Freeway and Arterial Management Effort (FAME) Research Plan

WA-RD No. 171.1

Final Technical Report

January 1988

Washington State Department of Transportation
Washington State Transportation Commission

in cooperation with the
United States Department of Transportation
Federal Highway Administration

WASHINGTON STATE DEPARTMENT OF TRANSPORTATION

TECHNICAL REPORT STANDARD TITLE PAGE

1. REPORT NO.	2. GOVERNMENT ACCESSION NO.	3. RECIPIENT'S CATALOG NO.
WA-RD 171.1		

4. TITLE AND SUBTITLE	5. REPORT DATE
Freeway and Arterial Management Effort (FAME) Research Plan	January 1988
	6. PERFORMING ORGANIZATION CODE
7. AUTHOR(S)	8. PERFORMING ORGANIZATION REPORT NO.
Rutherford, G. S. and Hallenbeck, M. E.	
9. PERFORMING ORGANIZATION NAME AND ADDRESS	10. WORK UNIT NO.
Washington State Transportation Center 4507 University Way, #204 Seattle, WA 98105	11. CONTRACT OR GRANT NO. Y3399, Task 30
12. SPONSORING AGENCY NAME AND ADDRESS	13. TYPE OF REPORT AN PERIOD COVERED
Washington State Department of Transportation Transportation Building, KF-01 Olympia, WA 98504	Final Technical Report
	14. SPONSORING AGENCY CODE

15. SUPPLEMENTARY NOTES

This study conducted in cooperation with the U. S. Department of Transportation, Federal Highway Administration.

16. ABSTRACT

FAME will be performed as nine separate but related tasks. These tasks will be pursued parallel to each other and will integrate together as they are completed. The basic tasks to be performed are as follows:

- Improve motorist information system.
- Develop incident management systems.
- Implement traffic management systems for construction projects.
- Design and implement real-time freeway management systems.
- Design and implement real-time arterial management systems.
- Integrate the arterial and freeway management systems.
- Analyze the potential effects of new technologies for relieving congestion.
- Develop improved treatment for HOVs.
- Improve methods for managing traffic demand of new developments.

The above tasks will be conducted in a manner that produces a series of tools and products that can be incrementally implemented to improve the flow of traffic in the state's urban areas.

17. KEY WORDS	18. DISTRIBUTION STATEMENT
Arterial Management, Freeway Management	No restrictions

19. SECURITY CLASSIF. (of this report)	20. SECURITY CLASSIF. (of this page)	21. NO. OF PAGES	22. PRICE
None	None	36	

WASHINGTON STATE DEPARTMENT OF TRANSPORTATION FREEWAY AND ARTERIAL MANAGEMENT EFFORT (FAME) RESEARCH PLAN

by

G. Scott Rutherford
TRAC Director

Mark E. Hallenbeck
Research Engineer

Washington State Transportation Center (TRAC)
University of Washington, JE-10
The Corbet Building, Suite 204
4507 University Way N.E.
Seattle, Washington 98105

Washington State Department of Transportation
Technical Monitor
Les Jacobson, FAME Project Manager

Final Technical Report

Research Project Y3399
Task 30

Prepared for

Washington State Transportation Commission
Department of Transportation
and in cooperation with
U.S. Department of Transportation
Federal Highway Administration

January 1988

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PROBLEM STATEMENT

The traffic levels in urban areas in most U.S. cities are expected to continue to grow throughout the coming decades. A recent FHWA research report, (a summary of which was published in the January 1987 edition of the ITE Journal) indicated that the central Puget Sound region has the sixth worst traffic congestion in the nation. This congestion results in an increasingly unacceptable level of delay for motorists and increased energy use. The funds do not exist to build new transportation facilities that might help alleviate the congestion that will be caused by this expected growth in travel. For several years now, the Washington State Department of Transportation (WSDOT) has implemented transportation system management projects that have attempted to increase the person- and vehicle-carrying capacities of existing facilities without the expense and urban dislocation required by new construction.

In arterial street networks, several street systems are now equipped with real-time traffic controllers that continuously update traffic signal timing plans to provide the smoothest traffic flow possible. Such systems are planned for additional signal networks as funding becomes available. For the freeway systems, HOV lanes, ramp metering and reversible lanes are among the options chosen by WSDOT to increase capacity, reduce congestion and provide a more environmentally sensitive and energy efficient transportation system.

WSDOT is also investigating and implementing a series of measures for constraining the demand for additional traffic capacity and improving the utilization of capacity that already exists. One on-going project is the implementation of a message sign system to improve the delivery of traffic information to drivers and increase their awareness of upcoming traffic conditions. Other means of controlling the rising demand for roadway capacity being pursued by WSDOT include promotion of carpooling and other forms of mass transit, cooperation of the WSDOT with traffic reporters for local radios, and the interaction of the WSDOT with other agencies (the police, transit authorities, etc.) to

mitigate traffic congestion due to traffic accidents and road construction through the design and implementation of special temporary traffic control plans.

At present, the WSDOT wishes to establish consistent procedures for comparing the above systems and develop a process for making these alternative strategies work in a coordinated, "real-time" fashion. A strong, coordinated effort is needed to identify the most beneficial of the available strategies and to integrate these traffic control strategies into a single system. Such a coordinated program would assist the WSDOT in operating under the best set of control measures for maintaining maximum traffic movement.

The program and procedures selected by the Department must also account for the changing nature of traffic congestion. While traditional, peak hour, suburban-to-urban congestion still exists and is growing, congestion in suburban areas, particularly that due to suburban-to-suburban movements, is growing at a much faster rate. Suburban travelers are traditionally more difficult to shift to high occupancy modes of travel because of their decentralized origins and destinations and their multi-directional travel paths. Consequently, different types of information, incentives and alternatives may be required to impact the traveling decisions of suburban-to-urban travelers than need to be presented to suburban-suburban travelers, and the system developed by the Department should address the needs of both types of travel.

BACKGROUND

All of the urban areas in the state experience periods of heavy traffic congestion. In most cases, the WSDOT has little opportunity to construct new miles of freeway or alternative facilities to help alleviate this congestion. Consequently, since the 1970s growing emphasis has been placed on increasing the person-carrying capacity of existing roads rather than on the construction of new facilities.

The Puget Sound region serves as an excellent example of the problems facing WSDOT traffic engineers. At a recent multi-corridor steering committee meeting that included the discussion of various mass transit alternatives, Puget Sound area governments and agencies decided, as a matter of policy, that rail transit will not be considered until 1993. This means that the existing arterial and

freeway systems and HOV lanes in each urban area's arterials and freeways will serve much of the mass transportation system through the year 2020.

As part of the Puget Sound transportation program, METRO began constructing a $400 million downtown bus tunnel this summer. Each end of this tunnel ties directly into the freeway system. This decision places even more importance on the operation of the freeway system and, in particular, how the HOV system relates to the freeway system. Having the cooperation of the city and county traffic engineering departments is also paramount to the successful outcome of this regional mass transit system. If the buses and other HOV vehicles cannot adequately access the freeway lanes from arterials, then the freeway system will not be able to provide the level of service which is needed to attract patrons to the mass transit system. This proposed project may provide the catalyst needed to gain the cooperation of many local officials, adding to its regional benefit.

The Washington State Department of Transportation (WSDOT) is currently performing or has recently completed several projects that are directly related to the FAME project. Among the projects recently completed are the following:

- **Park-and-Ride Study.** The Park-and-Ride study analyzed the cost effectiveness of 26 permanent park-and-ride lots within the Puget Sound area. This analysis included the extensive use of models developed in the San Francisco Bay area to describe the costs and impacts of various transportation improvements.
- **HOV Lane Analysis.** This study evaluated the cost effectiveness of HOV lanes in the Puget Sound area. It used analysis techniques similar to those used in the Park-and-Ride study and provided excellent data for continued evaluation of the freeway system.
- **Ramp Metering Project.** This WSDOT and FHWA project evaluated the effects of a ramp meter placed on State Route 520 in Seattle at the Montlake Boulevard entrance. This study documented the impacts of the ramp metering system on freeway, transit and local road traffic.
- **Flow System Documentation.** This project, conducted by one of WSDOT's district offices, evaluated the effectiveness of the Flow System, which incorporates 18 ramp

meters on Interstate 5 north of Seattle, and demonstrated the effectiveness of this type of freeway control strategy. The state is now actively involved in expanding these metering activities.

- **Telecommunications Link with Freeway Control Center.** This project provided a data transfer link between the Washington State Department of Transportation's Traffic Systems Management Center and the University of Washington's computers (Exhibit 1). The state is improving its capabilities to analyze traffic data for operations and research projects.
- **Inventory of Traffic Signal Timing Optimization Candidates.** This project, funded by the Washington State Energy Office, assessed opportunities to improve arterial flow using available signal timing software.

The area directly affected by these projects can be seen in Exhibit 2. Each of these projects examined some aspect of the urban roadway system, with the intent of improving traffic flow or maximizing the benefits of WSDOT's expenditures for urban roads. The findings of these reports now need to be integrated. This project proposes to analyze the feasibility of such coordination and begin the process of integrating different WSDOT efforts for improving traffic flow and driver information with the effect of reducing energy consumption.

In addition to the above WSDOT projects, local transit agencies throughout the region have projects underway to help reduce congestion on our transportation system. In particular, Seattle Metro is committed to improve mobility in the suburban areas within its jurisdiction. Pierce Transit, as part of the study to investigate the extension of the PSCOG's Multi-Corridor Study to the south, is looking at a express bus service from the Tacoma area to downtown Seattle as a short-term improvement in the I-5 South Corridor. Community Transit is addressing the demand for service between jurisdictions with an extensive contract commuter service which operates between south Snohomish County and downtown Seattle along the I-5 North Corridor.

There is also a considerable amount of work taking place both nationally and internationally on applying state-of-the-art electronic technology to transportation problems. The advent of inexpensive microcomputers, cellular telephones, other advanced communications technologies,

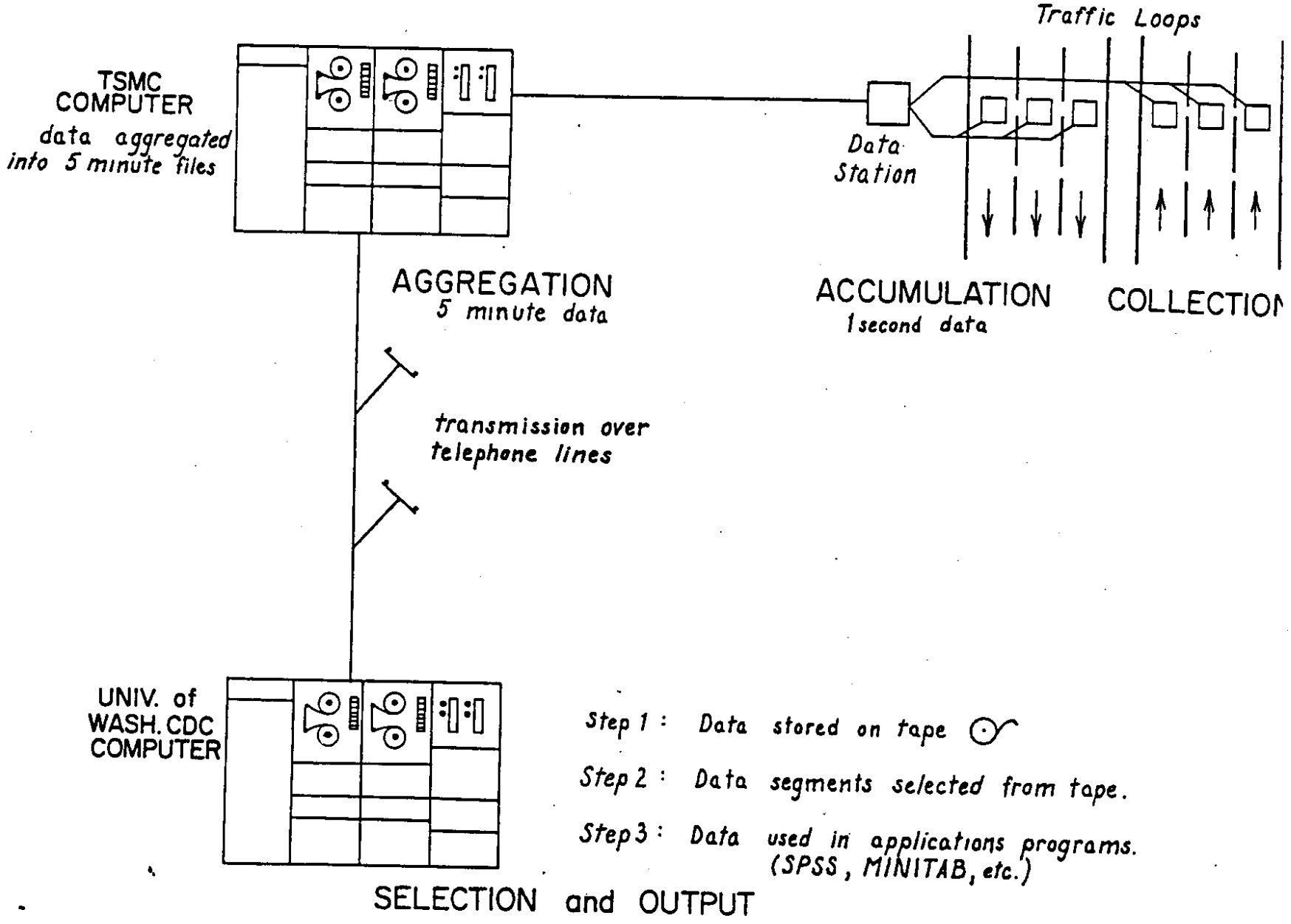
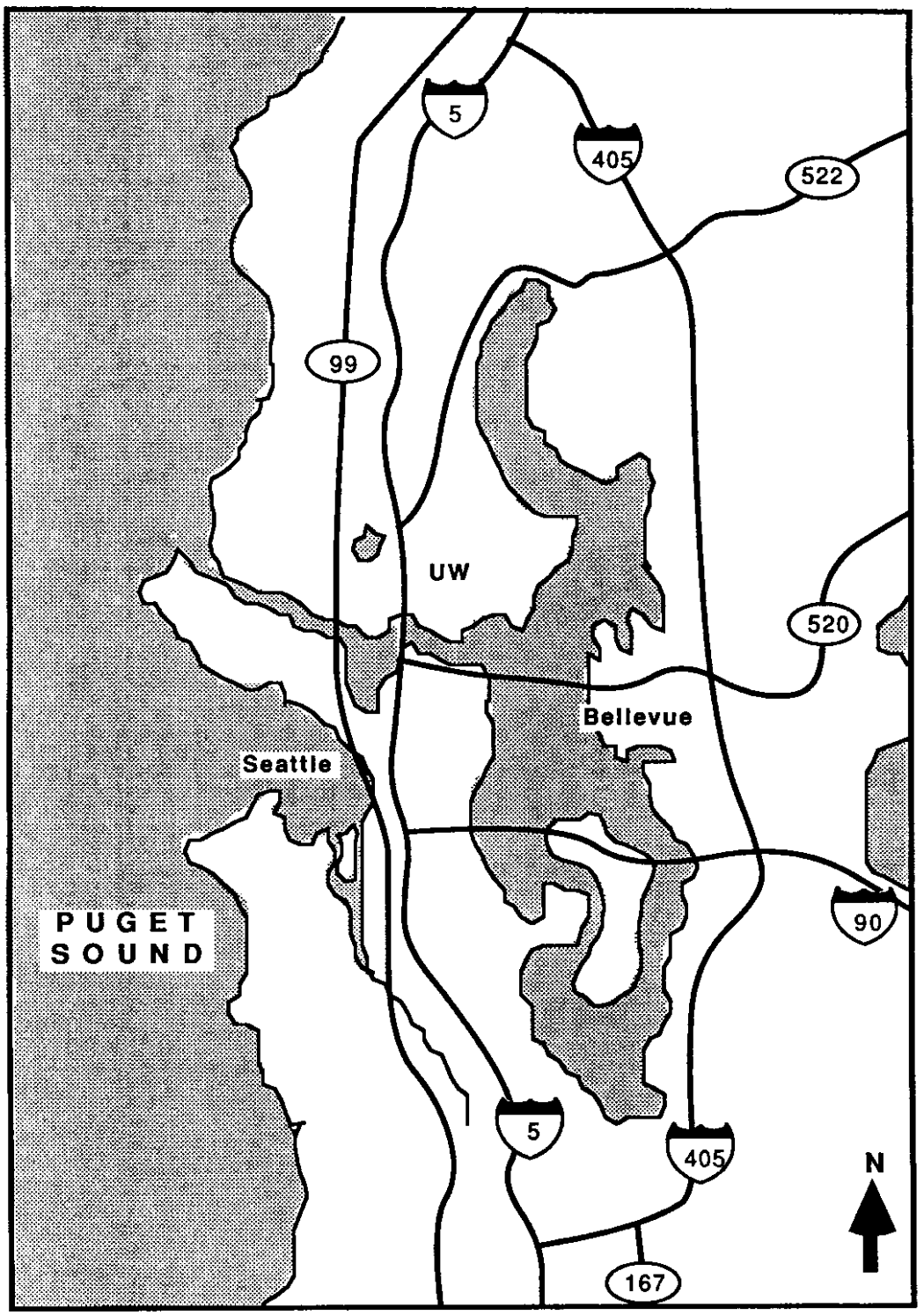


Figure 1. Data transfer link between the University of Washington and WSDOT Freeway Surveillance Center

EXHIBIT 2



computer networks, more powerful computer languages (e.g., artificial intelligence), and other related electronic components bring important new capabilities to the traffic engineer.

Among the many improvements in transportation technologies that have been demonstrated recently are the following:

- new traffic modeling techniques,
- new devices for collecting traffic flow information,
- electronic route guidance,
- automatic vehicle identification,
- improved means of providing driver information,
- adaptive traffic control,
- interactive traffic control, and
- automatic vehicle control.

Some of these technologies (notably automatic vehicle control) are still in the formative stages of system development. However, many of these technologies require only final systems specification and design before they can be implemented.

OBJECTIVES

The basic objectives of this project are to perform research to help plan, design and implement a series of systems (and components of systems) that will lead to improved traffic flow and decreased fuel consumption through better driver information, more productive and efficient operation of existing facilities, better response to traffic incidents, and better planning for future roadway improvements. Specific objectives within this project are to

- increase HOV usage,
- manage freeway flows with improved ramp metering techniques,
- design and implement a preliminary motorist information system via public access cable television and/or through other technologies and media,
- develop plans for a more sophisticated information system for later implementation,
- examine alternative traffic control plans for use during traffic incidents,

- in cooperation with the District 1 Construction Traffic Coordinator, the Washington State Patrol (WSP), and affected local agencies develop incident management techniques to help alleviate traffic congestion caused by these disruptions,
- improve the existing traffic management system for use in mitigating congestion due to planned freeway reconstruction,
- design and build a freeway and arterial database that can be used for analyzing the design and operation of various traffic control measures (ramp meter timing, new HOV facilities, new lanes of roadway at bottleneck points, etc.),
- evaluate, select and implement a demonstration of improved, coordinated, real-time traffic control on WSDOT (and/or cooperating local agency) operated arterial signal systems,
- improve the Department's ability to monitor and forecast HOV use,
- provide guidance for cities and counties seeking to improve vehicular flow,
- provide guidance to cities and counties seeking to improve their travel demand management capabilities,
- design and implement improved real-time freeway monitoring and control systems, and
- develop the plan for integration of the freeway and arterial management systems.

Funds to meet these objectives will come from a variety of sources, including but not limited to WSDOT HPR funds, WSDOT district operations funds, the Federal Highway Administration, and the State Energy Office.

PRODUCTS

The FAME project will result in a series of products over its life span. Some of these products will be the result of work done by district and headquarters offices in conjunction with the overall goals and objectives of FAME. While the specific form of some of these products remains to be determined by the outcome of the proposed research and the final systems design process, the functions of the majority of the products to be produced by FAME are as follows:

- a system design for a TV-oriented driver information system,
- a functioning, TV-based driver information system,
- an expanded driver information system that uses a variety of information dissemination technologies,
- a regionwide incident management system,
- a methodology for developing major reconstruction traffic impact mitigation plans,
- a database for developing major reconstruction traffic impact mitigation plans,
- a plan for an integrated freeway and arterial management system,
- an improved freeway metering control system,
- a database for analyzing potential new transportation improvements,
- a plan for monitoring the success of projects meant to encourage the use of HOVs,
- a method for forecasting HOV usage, and
- a plan for increasing private involvement in park-and-ride lot development.

IMPLEMENTATION

A primary goal of the FAME project is to implement the systems and strategies selected and developed in the FAME project. To perform this implementation, FAME will include coordination and cooperation with WSDOT's district offices, various offices in WSDOT's headquarters, the local council of governments, local transit agencies, local public works and engineering departments and planning agencies for the surrounding communities, county engineering and planning offices, and the Washington State Transportation Center (TRAC). The WSDOT State Traffic Engineer has agreed to provide overall direction for the program.

RESEARCH PLAN

This section describes the research plan to be followed by the Washington State Department of Transportation to evaluate, design and implement the complex series of systems that will be developed under FAME. The basic goal of these systems is to improve the operation of the region's urban freeway and arterial systems.

The research plan for FAME presented below will change over time as a result of the findings of the early phases of the program and the findings of ongoing and proposed research. However, these changes will not affect the basic structure and objectives of FAME as described below. In addition, funds for the complete implementation and operation of FAME have not been completely identified.

Overview

FAME will be performed as nine separate but related tasks. These tasks will be pursued parallel to each other and will integrate together as they are completed. The basic tasks to be performed are as follows:

Task 1 improve motorist information systems,

Task 2 develop incident management systems,

Task 3 implement traffic management systems for construction projects,

Task 4 design and implement real-time freeway management systems,

Task 5 design and implement real-time arterial management systems,

Task 6 integrate the arterial and freeway management systems,

Task 7 analyze the potential effects of new technologies for relieving congestion,

Task 8 develop improved treatments for HOVs, and

Task 9 improve methods for managing traffic demand of new developments.

The above tasks will be conducted in a manner that produces a series of tools and products that can be incrementally implemented to improve the flow of traffic in the state's urban areas. Emphasis will be placed on designing systems that are

- appropriate for the tasks they are expected to perform,
- maintainable within the budget and technical capabilities of the Department of Transportation,
- cost effective, and
- affordable within the Department's capital improvement, operations and maintenance budgets.

Within each of the nine tasks identified above will be one or more projects. Each of these projects will produce products or product specifications that can be used within the overall traffic management

system. In the task descriptions below, the goals of each task are initially explained. The various projects and subtasks that will result in achieving those goals are then described.

Task 1 -- Improve Motorist Information Systems

Goals

The specific goals of this task are to develop and demonstrate methods for improving the delivery of information to motorists that will allow them to make more informed decisions concerning their choice of routes and time of travel. With this information motorists will be able to reduce their traffic delays and decrease their fuel consumption. They will also increase the total vehicle and person carrying capacity of the road network as a whole by spreading trips more efficiently throughout the day and across parallel routes. Proposed efforts within this task will do the following:

- determine the information needs of motorists at different points during trips (e.g., before they leave their origin point, before they reach a major junction point, etc.),
- determine what messages and types of messages affect motorist behavior,
- evaluate alternative information dissemination strategies such as variable message signs (VMS), highway advisory radio (HAR) commercial radio, and television,
- improve the use of existing technologies by refining the manner in which they are used (e.g., using different messages on variable message signs or changing the lighting used on those signs),
- test some of the new or improved mechanisms for delivering information to motorists.

Results from the demonstrations and tests to be done in FAME will then be used to design advanced systems that are more capable than current systems (e.g., automated message generation and signal timing adjustment) and which can be implemented gradually as more information on traffic dynamics becomes available to the Department from tasks 1, 4, 5 and 6.

Subtasks

Two initial projects have been identified within the Driver Information System task. These projects will need to be followed by additional research, system development and testing.

The first project in this task will be broken into three phases. The first phase will investigate the information needs of motorists. This effort will determine the "market" for information. It will

describe the kinds of information required to impact motorist's route choice, mode choice and departure times. This information is required before actual systems of information dissemination can be developed. Without a determination of the messages and information required to impact driver behavior, even the "best" display of data (in terms of visibility, legibility, and clarity) will not affect travel. Work in this task will begin with a review of published research, including FHWA studies such as "Human Factors Requirements for Real-Time Motorist Information Displays" and "Human Factors Design of Dynamic Visual and Auditory Displays for Metropolitan Traffic Management."

The second phase will investigate physical systems for disseminating information. Systems to be examined include pre-trip and in-route information systems. Examples of pre-trip systems include:

- televised traffic advisories (on both commercial and public access TV),
- radio broadcasts, and
- telephone based trip planning systems.

In route systems that will be examined for means of improvement and/or implementation include:

- HAR systems,
- variable message signs,
- commercial radio,
- in-vehicle route guidance systems, and
- other technologies identified in task 7, through the work done in the first part of this task, and through other national research.

The third phase of the project will examine the impacts of the prototype systems on traffic flow. In particular, an attempt will be made to measure the diversion of trips between routes and the impact of those diverted trips on the performance of the two facilities.

This first project will require testing of a variety of messages, message displays, and information products. Specific graphics hardware to generate displays to communicate the desired information will be selected in this project.

Based on the outcome of this project, and any additional work that may be identified to complete the initial work in this area, at least one more project will be required to determine the combination of systems that can produce the required information outlets. At least one project will be

required to synthesize the results of these two projects and develop specifications for the components of a complete motorist information system based on the availability of data from the freeway and arterial management systems developed in tasks 5, 6 and 7.

The result of the final project should be a system design that can be implemented by the WSDOT to provide information to motorists.

Task 2 -- Develop Incident Management Systems

Goals

Under this task, FAME support will be integrated with the development of an incident management system within District 1 and other WSDOT Districts. While District 1 has already undertaken the initial steps of working with the Washington State Patrol (WSP) to develop plans, procedures and systems for more effectively performing incident management work, this effort will need to be continued and expanded upon. This task will rely on the results of the district's efforts. Coordination will take place with district personnel to prevent duplication of effort. Specifically, work will need to be done to

- improve routing and signaling plans for major freeway flow disruptions,
- develop plans for alleviating traffic congestion for commonly occurring traffic incidents,
- design and develop communication systems (VMS, HAR, etc.) for notifying motorists and local residents of the occurrence of incidents, and
- design and apply a methodology for examining the effectiveness of alternative incident response measures.

Some of these objectives will be met through coordination with work being done in other tasks.

Subtasks

Projects in this task will be coordinated with ongoing joint efforts among the Department of Transportation, the WSP and local police and transportation jurisdictions. The effort to more efficiently manage incident caused traffic congestion will be done concurrently with the task 3 efforts to improve management of traffic congestion caused by construction. Areas of study specifically within this incident management task are as follows:

- evaluation of incident response techniques,
- development of incident management systems,
- evaluation of incident detection techniques and detector spacings to be used in enclosed portions of I-90 to determine if similar systems should be installed and used in other corridors, and
- review and evaluation of alternative incident detection techniques for areas without the closely spaced detectors present in the I-90 corridor.

Research needs to be done to develop a methodology for evaluating the effectiveness of WSDOT's existing incident response techniques and assisting District offices in their efforts to work with the State Patrol. Data are required to measure

- the average length of incidents both in terms of the time to clear the incident from the road and the size of traffic backup,
- the time required to respond to different types of incidents,
- the effectiveness of specific responses, and
- the duration of incident related backups.

These data will be used as input into evaluations of all kinds of incident response measures. Currently no system exists for adequately collecting and analyzing such information. Methodologies for obtaining this information

- need to be developed,
- should be tested as part of this research effort, and
- should be used to test the effectiveness of a variety of incident response techniques.

Initial evaluations might include the effectiveness of accident investigation sites in the Seattle urban area or the impact of using remote equipment storage facilities to speed the WSP and WSDOT response to incidents.

One final project to be considered within incident management will be an evaluation of incident detection techniques, to be conducted within the enclosed portion of the I-90 corridor. Such an evaluation needs to be done to determine

- how well the incident detection algorithm works, and

- if the benefits of such a system warrant the expansion of this type system to the remainder of the urban freeway system.

Task 3 -- Implement Traffic Management System For Construction Projects

Goal

This task entails research into the mitigation of traffic congestion caused by planned construction projects as opposed to unexpected incidents. The goal of this task is the development of a process for routinely developing and analyzing traffic mitigation measures within the urban area. The database developed in this Task will be used to develop a management plan for the I-405 HOV construction project.

Subtasks

Within this task, a system for performing traffic diversion and routing plans will be designed for freeway reconstruction and major maintenance projects. This system will include the set-up and use of a database for analyzing prospective traffic diversion and congestion mitigation plans. The system will be initially tested and implemented as part of the HOV lane construction effort scheduled for I-405. The TRAF model will be used for developing the routing plans for this first test..

The development of construction management systems will be a long-term project. The initial work in this area will take place as part of the analysis of the TRAF model WSDOT is performing for FHWA. (TRAF is a modeling package written by FHWA which can simulate traffic on freeways and arterials simultaneously. It is also designed to provide information on route choice between parallel arterial and freeway routes.)

Management systems developed as a part of these initial efforts will be subject to revision based on continuing research, changing roadway conditions, available resources, and other factors. Initially, one corridor (I-405 between south Renton and I-5) in the Seattle urban area will be selected for study with the TRAF model. The traffic characteristics (routes, volumes, origins and destinations, common accident patterns, etc.) will be determined from available sources and combined with roadway geometric and control information. This database will then be used to examine the effects of different traffic management efforts on congestion caused by construction.

If the above approach is successfully implemented, it will be expanded to other corridors within the Puget Sound metropolitan region, the Spokane metropolitan area and the Vancouver, Washington, metropolitan area. Directions for using the system will be developed, and the database used by the evaluation system will be expanded for use within other corridors throughout the state. Methods for managing and maintaining this expanded database, such as the Integrated Traffic Data System (ITDS) will also be explored. This expansion of the system will constitute the second phase of this project.

Task 4 -- Design And Implement Improved Freeway Management Systems

Goal

The goal of this task is to design, demonstrate and eventually implement an updated freeway management system. The system will provide improved real-time management of the freeway ramp controls that currently exist or are scheduled for deployment on the Puget Sound freeway system. The system will provide short-term forecasts of traffic conditions for use within the Department's ramp metering algorithms and will eventually serve as the basis for an advanced motorist information system.

Subtasks

Three subtasks will be initially required for this task. These three subtasks are

- the set-up of a long-term method for collecting, validating, storing and analyzing traffic information available through the TSMC computer system and loop detectors,
- the development and testing of software for forecasting short-term freeway flow, ramp volume and ramp queue length for use in a coordinated metering system for each freeway corridor, and
- the analysis of alternative control strategies for future freeway operation using a computer model.

The initial project will continue work to set up a data transfer link between the computer operating the FLOW system and computers used to do research and other analytical tasks using freeway flow information. Currently this link can operate between the TSMC and the University of Washington. In the initial part of this subtask, an analysis will be needed to indicate

- what analyses are to performed with these data,
- what software should interface or use these data,
- what software is needed to store the data,
- what format the data should be stored in,
- where such a database should permanently reside,
- the size and capability of the computers used to store and analyze the data collected, and
- the software to be used to support the data analysis functions of the system.

Specifically, the study will need to determine whether the TSMC/UW telecommunications link should be permanently maintained or if the WSDOT should take over the storage of such data. If the WSDOT takes over the system, it will need to evaluate the question of whether to port the existing UW software to the WSDOT site or rewrite the software in a language currently supported by WSDOT.

A second subtask within this first project is to test and possibly improve the reliability of the vehicle detector information used by the FLOW system. This will help ensure that the data used by the freeway control system and the analyses conducted throughout FAME and future freeway operations research accurately reflect true traffic conditions. Improvements in the reliability of vehicle detection data might also enable computerized incident detection algorithms to function more effectively. Work done in this area will start with and expand on work done by ITS for CALTRANS.

A third portion of this project should examine ways in which erroneous data could be replaced with predicted data for use within the freeway control system. The need for this phase of the project will be dependent on the types of detector errors that are found, the ability of the system to forecast accurately, and a review of the effects of incorrectly estimating when detectors are malfunctioning.

The second project in this task will be the investigation of forecasting mainline and ramp volumes and queues for use in the ramp metering algorithms. This research effort will attempt to determine predictive algorithms that could be incorporated into the existing control system software to reduce the congestion effects currently caused by delayed system reaction to freeway incidents and flow disruptions.

The current algorithm used by the WSDOT calculates metering rates for each controlled ramp in the system every twenty seconds. The algorithm determines if vehicles are being stored in any section of the controlled freeway by comparing the number of vehicles entering the section on the mainline and on the adjacent on-ramp(s) with those exiting the section on the mainline and on the adjacent off-ramp(s). If more vehicles are entering than exiting and the lane occupancy is above a threshold value, the section is said to be storing vehicles. The algorithm then reduces the metering rates on upstream ramps by an aggregated total equal to the number of vehicles stored in the section. The amount of reduction for each ramp is distributed according to a weighting factor assigned to each ramp. The algorithm performs this calculation on each freeway section, defined by two adjacent mainline stations, in the control system. The most restrictive metering rate calculated for a given ramp by this algorithm will be implemented. This algorithm will react to incidents and change metering rates accordingly.

Under the Interstate 90 construction project, the current computer system used for ramp control will be replaced. The design of that system will begin in the spring of 1988. Both software and hardware will be designed in this effort. Although the current software algorithms will probably provide the basis for the new system software design, some modifications to these algorithms are possible. The Interstate 90 design effort may lead to future evaluation of the system and additional research, particularly dealing with improved real-time ramp control strategies.

The final project within this task will be to use the database developed under tasks 2 and 3 to analyze the impacts of proposed capital and operational improvements to the freeway system. The database developed in those tasks should allow the analysis of such energy saving projects as the extension of the HOV lanes, effects of alternative HOV lane configurations (e.g., required weaving movements), changes in the ramp metering strategies employed by the Department and the impacts of selected capital improvements (for example, addition of a lane at a particular congestion bottleneck).

Task 5 -- Select And Implement Improved Real-Time Arterial Management Systems

Goal

The goal of this task is to select and implement a management strategy that can react to real-time changes in traffic conditions for the arterials under the control of the WSDOT. In addition, under

this task the WSDOT will develop the expertise necessary for assisting local jurisdictions in implementing their own arterial management strategies for providing real-time control of arterial systems.

Subtasks

Initial research within this task will include two District 1 projects and some work with the City of Bellevue. The first of the District 1 subtasks will be the conversion of the District's existing signal system software for use on Type 170 traffic signal equipment. This software will allow the control equipment to act as a multi-leveled system with distributed intelligence. In the existing software, the local controller has normal, time-based signal control, plus background cycle lengths and conditional service. A local master supervises signals within a subsystem and handles communications with the local controllers concerning time of day, updates to timing parameters, collection of traffic data, alarm information and inquiries from a central computer.

The second programmed project will be the installation of new Type 170 equipment in District 1 signal systems. This project is being funded with EXXON oil rebate funds.

Bellevue is currently installing a UTCS 1.5 generation signal system for its downtown core. FAME will assist in the evaluation of this system and determine the cost effectiveness of this solution for other signal systems. This will be the third identified project.

In addition to these projects, WSDOT will need to examine the potential for regional or central control of the WSDOT arterial system. This project has two related subtasks. In these two tasks, WSDOT should examine

- the selection of regional controlling software and evaluate the impacts of installing such a system on WSDOT arterials, and
- the potential for using adaptive or interactive signal control on local arterial networks that connect to WSDOT facilities.

Adaptive and interactive signal control both attempt to modify signal plans in real-time, based on observed traffic volumes and queues.

Several local jurisdictions have heavily congested signal networks that may benefit considerably from the implementation of adaptive control systems such as OPAC, SCAT, SCOOT or

UTCS 1.5. Interactive traffic control may allow even more significant travel savings if the research performed in Task 7 shows it to be feasible. It is likely that investigations into either of these signal system alternatives will require a joint effort of the WSDOT with a local jurisdiction.

The investigation of the OPAC system would be of particular interest. Under current tests in Arlington, Virginia, and Tucson, Arizona, this control system has shown impressive benefits when compared to a two-phase actuated controller. Further research in implementing this system on model 170 controllers and in implementing OPAC on a system of adjacent intersections is needed. This could be the focus of another project within this task.

Task 6 -- Integrate The Arterial And Freeway Management Systems

Goal

The goal of this task is to integrate the arterial and freeway management efforts. A secondary goal is to examine the uses of both the freeway information gathered by the system implemented in Task 5 and the arterial information gathered in Task 6 to aid travelers preparing to take trips in the urban area.

The integration of the freeway and arterial control systems in the area (or at least for WSDOT systems) will provide the benefit of coordinating control plans for an entire corridor or even the entire region to best utilize the facilities available. Arterial systems could use information from the freeway system to predict future traffic demand on signalized intersections and choose appropriate control plans. Likewise, the freeway system could use information from the arterial systems to predict future traffic demands on the freeway and modify control strategies. Of particular interest will be the ability of the system to anticipate severe queuing and adjust to avoid or minimize the problem. System integration would also lead to a regional database of traffic data easily accessible by all jurisdictions involved.

Integration of the systems could lead to an integrated approach to driver information (Task 1) and incident response (Task 2) as well. The driver information system could direct drivers to use the best of several alternate routes in case of an incident. The arterial system could respond by modifying timing plans to anticipate additional traffic being routed to it. This approach is being used in the IMIS system on Long Island, New York.

Subtasks

The initial project in this task will be to conduct a needs analysis to define the type of system the Department and local jurisdictions should work toward. This project should be undertaken while the I-90 Surveillance, Control and Driver Information (SC&DI) consultant is defining and designing the TSMC computer system, so that decisions regarding systems integration can be included in the design of the freeway control system. Of special interest will be the communications requirements of such a system. In-depth analysis of current technology, operating costs, system requirements, and user needs will also be important issues.

Coordination and cooperation with local jurisdictions will be critical in this project. It will be necessary to design the system around their needs and concerns as well as those of the Department. It will be crucial that WSDOT build a basis of trust with these jurisdictions to make system integration possible.

One specific use of integrated information will need to be examined in this effort, and that is the potential for using real-time information from both the freeway and arterials to manage the urban area roadways from a central location. By bringing all freeway and arterial information into one central location, a central driver information service could be provided, routing decisions could be made, coordinated alternative plans could be selected and implemented, and incident response efforts could be managed. In addition, the central location of data would ease the collection and manipulation of that data off-line as the Department continues to examine ways of increasing the capacity of the existing urban road system.

At some point (providing the needs analysis confirms the need for such a system), a second project producing a preliminary system design for integrated control of freeway and arterial systems should be conducted. Emphasis would be placed on integrating the motorist information system and the incident response system with the freeway and arterial management systems. This project would incorporate the results of the completed FAME research, particularly in tasks 1 (Motorist Information), 2 (Incident Response), 4 (Freeway Management), and 5 (Arterial Management). It would provide additional direction to the Department for continuing the development of its operational control capabilities.

Task 7 -- Impacts of New High Technology Systems

Goals

The goal of this task is to examine the potential impacts of emerging technologies on the Department's ability to manage traffic. In particular, the project will examine

- the role that automated vehicle systems may play in controlling vehicle movements,
- the impacts of new route guidance technologies, and
- other new technologies as they emerge.

Subtasks

The initial project under this task will be participation in the NCHRP project 3-38(1), "Assessment of Advanced Technologies for Relieving Urban Traffic Congestion." FAME will need to ensure WSDOT input into this project and to carefully examine the results of the NCHRP effort in terms of its application to Washington.

Additional research in this area may be required at a later date if the NCHRP project and WSDOT determine that a new technology provides the potential for especially cost-effective improvements to urban travel.

Task 8 -- HOV Treatments

Goals

The primary goals of this task are to develop methods for increasing the number of high occupancy vehicles using the urban highway system and to provide cost effective incentives to users of those modes of travel.

Subtasks

The initial project within this task will be a study to investigate the potential for public/private development of park-and-ride lots in the urban area. The intent of the study is to investigate cost effective ways to

- increase the use of under-utilized park-and-ride facilities, and
- limit the cost to the state of constructing new park and ride facilities.

This study has already been jointly funded by the Urban Mass Transportation Administration and the Municipality of Metropolitan Seattle (METRO, the Seattle regional transit authority).

The second project to be conducted under this task should be the development of a system to monitor HOV lane compliance. An evaluation of the additional uses that could be made of data collected as part of the HERO program will be included. The HERO program currently allows motorists to report HOV lane violators. It has been exceptionally successful. The data collected by the HERO program is used extensively to educate violators about the HOV facility and in some cases to provide assistance to the WSP to help enforce HOV lane restrictions. HERO data may also provide a rich source of data on HOV violations in general, which might provide a means for more effectively enforcing HOV lane restrictions. A research effort will be required to examine the use of HERO data as a Measure of Effectiveness for HOV projects, set forth the HERO program's role within the scope of FAME, and define resources required to maintain or increase its utility to the WSDOT and METRO. Additional research will explore other methods to sample HOV lane compliance in a statistically valid manner. Specifically, the use of photography will be investigated. The data collected will be used to identify areas where WSP enforcement is needed and where improvements to the HOV lane signing or other design elements need to be improved.

Other areas of study within this effort are to monitor and forecast HOV usage on the urban area's freeway system, improve the mode choice analysis capabilities of the Department and develop methods for forecasting changes in vehicle occupancy as a result of new HOV incentives. Additional analyses not included in the above topics may also be required within this area. The advent of more sophisticated driver information systems (Task 1) and various high technology systems may require additional research into the HOV function. New research will need to be identified as currently scheduled projects are completed.

Task 9 -- Demand Management Issues

Goals

The goal of this task is to improve the understanding of the impacts and potential impacts of innovative travel demand management strategies. This task differs from Task 8 in that it is oriented towards public agencies that are not providers of transportation services. It is intended to develop guidelines and procedures for helping cities, counties and other governmental and private agencies improve the movement of people and goods by better managing growth and development.

Subtasks

Initially three projects have been identified under this research task. The first project will examine the effectiveness of various development conditioning strategies being employed in suburban areas. This project would look at the impacts of such policies as

- parking management strategies,
- employer HOV incentives, and
- land use conditions included in the zoning code.

The results of the project will help guide cities and counties in their continuing efforts to manage growing traffic levels.

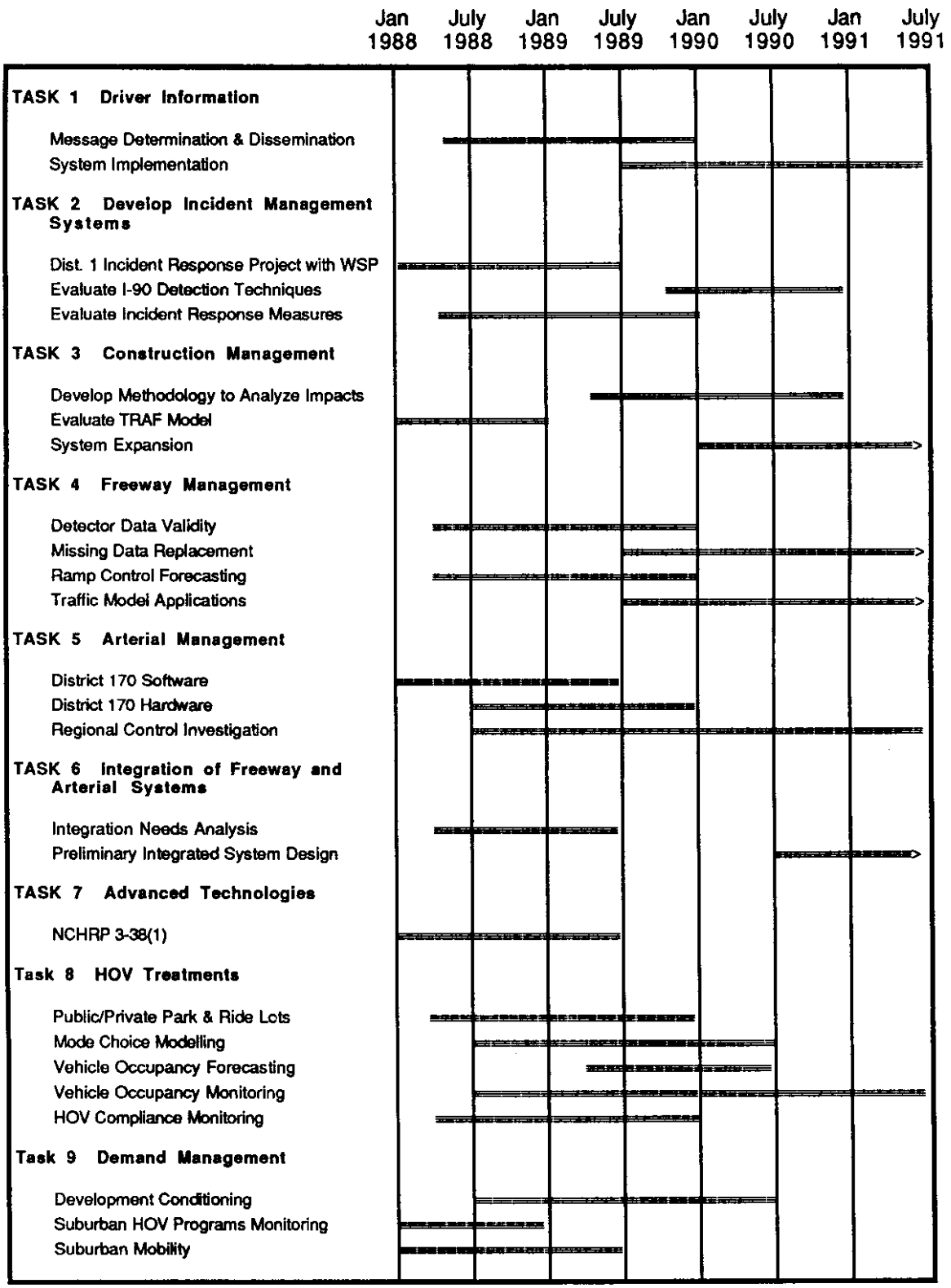
The second project in this task is to design an ongoing monitoring system which can measure the success or failure of travel demand mitigation measures studied in the first project. This project will be similar to the HOV monitoring programs, but would concentrate on the suburban centers as opposed to major roadways.

The third project deals with suburban mobility. The purpose of this project is to bring together public and private interests to clarify problems of suburban mobility, investigate actions, and identify one to five year projects to shift the demand for transportation toward high occupancy vehicles in suburban areas.

SCHEDULE

A proposed schedule of tasks and subtasks for FAME is shown in Exhibit 3. The proposed schedule is contingent upon the availability of funding for the Subtasks included in each task. Each of the tasks described in the work plan will produce a separate final report. Each project will include a three- to five-month period for review of the draft final report before completion of the final report for that task. For ease of project administration, some of these tasks may be combined into a larger effort, where the Subtasks identified in this exhibit are treated as tasks within the larger project.

EXHIBIT 3
FAME PROJECT SCHEDULE



COSTS AND FUNDING

Preliminary estimates of the project costs for each of the identified Subtasks is listed in Exhibit 4. This exhibit also includes the project team's recommended funding source for each project. Note that not all of the indicated Subtasks are currently programmed by the indicated funding sources.

STAFFING

Exhibit 5 provides a preliminary indication of the most appropriate organizations that may perform and/or assist in the performance of the indicated subtasks. This list is not final and should be expected to change based on personnel availability, work load and other factors.

PROJECT PROGRAMMING

Five projects are being proposed for funding with a combination of EXXON funds and HPR project 449 (Freeway Management Tools and Systems) funds. Exhibit 6 lists the proposed projects, the subtasks which they include, the proposed funding sources, and the estimated level of funding from each source.

EXHIBIT 4 - FAME Project Costs and Sources of Funds

TASK	TITLE	FUNDING SOURCE	ESTIMATED COST	FUNDING STATUS	PROJECT APPROVAL
TASK 1	Driver Information				
Subtask 1.1	Message Determination and Dissemination	EXXON	104000	Pending	None
		WSDOT Research #449 HPR	28000	Approved	
Subtask 1.2	System Implementation	Unidentified	100000	Unfunded	None
TASK 2	Incident Response				
Subtask 2.1	District 1 Incident Response System	Cat A Project #19902A	45000	Approved	Active
Subtask 2.2	Evaluate I-90 Incident Detection	Unidentified	50000	Unfunded	None
Subtask 2.3	Evaluate Incident Response Measures	WSDOT Research (Traffic Emergencies Mgt) HPR	45000	Approved	None
		EXXON	41000	Pending	
		WSDOT Research #449 HPR	15000	Approved	
TASK 3	Construction Traffic Management				
Subtask 3.1	Develop Methodology to Analyze Impacts	EXXON	36000	Pending	None
		WSDOT Research #449 HPR	13000	Approved	
Subtask 3.2	Evaluate TRAF Model	FHWA (TSM)	75000	Pending	None
TASK 4	Freeway Management				
Subtask 4.1	Ramp Control Volume Forecasts	WSDOT Research (Ramp Control) HPR	70000	Approved	None
Subtask 4.2	Detector Data Validity	EXXON	110000	Pending	None
		WSDOT Research #449 HPR	40000	Approved	
Subtask 4.3	Traffic Model Applicatio	Unidentified	77000	Unfunded	None
TASK 5	Arterial Management				
Subtask 5.1	District 170 Software	Cat A Project #19966A	210000	Approved	Approved
Subtask 5.2	District 170 Hardware	District 1 EXXON	350000	Pending	None
Subtask 5.3	Regional Arterial Control	EXXON	48000	Pending	None
		WSDOT Research #449 HPR	24000	Approved	
		Unidentified	200000	Unfunded	
TASK 6	Integrated Freeway and Arterial Systems				
Subtask 6.1	Integration Needs Analysis	EXXON	15000	Pending	None
		WSDOT Research #449 HPR	7000	Approved	

EXHIBIT 4 - FAME Project Costs and Sources of Funds

Subtask 6.2	Integrated System	Unidentified	50000	Unfunded	None
TASK 7	Advanced Technologies				
Subtask 7.1	NCHRP 3-38(1)	NCHRP	200000	Approved	Proposal
TASK 8	Encouraging HOV Usage				
Subtask 8.1	Public/Private Park and Ride	UMTA	200000	Approved	Active
		Metro	15000	Approved	
		WSDOT HPR	10000	Approved	
		Other WSDOT	10000	Approved	
Subtask 8.2	Mode Choice Model	WSDOT Research (Mode Choice) HPR	50000	Approved	None
Subtask 8.3	Vehicle Occupancy Forecasting	WSDOT Research (Vehicle Occupancy Forecast) HPR	50000	Approved	None
Subtask 8.4	Vehicle Occupancy Monitoring	Unidentified	100000	Unfunded	None
Subtask 8.5	HOV Compliance Monitoring	EXXON	46000	Pending	None
		WSDOT Research #449 HPR	23000	Approved	
TASK 9	Demand Management				
Subtask 9.1	Development Conditioning	Unidentified	60000	Unfunded	None
Subtask 9.2	TSM Evaluation	Metro	45000	Approved	Active
Subtask 9.3	Suburban Mobility	Metro	320000	Approved	Active
		TOTAL	2882000		

WSDOT Research #449	150000	
Other WSDOT HPR	225000	
District 1 Cat Projects	255000	
Other WSDOT	10000	
WSDOT Subtotal		640000
EXXON	400000	
District 1 EXXON	350000	
NCHRP 3-38(1)	200000	
FHWA(TSM)	75000	
UMTA	200000	
Metro	380000	
Unidentified Source TOTAL	637000	

EXHIBIT 5

Estimated FAME Staffing

Project Name	PR&PT	TSMC	HQ. O&M[1]	TRAC	Undetermined
TASK 1 DRIVER INFORMATION					
Message Determination and Dissemination	X	X		X	
Implementation	X	X		X	
TASK 2 INCIDENT RESPONSE					
District 1 Incidence Response System		X			
Evaluate I-90 Incident Detection		X	X		X
Evaluate Incident Response Measures	X	X	X		
TASK 3 CONSTRUCTION TRAFFIC MANAGEMENT					
Develop Methodology to Analyze Traffic Impacts		X	X	X	
Evaluate TRAF Model		X	X	X	
TASK 4 FREEWAY MANAGEMENT					
Ramp Control Volume Forescasts				X	
Detector Data Validity		X	X	X	
Traffic Model Applications					X
TASK 5 ARTERIAL MANAGEMENT					
District 170 Software		X[2]			
District 170 Hardware		X[2]			
Regional Arterial Control			X	X	X
TASK 6 INTEGRATED FREEWAY AND ARTERIAL SYSTEMS					
Integration Needs Analysis			X	X	
Integrated System					X
TASK 7 ADVANCED TECHNOLOGIES					
NCHRP 3-38 (1)				X	
TASK 8 ENCOURAGING HOV USAGE					
Public/Private Park and Ride				X	Metro
Mode Choice Modeling				X	
Vehicle Occupancy Forecasting				X	
Vehicle Occupancy Monitoring				X	
HOV Compliance Monitoring	X	X		X	
TASK 9 DEMAND MANAGEMENT					
Development Conditioning	X				X
TSM Evaluation				X	Metro

[1] FAME Project Manager
[2] District 1 Signal Operations

EXHIBIT 6

PROJECT PROGRAMMING

Project Names	Subtasks	Source of Funds	Funding Level
Driver Information Systems	Subtask 1.1	EXXON	104,000
		HPR 449	28,000
Incident Response /	Subtask 2.3	EXXON	77,000
Construction Traffic Management	Subtask 3.1	HPR 449	28,000
		HPR	45,000
Detector Data Validity	Subtask 4.2	EXXON	110,000
		HPR 449	40,000
Areterial Control and Integration	Subtask 5.3	EXXON	63,000
	Subtask 6.1	HPR 449	31,000
HOV Compliance Monitoring	Subtask 8.5	EXXON	46,000
		HPR 449	23,000

WSDOT **TRAC** Washington State Transportation Center

Freeway and Arterial Management Effort (FAME)

Research Plan Executive Summary

Description of Issues

Traffic in Washington state's urban areas has been increasing rapidly. The Councils of Governments, transit agencies and local jurisdictions are now considering long range transportation options that will help address this problem in the next century. However, some issues need our immediate attention. The Planning, Research and Public Transportation Division of WSDOT has made freeway and arterial management its number one priority for the next five years. We are now beginning a large, comprehensive research and operations study program in cooperation with WSDOT's district offices. This program has the following goals:

1) increase HOV use,
2) provide coordinated traffic signal operation,
3) manage freeway flows with ramp metering and other techniques,
4) improve traffic management during incidents and construction projects, and
5) provide better information to the traveling public on routes, travel times, congestion levels, and transportation options.

Our research program will be coordinated with national efforts to gain the maximum benefit of work conducted by others. We have the opportunity to increase levels of service to the public for very little cost.

Overview

FAME will be performed as nine separate but related tasks. These tasks will be pursued parallel to each other and will integrate together as they are completed. The basic tasks to be performed are as follows:

Task 1 - Improve Motorist Information Systems

The goal of this task is to demonstrate methods for improving information dissemination to motorists, who will use it to make more informed decisions concerning their choice of routes and time of travel. As a result, motorists will spread trips more efficiently throughout the day and across parallel routes, thus decreasing their traffic delays and fuel consumption while increasing the total vehicle and person carrying capacity of the road network as a whole.

Task 2 - Develop Incident Management Systems

Under this task, FAME support will be integrated with the development of an incident management system within District 1 and other WSDOT Districts. District 1 has already undertaken the initial steps of working with the Washington State Patrol (WSP) to develop plans, procedures and systems for more effectively performing incident management work. This effort will not only help District 1 in implementing its system, but will provide information and guidance to other districts as they develop procedures for improving incident management.

Task 3 - Implement Traffic Management System For Construction Projects

This task entails research into the mitigation of traffic congestion caused by planned construction projects as opposed to unexpected incidents. The goal of this task is the development of a process for routinely developing and analyzing traffic mitigation measures within the urban area. While this effort will augment the existing District 1 effort in construction traffic management through the Construction Traffic Coordination Office, it will also help other districts manage traffic during construction projects.

Task 4 - Design And Implement Improved Freeway Management Systems

The goal of this task is to design, demonstrate and eventually implement an updated freeway management system. The system will provide improved real-time management of the freeway ramp controls that currently exist or are scheduled for deployment on the Puget Sound freeway system. The system will provide short-term forecasts of traffic conditions for use within the Department's ramp metering algorithms and will eventually serve as the basis for an advanced motorist information system.

Task 5 - Select And Implement Improved Real-Time Arterial Management Systems

The goal of this task is to select and implement a management strategy that can react to real-time changes in traffic conditions for the arterials under the control of the WSDOT. In addition, under this task the WSDOT will develop the expertise necessary for assisting local jurisdictions in implementing their own arterial management strategies for providing real-time control of arterial systems.

Task 6 -- Integrate The Arterial And Freeway Management Systems

The integration of the freeway and arterial control systems in the area (or at least for WSDOT systems) will provide the benefit of coordinating control plans for an entire corridor or even the entire region to best utilize the facilities available. Arterial systems could use information from the freeway system to predict future traffic demand on signalized intersections and choose appropriate control plans. Likewise, the freeway system could use information from the arterial systems to predict future traffic demands on the freeway and modify control strategies.

Task 7 -- Impacts of New High Technology Systems

The goal of this task is to examine the potential impacts of emerging technologies on the Department's ability to manage traffic.

Task 8 -- HOV Treatments

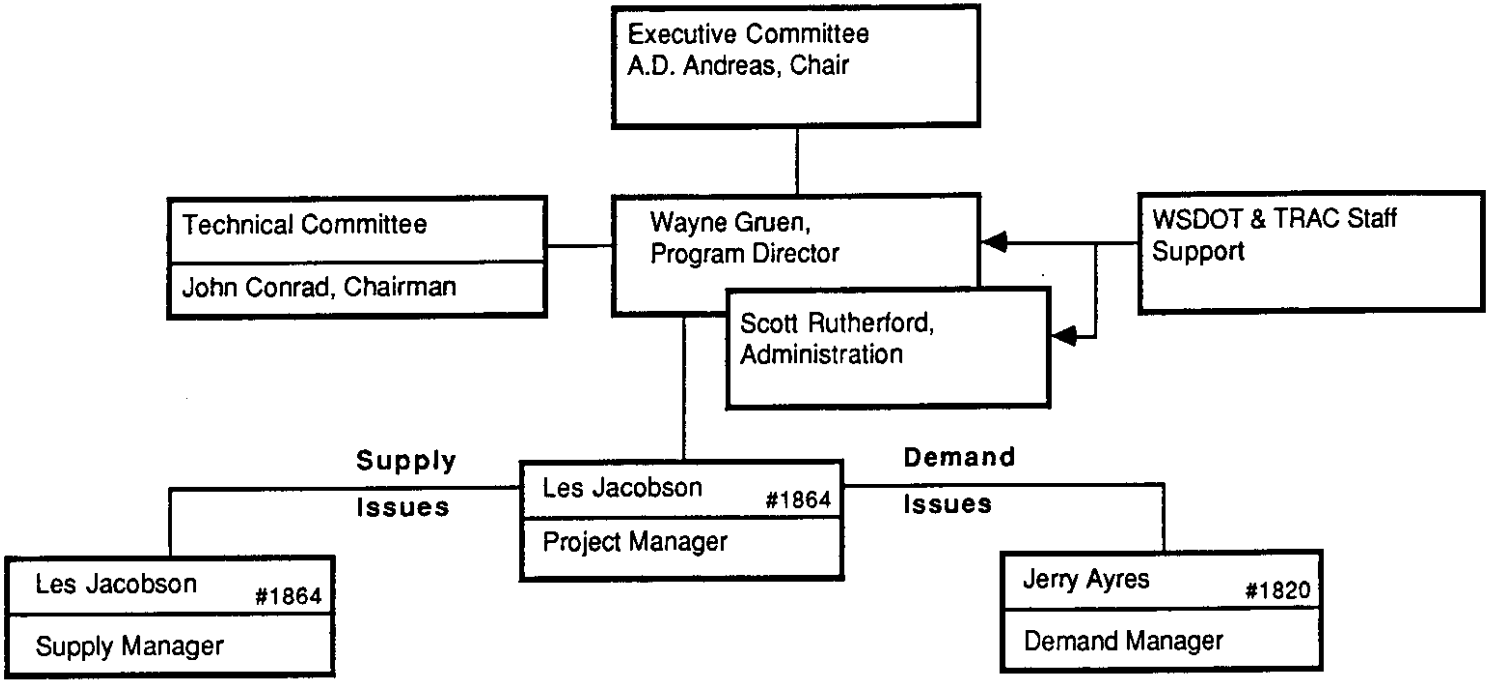
The primary goals of this task are to develop methods for increasing the number of high occupancy vehicles using the urban highway system and to provide cost effective incentives to users of those modes of travel.

Task 9 -- Demand Management Issues

The goal of this task is to improve the understanding of the impacts and potential impacts of innovative travel demand management strategies. This task differs from Task 8 in that it is oriented towards public agencies that are not providers of transportation services. It is intended to develop guidelines and procedures for helping cities, counties and other governmental and private agencies improve the movement of people and goods by better managing growth and development.

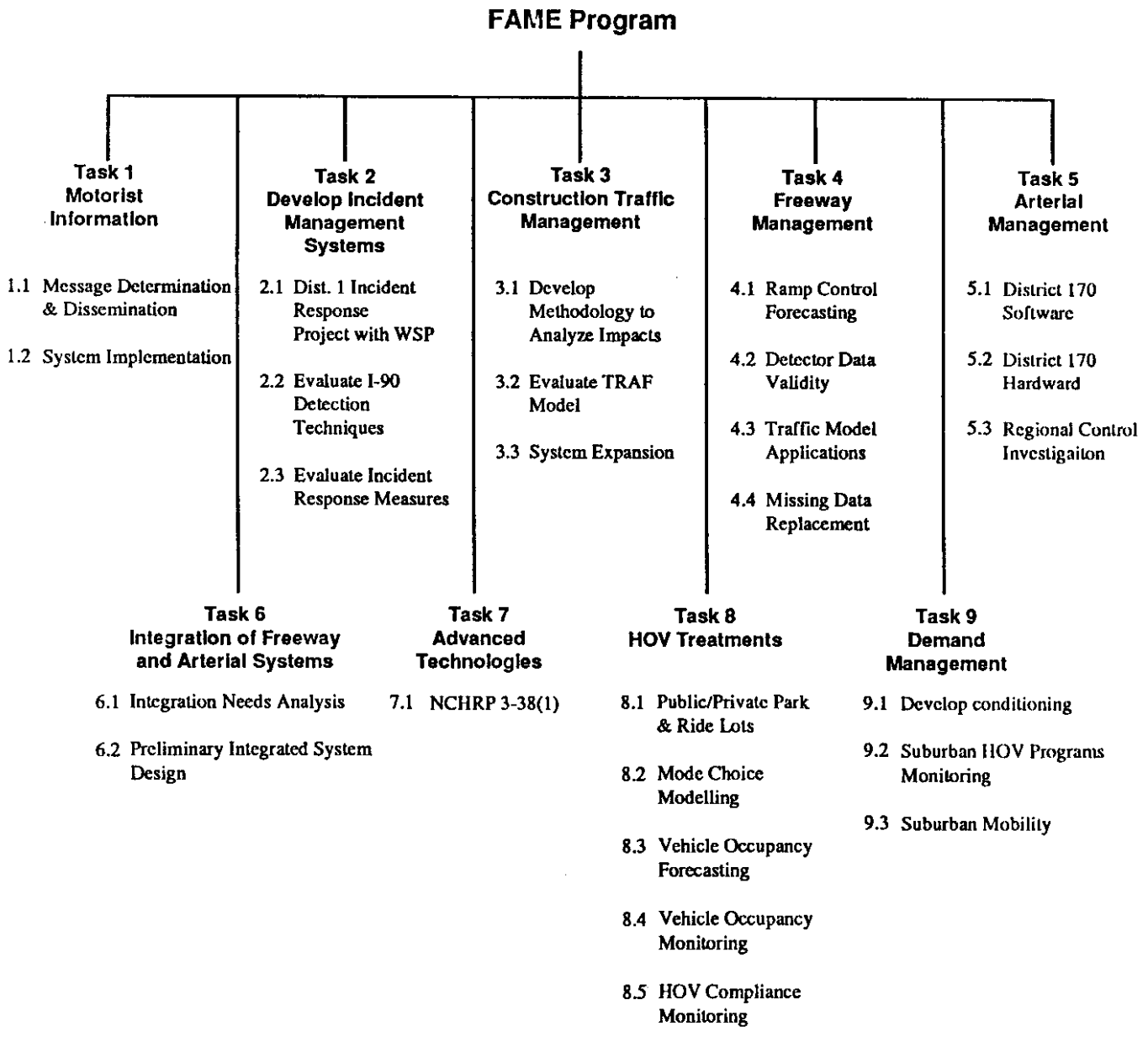
FREEWAY AND ARTERIAL MANAGEMENT EFFORT

(FAME)

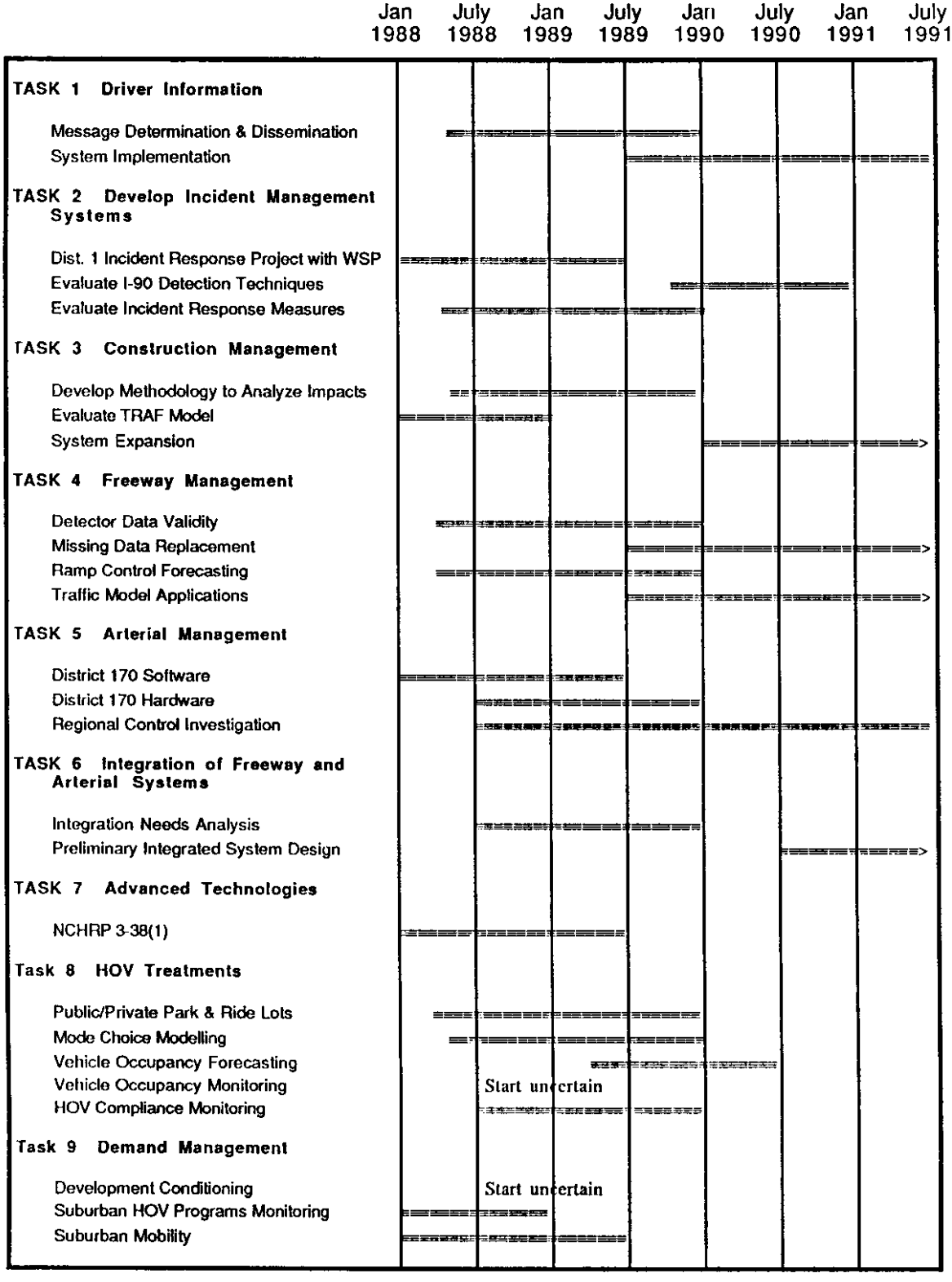


WSDOT

TRAC Washington State Transportation Center


FAME Program
Task 1
Motorist
Information
1.1 Message Determination & Dissemination
1.2 System Implementation
Task 2
Develop Incident
Management
Systems
2.1 Dist. 1 Incident Response Project with WSP
2.2 Evaluate I-90 Detection Techniques
2.3 Evaluate Incident Response Measures
Task 3
Construction Traffic
Management
3.1 Develop Methodology to Analyze Impacts
3.2 Evaluate TRAF Model
3.3 System Expansion
Task 4
Freeway
Management
4.1 Ramp Control Forecasting
4.2 Detector Data Validity
4.3 Traffic Model Applications
4.4 Missing Data Replacement
Task 5
Arterial
Management
5.1 District 170 Software
5.2 District 170 Hardward
5.3 Regional Control Investigaiton
Task 6
Integration of Freeway
and Arterial Systems
6.1 Integration Needs Analysis
6.2 Preliminary Integrated System Design
Task 7
Advanced
Technologies
7.1 NCHRP 3-38(1)
Task 8
HOV Treatments
8.1 Public/Private Park & Ride Lots
8.2 Mode Choice Modelling
8.3 Vehicle Occupancy Forecasting
8.4 Vehicle Occupancy Monitoring
8.5 HOV Compliance Monitoring
Task 9
Demand
Management
9.1 Develop conditioning
9.2 Suburban HOV Programs Monitoring
9.3 Suburban Mobility

FAME PROJECT SCHEDULE



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Summary of FAME Project Costs and Sources of Funds

TASK	TITLE	FUNDING SOURCE	ESTIMATED COST	TASK TOTAL
TASK 1	Driver Information	EXXON	104,000	
		HPR 204	28,000	
		Unidentified (89-91 Biennium)	100,000	**232,000**
TASK 2	Incident Response	USDOT Regional Center	34,222	
		HPR 207	45,000	
		EXXON	6,778	
		HPR 204	15,000	
		Cat A Project #19902A	45,000	
		Unidentified (89-91 Biennium)	50,000	**196,000**
TASK 3	Construction Traffic Management	FHWA (TSM)	75,000	
		EXXON	36,000	
		HPR 204	13,000	**124,000**
TASK 4	Freeway Management	USDOT Regional Center	48,889	
		HPR 206	70,000	
		EXXON	61,111	
		HPR 204	40,000	
		Unidentified (89-91 Biennium)	77,000	**297,000**
TASK 5	Arterial Management	EXXON	48,000	
		HPR 204	24,000	
		Cat A Project #19966A	210,000	
		District 1 EXXON	350,000	
		Unidentified (89-91 Biennium)	200,000	**832,000**
TASK 6	Integrated Freeway and Arterial Systems	EXXON	15,000	
		HPR 204	7,000	
		Unidentified (89-91 Biennium)	50,000	**72,000**
TASK 7	Advanced Technologies	NCHRP	200,000	**200,000**
TASK 8	Encouraging HOV Usage	USDOT Regional Center	26,914	
		UMTA	200,000	
		Metro	15,000	
		EXXON	19,086	
		HPR 204	23,000	
		HPR 244	50,000	
		HPR 245	50,000	
		Motor Vehicle Fund	10,000	
		USDOT District 1	10,000	
		Unidentified (Start Uncertain)	100,000	**504,000**
TASK 9	Demand Management	Metro (Metro Lead)	365,000	
		Unidentified (Start Uncertain)	60,000	**425,000**
		TOTAL	**2,882,000**	**2,882,000**
FUNDING SOURCE SUMMARY		USDOT Regional Center	110,025	(Pending)
		HPR 204	150,000	(Approved)
		Other WSDOT HPR	215,000	(Approved)
		District 1 Cat A Projects	255,000	(Approved)
		Motor Vehicle Funds	10,000	(Approved)
		WSDOT District 1	10,000	
		EXXON	400,000	(Approved)
		District 1 EXXON	350,000	(Approved)
		NCHRP 3-38(1)	200,000	(Approved)
		FHWA (TSM)	75,000	(Approved)
		UMTA	200,000	(Approved)
		Metro	380,000	(Approved)
		Unidentified Source TOTAL	637,000	(Unfunded)
		TOTAL	**2,882,000**	

D 1: D: PI: Hal: FA: FSoC&F

6/20/88