agency during particular incident conditions were defined. These incident conditions included the following:

- Weather conditions
- Special events
- Boundary incidents
- Hazardous material spills

Due to the importance of communications to inter-agency coordination, an overview of existing and future communication media available to the Coalition was provided. The intention was to give a brief review of what was available, how it worked, and its application to the traffic environment.

²² I-95 Northeast Consultants. Report No. I-95 CC 9-95-09.

Message Deployment

The purpose of this section was to provide general guidelines for the Interim CCC as to what types of incident conditions should be conveyed to motorists, and how far upstream of any incident should messages be deployed. This is influenced by the following factors:

- Type and severity of the incident
- Expected duration
- Resultant reduction in roadway capacity

To assist with message deployment, motorist information zones have been developed. These zones defined the information that should be disseminated to motorists based on their location from an incident. Three zones were identified:

- Primary Motorist Information Zone (PriMIZ)
- Secondary Motorist Information Zone (SeMIZ)
- Surrounding Motorist Information Zone (SuMIZ)

Response levels were combined with incident message ranges, to allow local and Interim CCC operators to determine the appropriate message range and response level. The response level and corresponding message ranges for various combinations of time of day, incident duration and capacity loss are listed in Table 2-1,

TABLE 24
INCIDENT MESSAGE RANGES

TIME OF DAY	INCIDENT DURATION	CAPACITY LOSS					
		0-33%		34-66%		67-100%	
		(MILES)		(MILES)		(MILES)	
PEAK PERIOD	0-20 min.	15	R-1	15	R-1	30	R-2
	20 min.-2 hrs.	15	R-1	30	R-2	60	R-3
	2-4 hrs.	60	R-3	120	R-4	150	C-1
	>4 hrs.	120	R-4	300	C-2	450	C-3
DAYTIME OFF-PEAK	0-20 min.	15	R-1	15	R-1	30	R-2
	20 min.-2 hrs.	15	R-1	15	R-1	30	R-2
	2-4 hrs.	60	R-3	120	R-4	150	C-1
	>4 hrs.	60	R-3	150	C-1	300	C-2
NIGHTTIME OFF-PEAK	0-20 min.	15	R-1	15	R-1	30	R-2
	20 min.-2 hrs.	15	R-1	15	R-1	30	R-2
	2-4 hrs.	15	R-1	15	R-1	30	R-2
	>4 hrs.	60	R-3	120	R-4	150	C-1

Legend:

- R-1=Regional Level One Incident: Information to surrounding agencies only - No response initiated.
- R-2= Regional Level Two Incident: Limited Response - Information to surrounding agencies and request for activation of VMS/HAR in the SeMIZ and SuMIA.
- R-3= Regional Level Three Incident: Moderate Response - Information to surrounding agencies, request for activation of VMS/HAR in the SeMIZ and SuMIA, and initiation of "soft" trip diversion needs, both geographical and time.
- R-4= Regional Level Four Incident: Moderate Response - Information to surrounding agencies. request for activation of VMWHAR in the SeMIZ and SuMIA, and initiation of "hard" trip diversion needs, both geographical and time.
- C-1=Corridor Level One Incident: information only to all Coalition agencies (may include R - 2 to R - 4 regional levels on a location basis).
- C-2= Corridor Level Two Incident - Moderate Response: Information to all Coalition agencies, request for activation of VMSMAR in the SeMIZ and SuMIA, and initiation of "soft" trip diversion needs, both geographical and time.
- C-3= Corridor Level Three Incident: Moderate Response - Information to all Coalition agencies, request for activation of VMSMAR in the SeMIZ and SuMIA, and initiation of "hard" trip diversion needs, both geographical and time.

Message Development. Standard Message Formats, and Abbreviations

The methodology for developing VMS/HAR messages was presented. Two principles of VMS/HAR information acquisition and processing were defined:

- Principle 1: Respect the limits of motorists to acquire, understand and remember highway advisory messages.
- Principle 2: Prioritize sequential message components to meet clearly identified motorist information needs to make decisions.

In addition, the elements of an advisory message were defined:

- A problem statement
- A location statement
- An effect statement
- An attention statement
- An action statement

Using these principles and elements, the construction of standard VMS and HAR messages was discussed. Several examples of message “templates” for portable and permanent VMS, and “fill-in-the-blank” messages for HAR were provided. Recommendations for standard abbreviations and contractions were also presented.

General VMS/HAR Operations

This section presented general guidelines for the operation of VMS/HAR in the Corridor. These guidelines were not covered in the previous sections:

- VMS/HAR coordination
- Precedence of messages
- Enhancing credibility
- VMS/HAR message legibility
- VMS programming and HAR broadcasting guidelines

To demonstrate the application of the “VMS/HAR Operations Guidelines and Recommended Practices,” they were applied to an incident on southbound I-95 reported by the Connecticut Department of Transportation (ConnDOT).

Uniform Field Installation Guidelines

Uniform field installation guidelines were described for the installation of VMS and HAR in the Corridor. These guidelines combined existing practices with recommendations from VMS and HAR manufacturers. The guidelines described the proper procedures to be followed and other issues to be taken into consideration when installing VMS and HAR:

- VMS Installation Guidelines
 - Site selection factors
 - Local installation of permanent VMS
 - VMS visibility
 - VMS technology
- Communications
 - Portable VMS placement
 - Special considerations
- HAR Installation Guidelines
 - General issues - types of HAR coverage, FCC licensing requirements
 - Site selection
 - Antenna installation methods
 - Pre-installation test
 - Advance signing installation
 - Operation control
 - Special installation considerations

Where necessary, any legal requirements to be satisfied were identified.

Amendment Procedures

The standards developed in the VMS/HAR Operations Guidelines and Recommended Practices²³ were intended to be flexible and current with the needs of its users. As such, procedures were developed for the amendment of, and/or addition to, the standards. Procedures to be followed for submitting a proposal for amending and/or adding to the standards were outlined. The proposal should include the following:

- A title page
- An abstract
- The main body
 - the problem statement
 - the proposal statement
 - the benefits statement
 - the time frame
 - tables, figures and appendix

The expected response by the Coalition upon receipt of the proposal was outlined as follows:

- Place on agenda/circulate copies
- Discussion
- Send to a working group
- Vote

Develop Model Specifications

The purpose of this section was to develop model specifications for the acquisition of VMS/HAR systems in the Corridor. It was determined from the results of the on-site interviews and the information gathered from the VMS/HAR questionnaires, that model specifications for VMS and HAR were required. Separate generic and performance-based specifications were developed for the purchasing of VMS and HAR systems by Coalition member agencies. Each member agency is required to insert its local construction specifications into the model specifications, and to supply construction drawings and standard details. The specifications are written to

²³ I-95 Northeast Consultants. Report No. I-95 CC 9-95-09.

accommodate future changes or new technologies as they become available. The VMS specifications covered the following:

- Character display elements
 - fiber optic
 - L E D
 - flip-LED (hybrid)
 - flip disk
- ◆ Electrical requirements
- ◆ VMS controller
- ◆ VMS controller communications
- ◆ Communications interface
- ◆ Construction methods for VMS mounting
- ◆ VMS field controller
- ◆ Compensation

The HAR specifications covered the following:

- ◆ Transmitter site components
- ◆ Ground plane systems
- ◆ Solar systems
- ◆ Portable HAR
- ◆ Leaky coaxial cable
- ◆ Communications
- ◆ System testing
- ◆ Central message center
- ◆ Transmitter cabinet - auxiliary equipment

The model specifications are available as separate documents:

- Special Provision for Variable Message Signs (VMS)²⁴
- Special Provision for Highway Advisory Radio (HAR)²⁵

24 I-95 Northeast Consultants. Report No. I-95 CC 9-95-03.

25 I-95 Northeast Consultants. Report No. I-95 CC 9-95-04.

TASK 3: VMWHAR IMPLEMENTATION POLICY

Having developed an inventory of existing and planned VMS/HAR from Task 1, Task 3 involved the identification of the locations where supplemental VMWHAR devices would be needed to complete the Coalition's comprehensive VMS/HAR network. An implementation policy and program for installing these additional devices was developed to effectively disseminate traffic information to motorists in the Corridor on a continuous basis. Task 3 activities included the following:

- Developing Coalition VMS/HAR Implementation Policy
- Relating the Coalition's VMWHAR Implementation Policies to Existing Agency Plans
- Developing the VMS/HAR Implementation Program

Policies for the implementation of VMS/HAR devices were developed and presented in Coalition VMS/HAR Implementation Policy.²⁶ The report discussed procedures for evaluating the need for and the location of additional VMS/HAR devices in the Corridor. To ensure the correct installation of VMS/HAR acquired by Corridor agencies, as well as the uniform dissemination of information to motorists along the Corridor, the report also outlined a multiple step process for deploying VMS/HAR. The I-95 Corridor Coalition expressed an interest in the NTCIP and as a result, the expansion of the NTCIP to include VMS/HAR devices was explored and the results presented in a report titled Application of the National Transportation Control/ITS Communications Protocol (NTCIP) to VMS/HAR.²⁷

A comparison of the Coalition's implementation policy against individual agencies' implementation policies gathered from Task 1, was carried out to identify locations that were not adequately covered by existing VMS/HAR devices. An implementation plan and schedule, to cover a ten year period, was developed for the additional VMWHAR devices identified earlier in Task 3. The plan and schedule was divided into five phases that extended from Year 4 through Year 13 of the I-95 Corridor Coalition Business Plan. The results of the comparison and the full details of the implementation plan and schedule are presented and discussed in the report titled, Comprehensive VMS and HAR System Development and Implementation.²⁸

²⁶ I-95 Northeast Consultants. Report No. I-95 CC 9-95-06.

²⁷ I-95 Northeast Consultants. Report No. I-95 CC 9-95-08.

²⁸ I-95 Northeast Consultants. Report No. I-95 CC 9-95-07.

Task 3 developed a plan that would be in place to guide the Coalition in determining the need for and location of new VMS/HAR devices, and provided a procedure for the phased installation of these new devices. The procedure for developing the implementation plan is summarized as follows:

1. Develop evaluation and priority guidelines for the determination of need and site selection for VMS/HAR equipment.

- Having determined the need for additional VMS/HAR devices to complete the motorist information dissemination network in the Corridor, a process to determine the location of these additional devices was developed. A number of factors were taken into consideration in developing this process:
 - the availability of parallel routes
 - the type of diversion points for each parallel route
 - the number of parallel routes accessed by a diversion point
- the vehicle miles of travel (VMT)
- an inventory of existing VMS/HAR equipment

Each factor received a score that was totaled for each diversion point and summarized in a table of ranked diversion points.

2. Develop a table of ranked diversion points.

- The diversion points were ranked to identify the order in which new VMS/HAR should be installed in the Corridor. A listing of the ranked diversion points was prepared.

3. Develop an implementation plan and schedule for the preliminary VMS/HAR expansion system.

- An implementation plan and schedule was developed for the installation of the additional VMS/HAR devices identified. The plan was divided into five phases over a ten year period, covering Years 4 through 13 of the Business Plan. In addition, a listing of the agencies responsible for overseeing installation and for maintaining the devices on a phase by phase basis was prepared.

4. Develop cost and operations estimates.
 - Cost and operations estimates were prepared for the preliminary VMS/HAR expansion system. Costs on a phase by phase basis for each affected agency were prepared.
5. Develop deployment procedures for the effective deployment of VMS/HAR in the Corridor.
 - A series of procedures for deploying VMS/HAR in the Corridor were developed. These procedures provided guidelines for the proper installation of VMS/HAR in the Corridor, and also informed Coalition agencies of any legal requirements associated with VMS/HAR installation. Uniform deployment of VMS/HAR will ensure a consistent information dissemination system within the Corridor.

Develop Coalition Implementation Policy

The purpose of this sub-task was to develop guidelines and policies for the implementation of VMS and HAR devices purchased by Coalition agencies. The implementation policy was presented in a final report titled, Coalition VMS/HAR Implementation Policy.²⁹ The report focused on the following areas:

- Evaluation and site selection of VMS/HAR
- VMS/HAR equipment standards
- Regulations, coordination procedures, and deployment procedures for VMS/HAR

Evaluation and Site Selection of VMS/HAR

Evaluation and site selection processes were discussed in this section. Evaluation describes the process used to determine the need for additional VMS/HAR devices in the Corridor. The five criteria used for the evaluation process will be examined in greater detail in a later section, "Relating Coalition Policies to Existing Agency Plans."

Placing VMS and HAR at locations where they would be of maximum benefit to motorists was the purpose of the site selection process. The following were considered for this process:

29 I-95 Northeast Consultants. Report No. I-95 CC 9-95-06.

- The placement of VMS and HAR with respect to the diversion point
- HAR site criteria
- VMS site criteria
- Common HAR and VMS site criteria

In selecting sites for locating VMS/HAR, it is important to remember that these devices should be located where they give motorists

- Enough time to read a VMS message,
- Listen to an HAR broadcast, and
- Make an informed decision, before reaching the diversion point.

VMS/HAR Equipment Standards

Equipment standards for the purchase of VMS/HAR equipment were developed. Functional requirements for VMS were described as follows:

- Sign display unit
- VMS sign controller
- Sign communication

Functional requirements for HAR stations were also described as indicated:

- Transmitter
- Recorder
- Antenna system

Regulations, Coordination Procedures, and Deployment Procedures for VMS/HAR

The FCC Rules and Regulations regarding the implementation of HAR were reviewed. The intention was to provide agencies with an overview of the HAR installation requirements of the FCC. The FCC Regulations cover the following areas:

- HAR conditions and limitations, and
- HAR technical standards.

The operation of VMS/HAR in tandem in the corridor, for the dissemination of traffic information, was the major aim of this project, Consequently, guidelines to be applied by Coalition agencies to ensure the efficient coordination of VMS/HAR were provided as follows:

- Agencies should always check for existing VMS/HAR
- VMS should be located within the operating frequency of an HAR
- Agencies should coordinate operations

Finally, a multiple step process summarizing a method for deploying I-95 Corridor Coalition VMS/HAR was presented:

- Step 1: Use the evaluation prioritization procedure to rank the possible sites
- Step 2: Determine the HAR broadcast range
- Step 3: Determine the available mounting locations for VMS/HAR based on the rankings for the evaluation prioritization procedure.
- Step 4: Determine the ideal locations.
- Step 5: Check the FCC regulations and technical standards
- Step 6: Install the communications system
- Step 7: Procure the VMS/HAR equipment

The aim of the deployment procedure was to ensure the proper installation of VMS/HAR, in order to achieve a uniform and compatible information dissemination system.

The Use of a Standard Communications Protocol

Included as part of the implementation policy was the development of a standard protocol for communications between the TOC and field devices. Based on the interest expressed by the I-95 Corridor Coalition in the NTCIP, a communications protocol being developed primarily for traffic controls, the expansion of the NTCIP to include VMS/HAR was explored. However, outstanding issues related to the design of the NTCIP had to be resolved before it could be adopted. These issues, addressed in the report Application of the National Transportation Control/ITS Communications Protocol (NTCIP) to VMS/HAR,³⁰ are as follows:

- An addressing scheme for the NTCIP
- Evaluation of existing protocols
- Message display lengths and broadcast requirements

Relatins Coalition Policies to Existing Agency Plans

The purpose of this sub-task was to compare the Coalition's implementation policies with individual agency implementation plans in order to determine locations for additional VMS/HAR devices needed to complete the VMS/HAR network. Project 9 was expected to provide a comprehensive VMS/HAR system for the Corridor, but the information from Task 1 revealed that the implementation of supplementary VMS/HAR devices was necessary. The results of this sub-task were presented in a final report titled Comprehensive VMS and HAR System Development and Implementation.³¹

Potential parallel alternate routes were identified using the VMS/HAR location maps developed in Task 1. Based on these potential alternate routes, diversion points were identified, scored, and ranked by use of the evaluation prioritization process. The ranking was used to determine the order in which additional VMS/HAR should be installed. The actual location of additional VMS/HAR devices to complete the Corridor network, was determined from the inventory of existing VMS/HAR compiled in Task 1. The prioritization process was based on

- Availability of parallel routes,
- Type of diversion points for each parallel route,
- Number of parallel routes accessed by diversion point,

³⁰ I-95 Northeast Consultants. Report No. I-95 CC 9-95-08.

³¹ I-95 Northeast Consultants. Report No. I-95 CC 9-95-07.

- Vehicle Miles of Travel (VMT), and
- Inventory of existing VMS and HAR equipment.

In addition, cost estimates to implement the additional VMS/HAR required to complete the I-95 comprehensive system, were calculated.

Availability of Parallel Routes

A potential parallel route network was developed for the Corridor using the VMS/HAR location maps, and diversion point information from Project 2, Incident Management - Detection, Response, and *Operations*. The primary purpose for developing the potential parallel route network was to determine the location of the additional VMS/HAR devices. Development of the parallel route network for the I-95 Corridor Coalition is the responsibility of Project 2. Two categories of potential parallel routes were defined as follows:

- Primary parallel routes
 - limited access freeway
 - tollway
- Secondary parallel routes
 - US or State highways (with or without traffic signals)

Type of Diversion Points for each Parallel Route

The type of parallel route that could be accessed at a particular diversion point was part of the criteria used. Six types of diversion points were identified:

- I-95 Primary Freeway - Primary parallel route
- I-95 Primary Tollway - Primary parallel route
- Primary Freeway - Primary parallel route
- Primary Tollway - Primary parallel route
- I-95 Secondary Roadway - Secondary parallel route
- Secondary Roadway - Secondary parallel route

Weight factors were awarded for each category of diversion points, with I-95 primary diversion points (I-95 Freeway/Tollway) receiving the highest, while secondary diversion points (Secondary Roadways) received the lowest.

Diversion Points for Multiple Parallel Routes

The number of parallel routes served by an individual diversion point was used as a factor in determining the rank of a diversion point. Points were awarded to diversion points for each potential parallel route for which access was provided. Diversion points with access to more than one parallel route scored higher than those with access to only one parallel route.

Vehicle Miles of Travel

Using data from Project 2, *Incident Management - Detection, Response and Operations*, an estimated number of incidents per mile per year based on VMT was computed for several links of I-95. Based on a ratio of the forecasted incident, the diversion points received a score for the link of I-95 that could be avoided.

Based on the above criteria, a table of ranked diversion points was produced and a partial listing of the highest ranked interchanges is presented in Table 2-2.

TABLE 2.2
PARTIAL LISTING OF RANKED DIVERSION POINTS

SCORE	STATE	NEAREST CITY	INTERCHANGE	VMS NEEDS	HAR NEEDS
134	NY	Bronx	I-95, I-295, I-678 Hutchinson River Pkwy	4	1
114	NY	Bronx	I-95, I-695	1	
114	NY	Bronx	I-95 Bronx River Pkwy		
104	NY	Bronx	I-295, I-695	2	
94	NY	Bronx	I-95, I-278	1	
94	NY	Bronx	I-95, I-895	1	
84	NY	Bronx	I-278, I-895	2	
84	NY	Bronx	I-278 Bronx River Pkwy	1	

Having determined the order in which VMS/HAR should be installed, the final step in the evaluation prioritization process involved determining the actual location of additional VMS/HAR to complete the I-95 network.

Inventory of Existing VMS and HAR Equipment

Potential parallel routes were determined from the VMS/HAR location maps and existing VMS/HAR devices that could be used for diverting motorists to these parallel routes were identified using the following criteria:

- The diversion point had to fall within the HAR broadcast range
- Permanent VMS should be available within the HAR broadcast range
- Portable VMS had to be available within the vicinity of the diversion point

Those diversion points that were not covered by existing VMS/HAR were identified as possible locations for the additional VMS/HAR devices. Some of the locations identified were as follows:

- I-64/I-95 - VA
- I-95/I-280 - NJ
- I-295/US 50 - MD
- I-95/US 1 - MA
- US1/RI 4 - RI

As a result of the prioritization process, the locations of an additional 561 VMSs and 92 HARs required to complete the I-95 VMS/HAR network were identified. In addition, each location received a ranking which gave an indication of its significance to the overall I-95 VMS/HAR network. These locations are listed in the Comprehensive VMS/HAR Expansion System Development and Implementation Report.³²

Develop Implementation Program

Having identified the location and estimated costs of the new VMS/HAR devices within the Corridor, this sub-task set out to develop a schedule for the implementation of these devices, and to identify the agencies responsible for the implementation and maintenance of these devices. An overview of the implementation program, which is expected to cover a ten year period, follows in the next section. The complete implementation program is presented in the report Comprehensive VMS/HAR Expansion System Development and Implementation.³³

³² I-95 Northeast Consultants. Report No. I-95 CC 9-95-07.

³³ I-95 Northeast Consultants. Report No. I-95 CC 9-95-07.

Implementation Plan and Schedule

The implementation plan and schedule covers a ten year period from Year 4 through Year 13 and Table 2-3 provides a listing of the affected agencies and the number of VMS and HAR to be installed in each phase. A summary of the implementation plan and schedule follows Table 2-3.

TABLE 2-3
LISTING OF THE AFFECTED AGENCIES AND THE NUMBER OF VMS AND HAR

AGENCY	PHASE 1 VMS/HAR	PHASE 2 VMS/HAR	PHASE 3 VMS/HAR	PHASE 4 VMS/HAR	PHASE 5 VMS/HAR	TOTAL VMS/HAR
Virginia DOT	9/2	4/2	17/4	23/4	15/2	68/14
DC DPW	0/0	0/0	2/1	0/0	0/0	2/1
Maryland SHA	9/1	8/1	21/3	14/4	0/0	52/9
Delaware TA	1/0	0/0	0/0	0/0	0/0	1/0
Delaware DOT	1/1	1/0	1/0	0/0	0/0	3/1
Penn. TA	2/0	0/0	0/0	0/0	0/0	2/0
Penn. DOT	8/1	3/1	4/1	15/2	0/0	30/5
New Jersey TA	5/0	11/0	4/0	2/0	0/0	22/0
New Jersey DOT	9/1	21/1	14/0	9/1	7/0	60/3
New Jersey HA	1/1	3/0	1/1	0/0	0/0	5/2
New York State DOT	13/2	16/2	12/2	0/0	0/0	41/6
New York State TA	2/0	8/0	4/1	0/0	0/0	14/1
Conn. DOT	12/1	17/4	17/5	0/0	3/1	49/11
Rhode Island DOT	11/2	0/0	4/1	5/1	6/2	26/6
Mass. HD	9/2	17/5	26/4	2/0	10/2	64/13
Mass. TA	3/1	3/0	2/1	0/0	0/0	8/2
New Hampshire DOT	3/2	0/0	0/0	0/0	13/4	16/6
Maine TA	1/0	1/0	0/0	0/0	4/2	6/2
Maine DOT	4/1	1/1	0/0	0/0	18/5	23/7

- Phase 1: Year 4 - 6 (1996-1998)
 - The majority of these diversion points are located on I-95 and access primary and secondary parallel routes within areas of very high VMT. The majority of these diversion points also access multiple parallel routes. This phase is expected to coincide with the HAR operational test and will comprise 103 VMSs and 18 HARs for 18 agencies. Included in this phase are the following:
 - I-95/I-295/I-678/Hutchinson River Pkwy - NY
 - I-95/I-695 - NY
 - I-95/Bronx River Pkwy - NY

- Phase 2: Year 7 - 8 (1999 - 2000)
 - Diversion points that provide access to primary parallel routes. Some of these diversion points are located on I-95 and all service primary parallel routes with high VMT and will comprise 114 VMSs and 17 HARs for 14 agencies. These include the following:
 - I-95/I-495 - D E
 - I-76/I-676 - N J
 - I-295/I-76 - N J

- Phase 3: Year 9 - 10 (2001 - 2002)
 - The majority of these diversion points are not on I-95 but are along primary parallel routes and will comprise 129 VMSs and 24 HARs for 14 agencies. Locations identified include the following:
 - US 301/US 50/I-97 - MD
 - I-95/I-695- MD
 - I-95 Harbor Tunnel Thruway - MD

- Phase 4: Year 11 - 12 (2003 - 2004)
 - Diversion points that service secondary parallel routes in areas of medium to low VMT. This phase will comprise 70 VMSs and 12 HARs for 6 agencies. Approximately half of these points are located on I-95:
 - I-95/US 1 - PA
 - I-76/US 1 - PA
 - I-95/US 63 - PA

- Phase 5: Year 13 (2005)
 - Diversion points that service secondary parallel routes with low VMT. This phase will comprise 76 VMSs and 18 HARs for 8 agencies. These points are located both along I-95 and secondary parallel routes:
 - I-95/US 1 - MA
 - I-495/US 1 - MA
 - I-295/US 1 - MA

Cost Estimates

Capital and operating costs were calculated for each phase of the implementation program using cost estimates received from Coalition agencies. To compute the estimated cost for the preliminary expansion system, six different cost categories were used as follows:

- Permanent VMS
- Portable Solar VMS
- Portable Generator VMS
- Permanent HAR
- Portable Solar HAR
- Portable Generator HAR

All six cost categories were not necessarily used in estimating the costs for each phase. The cost for each phase was calculated based on the type of devices recommended for that particular phase as indicated:

- Phase 1 - Phase 3
 - all permanent VMS/HAR because the majority are primary parallel routes
- Phase 4 & Phase 5
 - all portable VMS/HAR because they are all secondary parallel routes

The estimated VMS/HAR capital costs for permanent VMS/HAR are indicated in Table 2-4.

TABLE 2-4
ESTIMATED PERMANENT VMS/HAR CAPITAL COSTS

TYPE	VMS(PER	HAR (PER STATION)
Permanent	\$92,000 - \$225,000	\$30,000
Portable/Solar	\$27,000	\$45,000
Portable/Generator	\$23,000	\$ 30,000

¹ Varies according to sign technology and mounting structure

Power consumption and communication costs were calculated for permanent VMS/HAR and are indicated in Table 2-5.

TABLE 2-5
PERMANENT VMS/HAR MONTHLY OPERATION AND MAINTENANCE COSTS

OPERATION	VMS	HAR
Power	\$ 90	Negligible
Dial-up/Month	\$ 40	\$ 15
Cellular/Month	\$ 60	\$ 40
T1 LL/Month	\$ 3500/3 - 4 signs ¹	N/A ²
MAINTENANCE	VMS	HAR
Maintenance	\$ 125 - \$ 925 ³	Negligible

¹ One T1 Leased Line (T1 LL) can operate up to 3 - 4 VMS

² Not Available

³ Varies according to sign technology

The capital and operating costs were calculated for solar and generator powered portable VMS/HAR. The costs are indicated in Table 2-6.

TABLE 2-6
PORTABLE VMS/HAR CAPITAL AND MONTHLY OPERATION AND
MAINTENANCE COSTS

CAPITAL	COST (\$)
VMS Solar	27,000
HAR Solar	45,000
VMS Generator	23,000
HAR Generator	30,000
OPERATION AND MAINTENANCE	COST (\$/MONTH)
Diesel Fuel (Generator)	60
Cellular (All Types)	40

The capital and operational costs for each phase of the expansion system are presented in Table 2-7.

TABLE 2-7
VMS/HAR CAPITAL AND OPERATIONAL COSTS FOR EACH PHASE

PHASE	VMS CAPITAL* (\$)	VMS OPERATION* (\$/MONTH)	HAR CAPITAL (\$)	HAR OPERATION (\$/MONTH)
Phase 1	9,476,000 - 23,175,000	26,265 -284,795	540,000	720 - 1080
Phase 2	10,488,000 - 25,650,000	29,070 - 315,210	510,000	680 - 1,020
Phase 3	11,868,000 - 29,025,000	32,895 - 356,685	720,000	960 - 1,440
Phase 4	1,610,000 - 1,890,000	2,800 - 7,000	600,000 - 900,000	1,200 - 2,400
Phase 5	1,748,000 - 2,052,000	3,040 - 7,600	540,000 - 810,000	1,080 - 2,160

*Varies according to the sign technology.

CHAPTER 3

FINDINGS AND RECOMMENDATIONS

Project 9 builds on the existing and planned VMS/HAR locations filling in the voids where VMS and HAR are needed to complete the system. Complimentary to this system is a set of operational guidelines for the use of consistent procedures and messages throughout the Corridor. It is envisioned that the ultimate result of this project will be a coordinated consistent VMS/HAR system that the motorists depend on for real-time traffic information. This project has assembled the information to develop a comprehensive VMS/HAR system. The next step is to begin implementing the guidelines described in this report.

FINDINGS

Current Deficiencies Identified

Perhaps more than anything else, this project discovered the similarities in the problems faced by Coalition agencies, even though the individual approaches to these problems differed. The following areas were identified as the main areas of concern expressed by the coalition agencies.

HAR Credibility

The credibility of HAR with the motorists seems to be the predominant concern among the Coalition members. This credibility problem is due to several factors:

- Improper application
- Failure to update messages on a regular basis
- Poor reception quality
- Monotone broadcasts
- A shortage of operators
- The lack of real time information to disseminate to the motorists

Several years of bad experiences have convinced motorists that HAR will not provide them with useful information, if it can provide them with any information at all. In fact the improper use of HAR has left many motorists oblivious to the existence of HAR. It makes no difference to the

motorist whether the HAR is within the Corridor or outside of the Corridor, From the motorist's perspective, all HAR are run by the same agency. For this reason it is imperative that all HAR in the Corridor operate consistently and properly so that, to the motorist, they will appear as a single entity.

Installing additional devices to expand the network will increase the areas of coverage but will not address the credibility problems. This is a serious issue which the Coalition must make a conscious effort to resolve. This report, based on discussions with the Coalition, included several suggestions that could lead to increased acceptance of VMS/HAR in the Corridor. These suggestions are:

- HAR must be a 24 hour operation to give clear, accurate, and real-time information
- VMS should be used (whenever possible) to advise motorists to tune in to HAR so that only those motorists which the HAR message pertains to will tune in.
- HAR must always provide a strong, clear, static free signal
- A TOC should maintain continuous contact with VMS/HAR devices
- A standard HAR advisory sign should be developed for use in the corridor
- Providing message update rate for HAR
- Providing time and date stamp with HAR messages

Common Message Formats

Each agency currently uses its own message formats and abbreviations. To a motorist traveling through the corridor this can be confusing and result in information being disregarded or misinterpreted. As a result, standard guidelines were developed so that agencies could benefit from the research that has been performed. Motorists would then begin to become familiar with the various phrases and abbreviations greatly enhancing readability and comprehension.

Coordinated Response

The uncoordinated dissemination of information can provide motorists with inadequate information. Inter-agency coordination and the coordinated use of VMS/HAR can provide motorists with seamless traffic information throughout the corridor resulting in greater public satisfaction with each individual agency.

Inconsistencies were unearthed in the VMS/HAR policies along the Corridor. While not requiring individual agencies to make changes in their policies, it was apparent that some procedures and guidelines needed to be developed to facilitate the uniform dissemination of information in the

Corridor. The agency reviews and subsequent workshops unveiled the need to develop inter-agency coordination procedures for the uniform deployment of VMS/HAR in the Corridor

Equipment Compatibility

One frustration expressed by nearly every agency was the inability to control several vendors' signs with a single computer. Each sign type uses a different protocol to communicate with the sign and therefore several workstations are needed to communicate with signs from different vendors. The only other option is to buy signs from one vendor which creates problems when the low bid process must be used. Therefore a common protocol for all agencies for all VMS and HAR devices was explored. This protocol could then be used in all specifications for VMS and HAR procurement. The numerous agencies that would use this protocol would support the private sector conversion to this protocol. In fact, it would be beneficial for the vendors due to the numerous "generic protocols" that they are being asked to adhere to. Since there is currently a Federal effort to develop an ITS protocol which would encompass all ITS devices including VMS and HAR, the efforts to develop a generic protocol therefore followed this effort. The main development of the NTCIP up to this point, has focused on traffic signal controllers. Through our efforts this focus has been broadened to include VMS and HAR. Through this project the NTCIP development provided feasible addressing schemes for devices and a preliminary list of command definitions for VMS signs.

Gaps In The Existing System

Current gaps of HAR coverage leave the motorist without needed information. Once filled, these gaps can enhance the credibility of VMS and HAR and provide a means for disseminating information to motorists. These devices will have the potential to alleviate congestion during incidents which will in turn reduce congestion, decrease accidents, relieve driver frustration and enhance productivity for commercial vehicles. Also, by ensuring complete coverage of the I-95 Corridor, the motoring public will come to rely on VMS and HAR for their information needs.

RECOMMENDATIONS

This project has assembled a coordinated plan to enhance the reliability and credibility of VMS and HAR. The next step to fulfilling this mission is to implement this plan by conducting operational tests. Based on the findings of Project 9, the I-95 NEC recommends that the Coalition do the following:

- *Provide training programs for personnel*

To ensure that the procedures and knowledge developed in this study are thoroughly disseminated to the correct personnel in the Corridor, training should be provided to inform those directly involved in VMS and HAR. One way of ensuring that everyone will have a chance to participate in this training would be to develop a series of videos to teach the issues covered in the documents. An effort is needed to determine what information should be included in these videos followed by the production of the videos. The videos must present information in a way that makes it easy to follow, understand, and remember. To increase familiarity with the document, the videos should follow the format of the document and use it as a reference. An evaluation of these training videos should be performed following their completion to determine their effectiveness.

- *Use the procedures and recommended practices presented in the reports listed in Chapter 7 of this report*

In order for this project to be a success each agency should begin using the operations guidelines. Each agency may begin using the documents immediately in their TOC and in planning for operational changes, Some agencies may need to evaluate their existing agency's procedures and revise them, if necessary, to combine them with the I-95 Corridor Coalition's guidelines. Pages of the operations guidelines, which are used daily, may be copied and kept with other quick reference material in the TOC. The following pages should be copied for quick reference: VMS/HAR Operations Guidelines and Recommended Practices - pages 2-5,9,12,14; 3-3,7,8,15,23; 4-2,10,15,16,31,40,41,42,43; 5-6. The standard message format, which is developed to provide the information in a manner that is easy to comprehend, should be followed. The list of acceptable and unacceptable abbreviations should be available to all personnel involved, and it should be utilized. This page should be copied and kept near the equipment. The reports are intended to be used as guides and should be kept available as a reference for the people using the equipment. Memorandums of understanding should be developed to define the responsibilities to be executed by individual parties.

- *Staff level personnel should make a conscientious effort to address the credibility issues of VMS/HAR*

This item may seem somewhat ambiguous; however, it is likely the most important recommendation from this document. Training will help to solidify ways in which HAR and VMS operators can ensure that credibility is maximized. This matter should therefore be addressed in the training videos. Any information placed on VMS or

HAR should be verified before being presented, and then updated frequently. Maintaining good coordination and communications with the incident agency will also help to improve credibility through the good experiences of the public. An immediate goal of all agencies is for all VMS and HAR to be updated at least every 30 minutes.

- *Encourage Steering Committee level personnel to actively promote the enhanced credibility of VMS and HAR within the/r agency*

This will accomplish the most dramatic increase in the credibility of VMS and HAR. There should also be an emphasis from the upper level people in the agency on the importance of using these guidelines on a daily basis.

- *Compare equipment specifications for the purchase of VMS/HAR devices*

The specifications developed in this project are provided as a baseline for agencies to use when developing a specification for new equipment. Each agency should compare their specifications with these and make adjustments as needed.

- *Incorporate the VMS/HAR expansion system into agency strategic planning and capital/ improvement projects*

The expansion sites were developed by the Coalition to fill the “gaps” in the current system and were intended to be incorporated into each agency’s plans. Each agency should compare the expansion system with their current plans and make adjustments as necessary. This effort will eliminate most gaps in the system. These locations were also selected to assist motorists with regional diversions. A seamless motorist information system will result in the Corridor if every Coalition agency adopts this plan.

- *Continue development of the NTCIP communication protocol for VMS and HAR*

Given the success that the Coalition has had already in expanding the focus of the NTCIP from traffic signals to VMS and HAR, the Coalition should stay actively involved in the VMS development and develop a NTCIP protocol for HAR. Use of the NTCIP will reduce expenditure on hardware needed to control systems from various manufacturers and will help with system maintenance. Therefore, the Corridor should allocate funding to continue involvement in the NTCIP development process. Coalition members should attend the national NTCIP meetings and include VMS and HAR vendors. The NTCIP should be incorporated into local agency specifications when available.

- *Update the reports produced in Project 9 as the Coalition’s knowledge base increases, particularly after the conclusion of Project 2, and develop a single operations manual for VMS/HAR, incident management, and the IEN*

Because this project was completed before Projects 1 and 2, it did not have the benefit of the knowledge and refinements that will be worked out as a part of Project 2 (*Incident Management - Detection, Response, and Operations*) and Project 1 (*Information Exchange Network*). As these projects progress they will have a direct impact on the coordination procedures and the alternate routing work that was done as a part of this project. These reports are living documents and new information should be shared at Coalition meetings and the reports updated accordingly. A single operations manual is also desirable for traffic operations personnel to eliminate the several manuals that will be produced as a result of the I-95 Corridor Coalition projects.

- *Begin a HAR Operational Test to evaluate the guidelines developed in this project*
This test should implement and test the guidelines and the implementation plan. The test should also determine whether the performance of HAR is improved by the use of digital technology. further, as a part of this test, digital HAR should be tested to determine its compatibility with the NTCIP.

A summary of these recommendations are presented in Table 3-1.

CONCLUSIONS

This project has formed the foundation for the coordinated use of VMS/HAR in the Corridor. More importantly, this foundation was not developed in isolation, but from working together with the Coalition members. Consequently, these guidelines and recommended practices reflect the needs of the Corridor and lend themselves to integration into existing Coalition agency VMS/HAR strategies. Project 9 has presented the Coalition with the framework required to bring uniform dissemination of accurate, real-time information in the I-95 Corridor. These guidelines will not become a reality overnight but with the commitment and dedication of the member agencies, this coordination will become a reality and in the process the motorist will begin to rely once again on the usefulness of VMS and HAR. The Coalition now has the tools to bring a state-of-the-art traveler dissemination system to the I-95 Corridor and make it the showcase of the Nation.

TABLE 3-1

SUMMARY OF RECOMMENDED ACTIONS FOR THE I-95 CORRIDOR COALITION

ACTION	RESPONSIBLE PARTY	ACTION NEEDED BY:
Provide training program.	Project 11 I-95 CC Technical Coordinator	August 1995
Use the procedures and recommended practices.	HOGS	August 1995
Staff level personnel should make a conscientious effort to address the credibility issues of VMS/HAR.	HOGS	Begin July 1995
Steering Committee level personnel should actively promote the enhanced credibility of VMS and HAR within their agency.	Corridor Executive Board	Begin July 1995
Compare equipment specifications for the purchase of VMS/HAR devices.	FRAT I-95 CC Technical Coordinator	September 1995
Incorporate the VMS/HAR expansion system into agency strategic planning and capital improvement projects.	Steering Committee	May 1996
Continue development of the NTCIP communication protocol for VMS and HAR.	FRAT I-95 CC Technical Coordinator	Ongoing
Update the reports produced in Project 9 as their knowledge base increases, develop a single operations manual for VMS/HAR, incident management, and the IEN.	I-95 CC Technical Coordinator	Conclusion of Project 2 and Project 1
Begin HAR Operational Test to evaluate the guidelines developed in the project.	Steering Committee I-95 CC Technical Coordinator	Ongoing

Project No. 9
Coordinated VMS/HAR Strategies

PART III
APPENDIX



I-95 Corridor Coalition

APPENDIX I
VMS/HAR MAPS

REFERENCE TO MAPS

Information on VMS/HAR devices were summarized on base maps of the I-95 Corridor. Two of those maps are included in this appendix for general information:

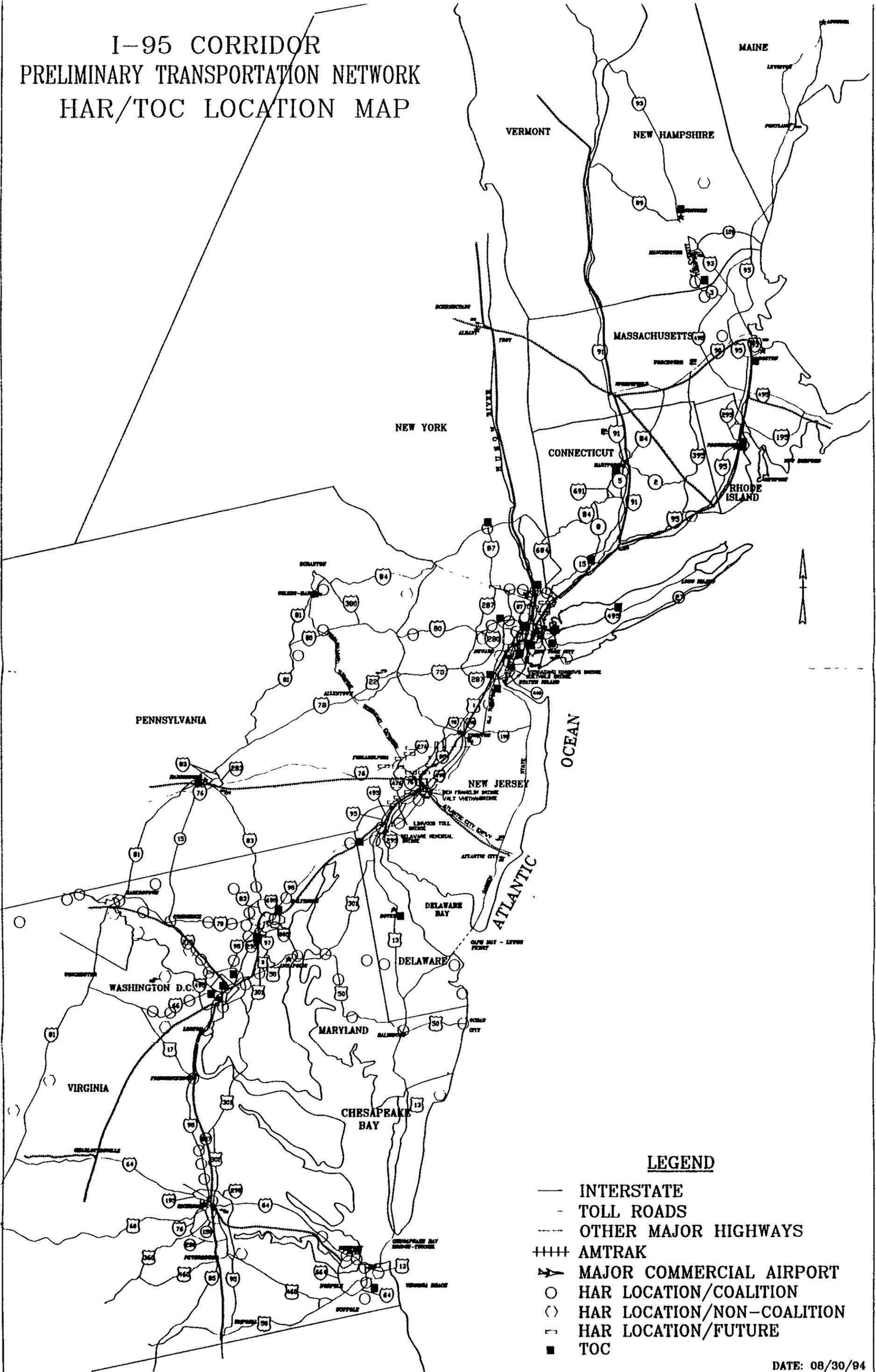
- VMS locations
- HAR/TOC locations

In order to minimize the size of the final report, it was not practical to include the more detailed maps produced as part of Project 9. For the readers' convenience however, a reference to these maps is presented below.

MAP	REPORT TITLE	PIN NUMBER
<u>VMS Locations</u> (1 section) <i>A map showing existing VMS locations.</i>	Operations, Policies, and Practices Coordination Workshop Notebook	I-95 CC 9-94-02
<u>HAR Locations</u> (1 section) <i>A map showing existing HAR locations.</i>	Operations, Policies, and Practices Coordination Workshop Notebook	I-95 CC 9-94-02
<u>HAR Ranges</u> (4 sections) <i>Maps showing the broadcast ranges of existing HAR.</i>	Comprehensive VMS/HAR Expansion System Development and Implementation	I-95 CC 9-95-07
<u>Proposed HAR Expansion System</u> (4 sections) <i>Maps showing the locations of proposed HAR by phase.</i>	Comprehensive VMS/HAR Expansion System Development and Implementation	I-95 CC 9-95-07

MAP	REPORT TITLE	PIN NUMBER
<u>Proposed VMS Expansion System</u> (4 sections) <i>Maps showing the locations of proposed VMS by phase.</i>	Comprehensive VMS/HAR Expansion System Development and Implementation	I-95 CC 9-95-07

I-95 CORRIDOR PRELIMINARY TRANSPORTATION NETWORK HAR/TOC LOCATION MAP



LEGEND

- INTERSTATE
- - - TOLL ROADS
- - - OTHER MAJOR HIGHWAYS
- ++++ AMTRAK
- ✈ MAJOR COMMERCIAL AIRPORT
- HAR LOCATION/COALITION
- HAR LOCATION/NON-COALITION
- - - HAR LOCATION/FUTURE
- TOC

DATE: 08/30/94

APPENDIX II
LIST OF ACRONYMS

CCTV	-Closed Circuit Television
ConnDOT	-Connecticut Department of Transportation
FCC	-Federal Communication Commision
FHWA	-Federal Highway Administration
GIS	-Geographic Information System
HAR	-Highway Advisory Radio
IEEE	-Institute of Electrical and Electronic Engineers
IEN	-Information Exchange Network
Interim CCC	-Interim Corridor Communications Center
ITS	-Intelligent Transportation Systems
MUTCD	-Manual of Uniform Traffic Control Devices
NTCIP	-National Transportation Control/ITS Communication Protocol
NEC	-Northeast Consultants
OIC	-Operations Information Center
PriMIZ	-Primary Motorist Information Zone
SeMIZ	-Secondary Motorist Information Zone
SuMIA	-Surrounding Motorist Information Area
TIS	-Traveler Information Station
TOC	-Traffic Operations Center
TRANSCOM	-Transportation Operations Coordinating Committee
TRB	-Transportation Research Board
TRC	-Technical Review Committee
TRIS	-Transportation Research Information Services
USDOT	-United States Department of Transportation
VMS	-Variable Message Sign
VMT	-Vehicle Miles of Travel

APPENDIX III

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