U.S. Department
of Transportation
Federal Highway
Administration

Incorporating ITS into Transportation Planning: Phase 1 Final Report

September 1997

Revision

1. Report No. FHWA-JPO-98-003	2. Government Accession No.	3. Recipient' s Catalog No.
4. Title and Subtitle Incorporating ITS into Transportation Planning: Phase 1 Final Report		5.Report Date September, 1997 6.Performing Organization Code
7. Author(s) Gregory Hatcher, James L. Milner and Gary G. Nelson		8.Performing Organization Report No.
9. Performing Organization Name and Address Mitretek Systems Center for Telecommunications and Advanced Technology McLean, VA		10. Work Unit No. (TRAIS) 11. Contract or Grant No. DTFH61-95-C00040
12. Sponsoring Agency Name and Address U.S. Dept. of Transportation FHWA Intelligent Transportation Systems Joint Program Office 400 Seventh St., S.W. Room – 3422 Washington, D.C. 20590		13. Type of Report and Period Covered 14. Sponsoring Agency Code HVH-1
15. Supplementary Notes Paula Ewen		

16. Abstract

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Key Words Transportation Planning, ITS Early Deployment Program, Strategic Plans, Metropolitan Transportation Plans (MTPS), TIP Program	18. Distribution Statement No restrictions. This document is available to the public from: The National Technical Information Services Springfield, VA 22161		
19. Security Classif. (of this report) Unclassified	20. Security Classif. (of this page) Unclassified	21. No of Pages 160[PC1]	22. Price

Form DOT F 1700.7 (8-72) Reproduction of completed page authorized

MP 1997-52

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Sponsor: FHWA
Dept. No.: Q020
Contract No.: DTFH61-95-C00040
Project No.: 099718E10A

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KEYWORDS: Transportation Planning, ITS, Early Deployment Program, Strategic Plans, Metropolitan Transportation Plans (MTPs), TIP Programming

Preface

This report, originally completed in June 1996, has been revised by Mitretek Systems in order to address the comments of reviewers of the report, including FHWA and Seattle and Houston transportation professionals. Besides the editorial changes and corrections, the main changes in the revised report are in the improved presentation of the study context, along the major theme of how to "mainstream", or integrate, ITS into the general transportation planning process at the state, regional and local levels.

Acknowledgments

The authors express their appreciation to the transportation planning staffs of the two case study regions, Houston, TX and Seattle, WA for their cooperation in allowing Mitretek to examine the planning process in their regions. Special thanks are due to Messrs. Robert H. Siegfried, Andy Mullins, and Ms. Nancy Bench, Houston-Galveston Area Council; Messrs. Hans C. Olavson and James A. Heacock, Texas Department of Transportation; Mr. Greg A. Rhodes, Houston Metropolitan Transit Authority; Messrs. Peter Briglia, Ed Conyers, David McCormack and Pat Morin, Washington State Department of Transportation; Mr. Nicholas P. Roach, Puget Sound Regional Council; and Mr. David Canty, King County Metro, for their willingness to provide time for discussions, and copies of descriptive documentation, to us.

Executive Summary

Introduction

The Intelligent Transportation Systems (ITS) Joint Program Office (JPO) of the United States Department of Transportation (USDOT) has contracted with Mitretek Systems to investigate the incorporation of ITS into transportation planning. The objective is to promote consideration of ITS projects and alternatives in the planning process. Mitretek's task is to:

- Review existing procedures and develop a quantitative investment analysis methodology for state/local use in transportation planning.
- Develop case study-based estimates of relative costs and benefits of ITS versus conventional investments.
- Identify where improved methods of project selection are needed.

The study will occur in two phases: Phase 1 examines how different projects are being prioritized for investment, and Phase 2 will develop alternative evaluation methodologies for a transportation problem in an area or corridor.

Mitretek has begun studies of two regions, Houston, TX and Seattle, WA, to describe existing practices relative to ITS. This is the interim report for Phase 1, focusing on the inter-project prioritization process in Houston and Seattle, and containing recommendations for project evaluation. Phase 2 will use at least one of the cases to develop a more detailed project alternatives evaluation methodology.

Transportation Planning Process

The transportation planning process is an established but evolving process that has been designed to support local decisions on transportation plans, programs, and individual projects. Because one of the goals of the planning process is to provide objective analytical information for use by decision makers, it is extremely important that ITS be considered early and consistently throughout the various stages and venues that comprise the planning process. In other words, ITS strategies and project directions, including the potential of combining ITS with traditional transportation elements, should be developed and considered as part of the overall planning process.

ITS and conventional transportation projects are typically initiated and developed within sponsoring modal agencies. These are of several types, but primarily state departments of transportation (DOTs), regional transit agencies, and local departments of public works (DPWs). Although generally not an owner or operator of transportation infrastructure, metropolitan planning organizations (MPOs) can also initiate or spearhead implementation projects in order to address regional transportation needs. Under the framework established for federal funding, projects then go through various inter-project coordination and project alternatives evaluation steps.

The federal transportation planning requirements in urban regions include programming through the transportation plans and transportation improvement programs (TIPs) of metropolitan planning organizations (MPOs). This is where the several streams of project development are combined into approved programs. Statewide, there are transportation plan and TIP requirements on the DOTs.

Project development involves selection and refinement among project alternatives. This generally occurs in different phases (concept, scoping, location and design) associated with environmental, investment and hearing processes that are federally specified.

The focus of this task is to provide improved methodologies for evaluating ITS projects within the TIP programming (in phase 1), and to evaluate ITS alternatives within the scoping and location phases of environmental and investment studies (in phase 2). This report only addresses the phase 1 findings.

Case Studies

This task focuses on urban case studies to gather descriptive information on how planning relates to ITS, and for development of analysis methodologies. Houston and Seattle were chosen for study primarily because of the extent of ITS deployment in those regions. Other regions may be chosen later for comparison. At least one of the original two regions will be used for detailed project alternative methodology development in Phase 2. Details on planning in the two regions, and associated state DOT planning, are reported.

Case Study Comparison

The study findings indicate that many similarities exist in the planning and programming process between the two case studies. The significant differences are difficult to relate to any overt characteristics of the regions, and reflect particular historical and political circumstances. Perhaps the greatest difference in emphasis on ITS is due to the faster growing congestion problem in Seattle, a greater concern there with development control, and its topographical constraints regarding new capacity construction.

In the end, it is the combination of differences in agency dedication to ITS, decision maker awareness and understanding of ITS, regional context, policy emphasis (funding and otherwise), and prioritization processes, that lead to differences in the outcome of generating and constructing ITS projects. Funding constraints imposed on ITS have also affected its level of development. It must be emphasized that an important avenue for implementing, operating, and maintaining ITS initiatives is through the local and state (non-federally approved) funding channels. These projects may never appear in the federally-mandated planning documents.

Due to the need to consider the information sharing, communications, and control features of ITS as a system, some ITS-focused planning activities may need to occur, as has been the case in

Seattle and Houston. Examples of this include Early Deployment Plans and strategic plans. In order to advance the goal of effectively incorporating ITS into the transportation planning process, it is important that these activities take place within that overall context.

Recommendations

Scoring of projects within a TIP project selection process cannot overcome some fundamental problems, no matter how many different factors are used. These problems include the combining of qualitative and quantitative criteria, achieving inter-project coordination, and reflecting general policies at the project level. In practice, the hybrid approach of project prioritization through multiple funding/agency channels, the use of several incommensurate criteria in scoring, and a final policy-based voting process address these problems more or less explicitly. There is no compelling reason to make a wholesale alteration to this process, but some issues are of relevance to ITS projects. These issues are:

- Limitation of ITS projects to certain funding categories, with their own prioritization channels into the TIP;
- Difficulty of conveying project dependencies and priorities through scoring (that arise, for example, when one project is actually a part of a larger implementation program and serves as a critical link in the overall system);
- Lack of uniformly reliable quantification of project impacts; and
- Focus of impact evaluation on average network conditions rather than exception cases, such as traffic incidents, where ITS may have most effect.

Preliminary recommendations for enhancement of the TIP process follow; Phase 2 of this task will investigate methodologies concerning the latter two issues presented above. *The recommendations presented here should be viewed only as suggestions for scoring factors, with the primary emphasis on ensuring that any such process is sensitive to ITS impacts. It is also recognized that other factors besides scoring will ultimately affect the prioritization process. No attempt was made to prescribe a scoring process for areas to use.*

- <u>The following qualitative factors should be </u>considered in project prioritization processes that involve multiple projects addressing different transportation problems and needs:
  1. Responsiveness to or consistency with regional transportation policies, goals and objectives.
  2. Anticipated environmental impact of the proposed improvement.
  3. Expected regional impact (based on adopted performance measures).
  4. Ability of the proposed improvement to respond to and manage traffic incidents or changing conditions.
  5. Ability of the proposed improvement to provide transportation system users with a new or improved service (including customer convenience).

6. Ability of the proposed improvement to support multiple uses for the transportation system or across different agencies, including the ability to provide traffic operations and planning data.

- The following quantitative factors should be considered in the technical scoring process:

  1. Cost effectiveness (or benefit-cost) ratio.

  2. Air quality impact or effectiveness.

  3. Estimated cost savings (or revenue increases) to transportation agencies.

- Overall scoring and weighting procedures to be considered

  The TIP scoring process by itself may not be able to adequately reflect the fact that some projects should be given priority over others. Such projects could be considered to be regional priority projects, and given a priority independent of their technical score. Mitretek recommends that consideration be given to this issue. One possible approach is to attach a regional priority rating to projects as a separate consideration; projects would be ranked first by overall priority, then by technical score, in order to ensure that issues of program continuity and regional priorities are kept visible.

- Other Considerations

  Add capability to track yearly progress of large regional projects, to monitor project effectiveness and implementation status.

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Section 1

Introduction

1.1 Task Purpose and Background

As more and more Intelligent Transportation Systems (ITS) capabilities become ready for deployment through use of regular funding sources, they will need to be integrated into the established transportation planning process. This process involves choices among competing projects within financial and other constraints. ITS components will in many cases be combined with more conventional transportation components as part of an alternative to address a specific transportation problem. These possibilities raise many questions about how to select and evaluate ITS projects and conventional projects containing significant ITS components within the framework of the transportation planning process.

In addition, transportation planners often times have less experience with ITS compared to traditional projects and programs, and hence analytical techniques have not been developed to adequately address the ITS component (partly because the impacts of ITS are only beginning to be understood and documented). This raises issues about how ITS will be addressed in a selection process among qualitatively different projects, or how ITS might be chosen to form part of a project to solve a given transportation problem.

To address these questions the Intelligent Transportation Systems (ITS) Joint Program Office (JPO) of the United States Department of Transportation (USDOT) tasked Mitretek Systems to investigate the incorporation of ITS into the transportation planning process. To accomplish this Mitretek initiated a two year, two phased study effort. The overall study goal is to promote consideration of ITS projects and alternatives in the planning process.

Mitretek's primary task objectives include:

- Review existing procedures and develop a quantitative investment analysis methodology for state/local use in transportation planning.
- Develop case study-based estimates of relative costs and benefits of ITS versus conventional investments.
- Identify where improved methods of project selection are needed.

These objectives translate into two kinds of analyses: (a) the formulation/selection of alternative solutions to a given transportation problem, as part of the planning process, that will eventually become a proposed part of the Transportation Plan and the Transportation Improvement Program (TIP); and (b) inter-project prioritization analysis, or "scoring", in order to program projects within budget constraints, typically in the TIP project selection process. This task will develop methodologies using cost and benefit information for these two related types of investment analyses and will identify areas where improved methods or tools are needed.

The first phase of the study was completed in July 1996 and the second is scheduled to extend a year later. Phase 1 focuses on the inter-project scoring process within two urban-regional TIPs:

Houston, TX and Seattle, WA. This report provides the background and initial findings for these case studies. Phase 2 will use one of the cases to focus on development of a methodology for alternative solutions analysis and selection within a corridor or subarea.

1.2 Case Studies

Mitretek's approach to determining ways in which ITS can enter the mainstream of transportation planning is based upon developing case studies in several regions of the country where ITS has been successfully deployed, in order to identify those factors that have the best chance to favorably impact state and local planning. As this effort continues, one or more additional areas may be selected for study to attempt to contrast successful ITS deployments with cases in which traditional transportation planning has led to traditional programming of capacity improvements; i.e., cases where ITS has not yet been applied.

The selection process for case study areas involved examination of numerous TIPs and Early Deployment Plans (EDPs), and review of the literature to select regions that have achieved some measure if ITS deployments to date. After a preliminary selection of candidate cities, contacts were established to ascertain that the local Metropolitan Planning Organizations (MPOs) and state Departments of Transportation (DOTs) would be willing to serve as a case study region.

After a final selection, Houston and Seattle were approved by the ITS Joint Program Office (JPO), Federal Highway Administration (FHWA). Site visits were made to each city in December 1995 in order to meet with MPO, transit authority and state DOT staff, to apprise them of our task and to collect documentary material for review. Telephone follow-ups and another pair of visits in March 1996 were made to get more details, particularly on modeling practices.

The studies of the Houston and Seattle urban areas have focused on determining the methodology by which transportation projects are implemented in the respective areas. In our review, it has become apparent that each metropolitan area goes through a similar, but not at all identical, process of bringing projects to the point where they are chosen for inclusion in the financially constrained transportation plan and TIP.

It is well known that activities such as building coalitions, obtaining political support and finding/creating champions to further the interests of particular solutions to transportation problems are integral to the process of transportation planning, and these activities are adequately described elsewhere [1]. The above activities do indeed play a significant part in the selection of projects in Houston and Seattle.

1.3 Report Organization

The remaining sections establish the transportation planning and programming context of the task, and report on the case study findings relevant to the Phase 1 investment analysis methodology.

- Section 2 discusses the major parts of transportation planning and programming, to establish the venues and audiences for any ITS project scoring or alternatives analysis, and to establish the focus of this task within the total range of analyses.
- Section 3 describes the regional and planning background in Houston, and gives the funding and project selection findings.
- Section 4 gives the Seattle background and findings.
- Section 5 makes a comparison of the two cases regarding investment analysis performance and needs.
- Section 6 makes initial methodology recommendations regarding the TIP scoring processes for ITS-containing projects relative to conventional projects.

Section 2

Transportation Planning Process Overview

Analysis methodologies are developed in this task for use by transportation planning agencies to evaluate ITS investments. This section describes the transportation planning process in order to define the audiences and uses of such methodologies. Local variations in planning organization and practices are explored in the case studies, in the next several sections.

2.1 Transportation Planning

The transportation planning process is an established but evolving process that has been designed to support local decisions on transportation plans, programs, and individual projects. The planning process produces two major products to document these decisions: the transportation plan and the Transportation Improvement Program (TIP). Under the Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA) and subsequent rulings, certain requirements have been set forth for both statewide and metropolitan planning[2]. Because the case study locations selected are in metropolitan areas, it is the planning environment at the metropolitan level that will be the focus of this report.

The major elements of transportation planning in metropolitan areas, as defined in "A Guide to Metropolitan Transportation Planning Under ISTEA", include a proactive and inclusive public involvement process, consideration of 15 specific planning factors to ensure that a variety of concerns are addressed such as land-use planning, the conduct of major investment studies, the development and implementation of management systems, the development of financial plans, and assurance that the transportation plan and TIP conform to the State Implementation Plan (SIP) pursuant to the standards of the Clean Air Act Amendments of 1990 (CAAA)[3].

More discussion on some of the key parts of the planning process related to the evaluation methodology focus of this task is given below. Because one of the goals of the planning process is to provide objective analytical information for use by decision makers, it is extremely important that ITS be considered early and consistently throughout the various stages and venues that comprise the planning process. In other words, ITS strategies and project directions, including the potential of combining ITS with traditional transportation elements, should be developed and considered as part of the overall planning process.

The apparent emphasis in this report on the scoring methodologies for evaluating projects is strictly related to the investment analysis focus of this task, and should not be interpreted as a judgment of its level of importance towards the overall goal of incorporating ITS into the transportation planning process. For broader treatment of how ITS should be integrated into the various other aspects of the planning process, refer to "Integrating Intelligent Transportation Systems with the Planning Process: An Interim Handbook" [1].

Project Development and Programming

Consistent with the project directions identified through the transportation planning process, projects and programs are identified by implementing agencies and are then programmed to obtain federal, state or local funding. The distinction between project *development* and *programming* differentiates which agencies will use an investment methodology, and for what purposes.

The project *development* process, taken as the increasing definition and design of a transportation project, up to its implementation, concerns transportation agencies that select among alternatives to address specific transportation problems. Note that project development, as discussed here, actually encompasses the planning and detailed development phases of a potential project (i.e., project planning and project development), but will be simply referred to as “project development” for ease of presentation.

Programming, defined as the set of steps necessary to obtain project funding and approval, is concerned with how projects that address different transportation problems are selected for funding. Programming is a necessary part of the overall transportation planning process, in that funds must be allocated for any particular project to ever be realized.

Federal transportation planning requirements apply to most public sector operating agencies, and so will be used as a framework for describing the transportation planning process. Within this framework, there is a great deal of state-, regional- and local-agency variation. The ITS-sensitive analysis methods recommended under this task will not be limited only to the federal funding or regulatory requirements. This is important since many transportation projects, including those with ITS features, will be locally funded and will not necessarily be subjected to the federal requirements.

The federal planning requirements do not address some privately-financed ITS initiatives or products, such as private vehicle systems, that may need to operate with federally funded and public transportation systems. Integration of these other initiatives lies within the National ITS Architecture development [4] and is not within the scope of planning addressed here. Also, a large degree of coordination is achieved through ITS standards that the architecture promotes. Such standards become relevant to projects within transportation planning, but the standards process is not addressed here.

2.2 A Schematic of Analysis Methodologies

The figure below will help put the parts of transportation planning into perspective, focusing on analytical evaluation steps, for the purposes of this task:

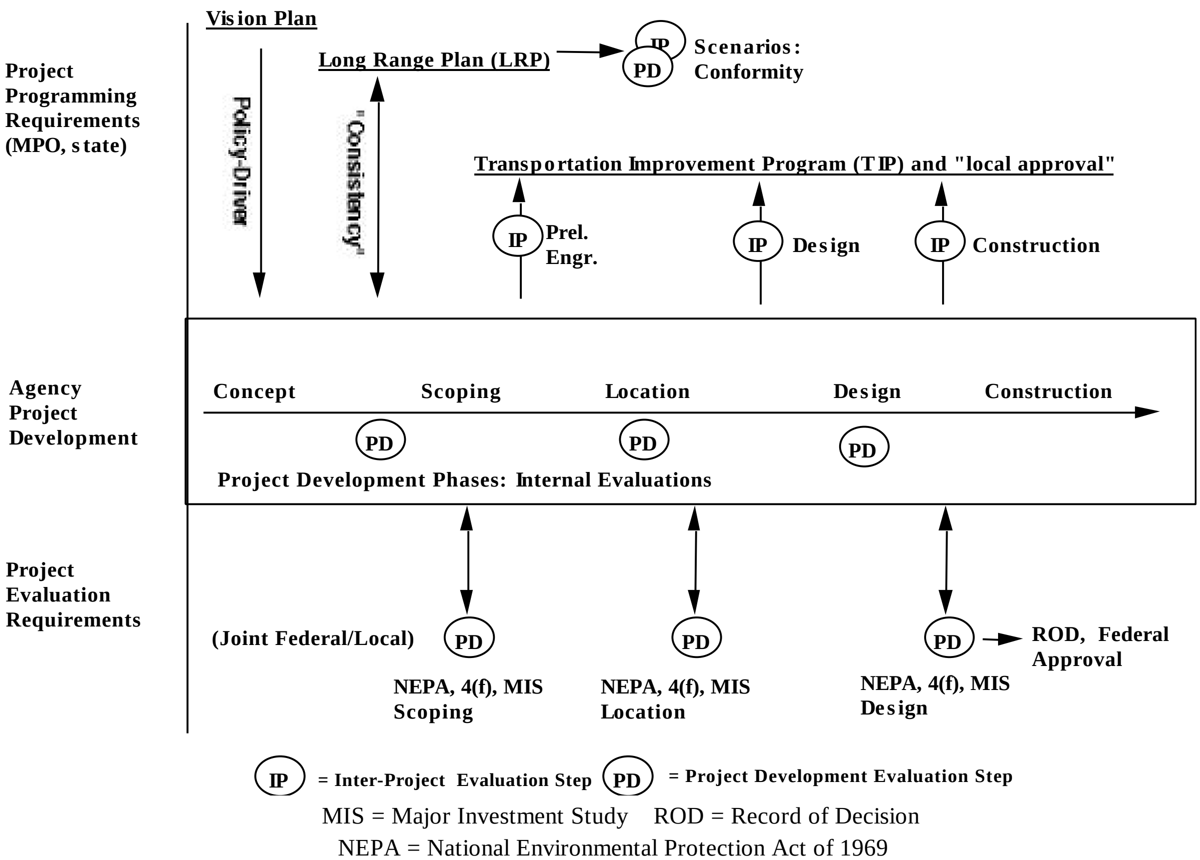

Figure 2-1. Evaluation Steps in Transportation Planning

The figure divides into three general processes, represented in the upper, center and lower parts. The central process, denoted as agency project development, generally occurs within transportation operating agencies. Along the horizontal axis, the steps involved with planning, designing, and implementing transportation projects are represented (concept, scoping, location, design, and construction). The order of these five steps is essentially the same as projects typically go through, and corresponds to the increasing level of detail needed for eventual implementation. At the top of the figure is the programming process done primarily by agencies such as state DOTs and MPOs. At the bottom are project evaluation steps, that are federally required for programming, but that often are significant in setting the processes and pace for project development. The main point of the figure is to show the key potential evaluation steps, denoted by the circles as either inter-project (between projects) or project development (occurring within a project), that should be able to use the methodologies recommended in this task. The arrows represent reporting requirements, which often correspond to the evaluation steps.

Phase 1 of this task selects and documents case study regions to add the local detail to the general process descriptions, and focuses on the upper, inter-project (IP) programming evaluation steps. The IP steps occur primarily within state transportation agencies and the MPOs of urbanized areas, that are the focus of the case studies.

The project development process is where projects that are consistent with the transportation plan, including ITS projects, are further defined and driven to implementation. These projects may have been initiated within an operating agency or MPO, or may have been recommended as an investment strategy from a planning study or activity such as a Congestion Management System (CMS) plan or a Major Investment Study (MIS). The horizontal axis can be interpreted as the time sequence (not to relative scale) of the development steps. Unless agencies can recognize the potential effectiveness of ITS, and select ITS as part of, or in favor of, other kinds of transportation solutions, there will be no ITS projects to program. The CMS involves the establishment of ongoing performance monitoring, evaluation, and incorporation of congestion management strategies into plans and TIP's. The CMS planning activity, while not explicitly shown on Figure 2-1, is an important venue for introducing ITS strategies, since it is far enough to the left on the horizontal axis (at the concept stage) to influence the subsequent development steps. Phase 2 of this task will develop methodologies that relate to project development both for internal agency development steps and for the externally required project evaluation steps.

The project development evaluation steps will change in their nature along the development axis. Initially, the issues are to select among broadly defined options and to package these into alternative projects. This progresses through various selection points, generally with fewer and more detailed alternatives as the project development process moves from left to right on the axis. The analysis methodology must therefore become successively more sensitive to detailed characteristics and differences of the alternatives, possibly leading to design optimization. The scope of this task, in Phase 2, will be confined to earlier, and broader, comparisons, for ITS-inclusive alternatives.

The externally required project evaluation steps, as shown, will apply only to major construction projects. Such projects may have associated ITS components. ITS stand-alone projects not involving traditional highway construction generally go through the internal agency steps, but can have very truncated external steps. The analysis methodologies developed in Phase 2 will apply to the external project evaluation steps as extensions of project development.

2.3 Project Development

Transportation project development is the process of realizing general transportation goals and objectives through a succession of activities that lead to project construction and operation. Transportation projects are developed by agencies with missions requiring capital construction of facilities and their operation. These agencies are concerned with various modes and various geographic jurisdictions. Both public agencies and non-governmental organizations (NGOs), such as public interest, professional and business groups, have a role in project development. All such agencies can use an ITS-inclusive alternatives investment analysis somewhere in project development. It is important to point out that an ITS component could emerge as an enhancement or add-on during the project development process of a traditional capital and operating project.

All the agencies enumerated below can be audiences for the ITS-sensitive investment methodologies to be developed in this task. For the agencies directly involved in projects seeking federal funds, federal guidelines and regulations may promote use of particular methodologies for planning projects. Other audiences will respond to data and techniques useful in making economically efficient investments.

2.3.1 State DOTs

Every state has a transportation planning and operating agency that will be referred to generally as a state DOT, although they may be called highway or public works departments, and are referred to in relevant federal regulations as State Highway Agencies. The DOTs are under policy control of executive-appointed state transportation commissions. The DOTs may have multi-modal and regulatory roles, but have historically developed from state highway agencies, and highway programs remain their primary responsibility. The jurisdiction of state DOTs relative to local agencies regarding highways and other modes will vary. The state DOTs usually have highway jurisdiction in rural, unincorporated areas and for the highest class roadways—freeways and some primary arterials (typically labeled as state routes). The state DOTs have ITS project development responsibilities on the highways under their jurisdiction, and may play a coordinating role for other ITS projects. Because they have large technical-specialist staff, state DOTs have tended to play a leading role in ITS and should be a primary audience of both Phase 1 and Phase 2 products of this task.

2.3.2 Local DPWs, Transit Agencies, and Authorities

Counties and incorporated places will have local highway jurisdiction, through what will be called generally their departments of public works (DPWs). The DPWs are under policy control of their local governments. Depending on the particular jurisdictional splits with their state DOT and other levels of government, the DPWs will develop ITS projects for some highways, especially their signal control systems. In coordination with local emergency services, this extends to area communication systems.

The largest transit agencies have jurisdiction in urban regions, and are often, though not always, independent government authorities. They will develop transit ITS projects. Smaller transit operators, often operating under Federal Transit Administration (FTA) Section 18 funding, are typically state DOT-coordinated. Currently, there is not enough ITS project development experience for these smaller transit operations to generalize whether the operator or the state may take the lead project development role. Transit operations will have to coordinate with state or local highway agencies for roadway portions of transit ITS, such as signal preemption or multimodal traveler information systems. Transit agencies and DPWs are important audiences for Phase 2 products of this task, and may respond to project prioritization methodologies from Phase 1.

There are other local or private transportation providers involved in ITS: port authorities, including water terminals and airports; commercial vehicle operators (CVOs); vehicle manufacturers; and railroads. Private operators, emphasizing economic efficiency, will have an interest in investment analysis methodologies for ITS, but the focus of this task is on public sector, ground transportation, planning.

2.3.3 MPOs

MPOs, which serve as coordinating transportation planning organizations for urbanized areas with population of 50,000 or more, are a very important audience for this task. Although MPOs are generally not responsible for operating elements of the transportation system, they have a primary in coordinating transportation programs and projects within a region. They have many important responsibilities, to be carried out in cooperation with the state and local transportation providers, including development of the transportation plan and the TIP and the determination of conformity. Under the 1991 Intermodal Surface Transportation Efficiency Act (ISTEA), more emphasis has been put on the MPO's role in the area of prioritizing projects under certain funding categories (such as the Surface Transportation Program (STP) and Congestion Mitigation and Air Quality [CMAQ] categories) and in order to meet financial constraint requirements.

Many MPOs adopt "vision plans" as policy frameworks for the transportation plan and TIP, since, in part due to financial constraint requirements, these two types of plans tend to be project prioritizing lists more than project development frameworks. Besides the transportation plan and TIP development, MPOs have responsibility for or are participants in all major regional or corridor planning activities within a metropolitan area, such as CMS development and MIS or other alternatives analysis studies.

It is important to recognize that the MPOs are synthesized from, but are different in function from, the operating agencies that develop the projects. MPO policy boards do not derive directly from established political jurisdictions like the state DOT and local DPW boards do. MPO boards are specially chartered federations of state and local jurisdictions. An MPO may be a division of, or one role of, a regional authority established for other, locally defined, purposes, such as growth management or regional public works.

2.3.4 Public/Private Interest Groups

Public/Private interest groups or stakeholders (sometimes referred to as Non-Governmental Organizations) should not be overlooked as a source of project development. Under the 1991 Intermodal Surface Transportation Efficiency Act (ISTEA), these interest groups have actively developed non-traditional projects ("enhancements"). They are also strong players in the programming process and the external project evaluation steps. Organizations like ITS America, or other professional groups involved in standards development, can play a planning coordination and integration role that the conventional transportation agencies do not perform.

2.3.5 ITS Project Development

An ITS program goal is to "mainstream", or integrate, ITS planning into general transportation system planning. Federal programming and project evaluation regulations already emphasize broad transportation system analyses and equitable consideration of alternative solutions. Despite this top-down, integrative prescription, transportation planning continues to have a strong element of bottom-up, mission-specific, project programming by specialist agencies, jurisdictions, and modal advocates. Under these circumstances, mainstreaming requires that ITS strategies be advocated by operating agencies as well as better understood in terms of how they fit within the existing planning framework.

Among federal planning and demonstration grants, the EDP grants especially are aimed at bringing ITS project development by local agencies up to the capability for developing more familiar projects. This is necessary because ITS involves technology and services that are new to most local transportation agencies, and also because ITS project development involves a system engineering discipline unfamiliar to most transportation planners and civil engineers. At present, the ITS demonstration grants and the EDP processes are outside the normal transportation programming and planning. It is noteworthy that EDPs have been conducted under both DOT and MPO auspices, sometimes within the same state (e.g., Ohio).

In building up practical ITS experience over the last decade (and longer), agencies specializing only in conventional projects have adopted ITS piecemeal into their operations and construction programs. However, the intent of the National ITS Architecture and EDP efforts has been to allocate ITS capabilities more systematically. The need for this becomes locally apparent as the ITS infrastructure pieces demand to be integrated for reasons of compatibility and effectiveness. This will make it more typical in the future that ITS projects become allocated from systematic ITS planning, based on general matches of transportation needs, technologies and services. The common infrastucture that underlies ITS applications may then be implemented separately or programmed with other construction (not necessarily transportation) projects. The ITS application projects then will be adapted to geographical and transportation network locales.

Specialist ITS planning and project development does and probably will continue to occur within the transportation operating agencies. State DOTs and transit agencies often will combine ITS and conventional transportation planning, within the general agency mission for highways or transit. The specialization is not likely to be as formal within a DPW, but it will still perform integration within the agency for projects within its domains (e.g., signalization). This agency-level integration does not go as far as cross-modal or urban-regional integration. However, state DOTs and transit agencies typically are the sole sponsors of the largest regional projects and can perform extensive integration within themselves. MPOs are assigned a larger coordination role and can play an effective role in integration by providing a forum for stakeholder agencies to discuss operational issues (e.g., some MPO's have established technical committees, sub-committees, or working groups for this purpose).

2.4 Programming Required by Federal Regulations

Federal transportation funding through ISTEA, and the conformity requirements set by the Clean Air Act Amendments (CAAA), establish programming requirements. These requirements establish project approval steps at various points in project development, ultimately for project funding. Although programming is a federally formalized process to sift projects, it cannot guarantee ITS-inclusive projects and has only indirect effect on the integration of ITS into the transportation system. An ITS-inclusive programming evaluation methodology, between projects with different purposes, should ensure the fair recognition of ITS benefits relative to other kinds of projects.

The relevant federal programming requirements are set in Title 23 of the U.S. Code [5] (hereafter USC) and in the corresponding Title 23 of the Code of Federal Regulations [6] (hereafter CFR). While originally for highways, these titles contain the state and metropolitan project programming requirements for federally funded highways and transit projects in general. The specified programming is also the means of conformity to the CAAA, with provisions codified in 42 USC. These regulations relate to the Phase 1 investigation here and the inter-project evaluation methodologies. The requirements of the National Environmental Policy Act (NEPA), with its regulations now at 40 CFR, impinge on programming steps but are more relevant to the project development steps, to be focused on in Phase 2.

Under ISTEA there are parallel state DOT and MPO procedures. These essentially derive from the 1962 Highway Act, and so are longstanding parts of the programming process. The MPOs are to maintain a multimodal "continuing, cooperative and comprehensive" (3C) process (23 USC 134) in metropolitan areas. State DOTs play an analogous role outside the urbanized areas. The MPOs are multi-jurisdictional agencies that include the state DOTs and local jurisdictions on technical and policy boards. The law requires maintenance of a longer horizon transportation plan (historically referred to as a Long Range Plan) and a shorter range TIP, generally with multi-year horizon and annual or biennial updates.

The transportation plan is formally developed and adopted by MPO boards of elected officials. The transportation plan includes long-term and short-term actions that reflect environmental and intermodal considerations and provides a financially-constrained vision of future transportation investments. There is an important difference between the functions of the transportation plan and TIP. The transportation plan is an intermediate step between initial project development and approval in a TIP. At the transportation plan stage, some projects may be only generally defined (e.g., a corridor capacity problem) and therefore are more liable to be shaped by regional or statewide coordination planning. In practice, some projects enter without much feedback from the coordinative level to the project development level. Since ISTEA has specified financial constraint of the transportation plan, meaning that the value of projects has to be within realistically foreseeable funding, the transportation plan is now playing more of a project sifting and prioritization role. Particularly in non-attainment areas, plans contain sufficient detail to permit in-depth air quality impact analysis.

The “consistency” requirements within the transportation plan is with policy enunciations contained there. As a policy document, the transportation plan need not be updated as frequently as the TIP. However, insofar as the transportation plan is also an extended list of projects, the practice is to amend it as new projects are programmed, often simultaneously with annual or biennial TIP updates. Rush projects can always be included “off-cycle”. Small scale projects need not be listed explicitly in the transportation plan at all. The latter may include many ITS projects not associated with major construction.

There are no direct requirements in law or regulation for ITS to be in the plans. However, ISTEA includes features that strongly encourage approaches other than additional transportation construction. In particular, for areas of over 200,000 population, the establishment of Transportation Management Areas (23 USC 134(i)) and their congestion management systems (CMSs) by MPOs strongly relates to ITS projects (via transportation system management strategies).

MPOs, in addition to having a policy board, also generally have a staff that includes transportation planners to carry out the responsibilities of the organization. The degree to which an MPO can affect project development, and therefore specific consideration of ITS as a project component, varies across MPOs. The MPO technical staff are an audience for both project development methodologies and for investment methodologies used for cross-project analysis and prioritization. This means that such a methodology must be applicable to all kinds of transit and highway projects. For this report (Phase 1), the TIP prioritization role will be primary.

State DOTs, as primary players in the MPO programming, have long developed their projects through parallel long range and short range plans. The formal requirement for multimodal state transportation plans and TIPs is now set in 23 USC 135 and applies to projects outside the MPO regions, as well as those programmed through the state DOTs and into the MPOs. For state DOTs, the transportation plan can play an important and direct project prioritization role. As will be seen from the case studies, there are important variations in state-MPO relations in the programming process, regarding which is the primary audience for ITS evaluation, and at what point.

There are few formal programming requirements for DPWs. other than to include relevant projects in the state or MPO plans. If they face internal prioritization tasks, they will have use for ITS-inclusive methodologies.

Large transit agencies tend to have strategic plans and have requirements for Capital Improvement Programs (CIPs) that parallel the transportation plan and TIP of their MPO. The way in which transit or other projects enter the transportation plan and are approved in the TIP is essential to application of the investment methodology of this task. These procedures are so varied that detail will rely on the case study data.

The overall effect of the inter-project programming regulations is to establish discrete points of approval where a validated investment analysis will be part of project documentation and prioritization. This applies primarily to the TIP approval process. These programming processes inherently involve comparison across a wide variety of projects serving different purposes.

2.5 Alternatives in Transportation Planning

Transportation planning involves making investment decisions between transportation alternatives. Different analysis methodologies are required depending on how an alternative is defined. Three general kinds of alternatives are described below: as transportation plan scenarios, as projects for TIP selection, and as alternative solutions in project development. The scope of Mitretek's task currently is limited to certain levels of detail of the latter two kinds of alternatives.

2.5.1 Transportation Plan Scenarios

The term "scenarios" will be used for the kinds of alternatives unique to the transportation plan scale of planning. While this kind of alternative is not focal to this study, transportation plan scenario analysis can use ITS alternatives evaluation methods. The transportation plan scale of analysis poses special challenges to any methodology. This includes the difficulty of doing micro- and behavioral-simulation modeling over regional networks or using traditional regional demand models in general. Such modeling probably is necessary for ITS impact evaluation. However, there are ways that project-level evaluation can contribute to transportation plan evaluation.

In the prescribed project programming, some kind of strategic plan should frame project development to meet regional policy criteria. This is a "top-down" approach to project development. Here the problem is not confined to congestion in a particular corridor, or need for a new bridge—it may be that growth (or even existing congestion or air pollution) cannot be accommodated by adding more streets and highways. Some problems, like regional ozone air quality exceedence, cannot be decomposed to local, project specific, remedies [although project-level analysis for carbon monoxide can be done]. A transportation demand management (TDM) program or CMS also transcend typical single-project scope.

The strategic scale of planning is represented by the vision/policy plans and transportation plans of the MPOs and state DOTs. These have to be converted to alternative development and transportation network patterns (scenarios), via regulations, construction projects, and management systems, like ITS. The contents of the scenarios represent a whole range of programs, from general "strategies" to specific projects. Depending on the network size, and the complexity of environmental, growth and intermodal issues, the difficulty of analyzing the scenarios will vary.

An MPO may examine alternatives such as transportation demand restrictions, limits to growth, increased transportation taxes, commitment to construction and funding of public transit systems, or regional adoption of advanced technology such as ITS. ISTEA and the CAAA have introduced more stringent requirements for analysis of the transportation plans. The regional transportation plan must demonstrate conformity to the air quality attainment goals, and there are State Implementation Plans (SIPs) correspondingly. This has promoted development of more accurate air quality evaluations at the regional scale, and ITS methodologies would have to meet such requirements. It is intended that transportation plans show effective consistency with the 15 factors of ISTEA at 23USC 134(f).

Fiscal constraints encourage every agency to examine alternatives to get the most favorable effect within a budgetary limit. However, it is not practically a matter of deciding how best to allocate a total regional pot of money. There are additional constraints on how funds are categorized, by purpose and controlling recipient. At the federal level there are still at least four fairly distinct categories, in terms of allocation and programming: transit funds, and highway funds broken into Surface Transportation Program (STP), Congestion Mitigation and Air Quality (CMAQ) and "other". Effective control of these and local funds is by transit authorities, the MPOs, state DOTs and local DPWs. There could be dozens of partitions that channel funds to specific sets of projects, and prevent any comprehensive regional control or "optimization" of funding allocations. This fact now prevents regional scenario evaluation from having potent effect on project development. It is within this context that ITS has been "protected" by earmarked funds so far. As earmarking fades out, ITS will have to be more competitive, and will need the methodologies of this task, but still not at a general level of transportation plan integration.

An ITS sponsor, such as a state DOT, may have its own ITS strategic plan as well as an agency-wide strategic plan. Therefore, there is potentially a three-phase process of analysis at the strategic level: ITS specific, across the sponsoring agency, and within the MPO. If a methodology is used in the strategic ITS plan, it can feed upward, additively with other projects, into general transportation plan evaluation. But dependencies of ITS with other transportation plan contents—the case that integrated transportation plan analysis is supposed to address—prevents such a "summation" approach, and methodologies must be developed for a larger and more complex scale of analysis. This task is only a step in that direction.

2.5.2 TIP Selection

The second category of "alternative" arises when a transportation agency must choose among various projects that have been proposed for transportation improvements in the state, region or operating jurisdiction. The alternatives are the projects to be put into the approved, and fiscally constrained, TIP. The proposed projects will be many and varied—some will be for new construction, some for modifying intersections, some for intermodal access improvements, some for adding loop detectors or ramp meters to existing roads, some for traffic signals, some for bikepaths, etc. TIPs are developed as composites of the several funding-jurisdictional channels described for the transportation plan.

The typical method of project selection is to prioritize projects numerically by a "scoring" process, using a weighted sum of criteria evaluations. The criteria are varied and incommensurate, including quantitative and qualitative criteria. In one of the case studies, some criteria are transformed into the uniform score while others are kept as auxiliary yes-no (binary) decision factors.

The simple scoring process suppresses the issues of how disparate criteria are made comparable by scaling and weighting to achieve a single, arbitrary, rank score for each project. Analytical approaches attempt to do this in a more explicit way, e.g., to calculate an economic rate of return, or net benefit to rank all projects uniformly. The objection to such approaches is that they are more complicated and introduce contentious analytical assumptions. Scoring only obscures these issues. Indeed, where it is desired to reflect policy into the selection, as opposed to some policy-free process, the problems of trying to reduce multiple criteria into one are unavoidable. Since the TIP should be both a conduit of policy priorities *from* decisionmakers, and a presenter of objective measures *to* decisionmakers, there will be qualitative and quantitative criteria. It can be required that these be assessed explicitly and uniformly across projects. This is where a methodology that is ITS-inclusive comes in, not to make the whole process analytical, but to ensure uniform treatment of ITS and conventional projects within each criterion. Beyond this, the choice of scales and weights should fairly reflect the policy emphases. Regardless of the scoring approach, planning judgment is often used to supplement the scores.

Another, but equally fundamental, problem with scoring is project score independence. The process is simplified if it is assumed that each score is derived only by looking at characteristics of each project in turn. This assumption is supported if each proposed project addresses a unique problem allocated down from the strategic planning level, but is developed according to detailed knowledge of the agency with the mission to address the problem. In practice, some of the integration problems of the transportation plan are delegated to the TIP level. This is why qualitative, policy, criteria show up in scoring. Some problems are:

- Among many contending agencies, there is a variety of overlap as to how the problems are defined and how corresponding projects address them. For example, to address a traffic congestion problem along a given arterial, without the proper coordination, a transit authority might recommend more transit service and a transit priority system among the signals, while the local DPW has recommended that a lane be added, various geometric improvements made, and small-scale signal timing improvements implemented.
- Projects have functional interdependencies. The impacts of individual projects may be more or less depending on what other projects, in what order, are approved. This applies to ITS projects relative to the whole ITS, and ITS relative to conventional projects.
- Systematic interdependencies are supposed to have been resolved at the transportation plan level, but insofar as specific projects become more detailed at the TIP level, new coordinative issues may arise.

These problems cannot be solved by any simple project scoring process, even when qualitative policy criteria are used. This is why TIP approvals typically occur in a two-stage process—the first being more analytical for scoring, and the second being before the policy board for voting and discretionary alteration of priorities.

Some of the interdependency problems are also addressed by the partitioning of TIPs into the different funding categories. This has long occurred by separation of highway and transit funding, with many sub-categories, in eligible uses and agency control. ISTEA has made funding more "flexible" by reducing categorical constraints, yet it has also reinforced partitions of project development by adding the STP and CMAQ categories and encouraging more direct MPO, as opposed to state DOT or transit agency, prioritization of those funds. This approach does not *resolve* the functional interdependencies, nor can it ensure proper systematic development. It does reduce mission overlap by declaring different missions for different funds, and by reducing the sets of projects within each programming channel, makes processes of project integration more manageable. Thus, there tend to be two levels of the "stage 2" policy integration—within the agencies associated with each funding category, and finally at the MPO policy board.

Within scoring, another issue is uncertainty in evaluation, for either the quantitative criteria or the scaled values for qualitative criteria. Different projects in different settings will have different reliabilities of the quantitative scores they produce. The spread of policy opinion ("votes") produces a range of preference strengths in qualitative criteria. The use of risk measures and risk-weighted scores is indicated in this case. This is not usual practice in TIP scoring. Risk evaluation will aid the bias in project selection if measures for projects are not equally reliable. Indeed, there is reason to believe that projective biases under uncertainty will favor the projects whose measures are less reliable but are capable of high benefit somewhere in their range (risk seeking in speculative projects). Heretofore, this may have been a factor in favor of ITS. In fact, there is no reason to believe that all other types of projects, in all TIPs, now are more reliably evaluated than ITS.

The need to merge project-level evaluations of differing reliabilities in TIP scoring is another reason, besides consideration of interdependencies, why TIP scoring methodologies are distinct from evaluations that might be used in project development. Therefore, there is good reason to believe that the TIP scoring methodology considered in Phase 1 of this task is distinct from the project development analysis of Phase 2.

2.5.3 Project Development

The third category of "alternative" is when different types of solutions are considered for application to the same problem, as part of project development. This project-scale alternatives analysis is more or less formal, depending on the project scale and nature, varying among large additions to capacity, building a by-pass route, building a light rail route, converting Single Occupancy Vehicle (SOV) lanes to High Occupancy Vehicle (HOV), adopting road pricing procedures, etc. For the most significant projects, particularly capacity additions, there are stringent regulatory requirements for alternatives analysis.

2.5.3.1 Project Phases (scoping, location and design)

An important thread in all the required project development evaluations is the use of different levels of analysis at different project phases. These conventionally are called the scoping, location and design phases. These phases are more or less distinct, depending on the type of project and how it triggers regulatory requirements. These phases are analogous to different levels of design allocation in ITS engineering, as specified formally in system engineering methodologies, and as are being followed in the national and some regional architecture development. However, the ITS engineering levels may not be coincident with the phases of a construction project in which ITS is deployed. ITS projects may be fully developed up to the point of construction, and then be programmed with a transportation construction project at a different stage of development. This would occur, for instance, to complete a transportation management system incrementally by emplacing new sensors and controls with additions to HOV lanes. Therefore, in speaking of different levels of analysis for different project development phases, it should be recognized that the ITS and non-ITS components *in the same project* may be at different phases.

2.5.3.2 Hearing Processes

In 1968, a two-hearing process was adopted for major highways. This explicitly created a phase for considering alternatives in project location, and then a phase for design. The intent was to determine broad alternatives to a corridor or area problem, and then more specific ones. ITS alternatives evaluation, at two different scales, would be applicable in both hearing phases. Since the hearing process is now treated primarily through NEPA programming (see 23 CFR 771) for all projects, phased hearing analyses can be discussed in that context.

2.5.3.3 The 4(f) Requirements

A variation on alternatives analysis is set by the 4(f) requirements in the original United States Department of Transportation (USDOT) Act of 1966, and now at 23USC 138. These requirements concern parklands and historic sites affected by construction projects. The requirement is that there be "no prudent or feasible" alternative to the construction that might harm such sites. This sets a very stringent analysis requirement that may be interpreted to mean that ITS has to be examined as an alternative that would replace construction, or as an adjunct that would mitigate construction impacts. Such analysis is programmed as part of more general NEPA requirements.

2.5.3.4 NEPA

The requirements to fulfill NEPA are at 23 CFR 771. Depending on the nature of a project, NEPA generates a Finding of No Significant Impact (FONSI), an Environmental Assessment (EA) or, most elaborately, an Environmental Impact Statement (EIS). An ITS project, by itself and involving no construction, is subject to a categorical exclusion under NEPA and generates no alternatives analysis requirement, other than that required by the operating agency for project development purposes. But ITS often will combine with other construction elements as part of NEPA analysis.

NEPA requirements have been open to judicial interpretation, and that has been lenient with respect to analysis requirements. Alternatives need to be considered, including a baseline "no build", but the kinds of alternatives and depth of analysis are not specified. NEPA supports no stringent requirement for benefit-cost analysis, or to select "best" investments for any project. The level of alternatives analysis will be driven more by internal project development missions than by requirements under NEPA. In this regard, NEPA has been supplanted by the more stringent requirements of the Major Investment Study (MIS).

NEPA has stipulated the project development process by its required steps in conjunction with the hearing process. For all major projects (and where ITS would be linked with major construction options) there is a scoping phase to determine the nature of alternatives and EIS analysis scope. This is followed by a draft EIS (the location phase) and a final EIS (design phase). There is also the provision for "tiering" the level of NEPA analysis. Tiering involves a general "programmatic" EIS for a set of projects, with its own draft and final versions, and then separate draft and final project EISs. Tiering would be a good way to insert ITS systematically into transportation plans at the programmatic level. Unfortunately, the transportation plans and TIPs themselves (as opposed to projects) have been ruled not subject to NEPA. A final EIS will lead to project approval by the federal sponsor, backed by a record of decision (ROD). It is the federal role that triggers NEPA and sponsor approval is not the same as local project approval through the TIP. In some states, there are comparable "mini-NEPA" requirements for non-federal sponsors. However, the ROD must show some consideration of project alternatives, and this is where an analysis methodology will enter. The three EIS phases, within tiers, will accompany successively more detailed levels of alternatives analysis.

2.5.3.5 MIS

The MIS requirements are a strengthening of the NEPA analysis requirements, including alternatives, for largescale, federally funded, construction projects. They will pertain where ITS has the potential to accompany or modify such construction. See the MIS Desk Reference for more details on the MIS techniques and requirements [7].

The current MIS requirements are recent, from October 1993, and so are still developing in practice. However, the intent and procedures go back several years, particularly to the FTA requirements for major rail transit projects, since a scarcity of funds for such projects has required a strong showing of effectiveness. The MIS was also enforced by Executive Order 12893, of January 1994 requiring a "systematic analysis of costs and benefits of proposed investments" [8].

The MIS is programmed as part of the NEPA and hearing processes. Therefore it generally has successive levels of detail in a concept, scoping, location and design phases of project analyses. The initial MIS alternatives generally vary significantly in design concept and scope (e.g., highway construction vs. transit-oriented options). Investment analysis methodologies that are sensitive to ITS elements and relevant to the MIS requirements will be investigated in Phase 2 of this task. This should prove to be useful for contributing to the incorporation of ITS in MIS procedures. for projects that must demonstrate a superior benefit-cost result, possibly by use of ITS adjuncts, or, in rare case, by an ITS alternative to construction.

2.5.3.6 Agency Project Development

The alternatives analysis procedures described above have been developed for construction projects and do not apply to ITS by itself. The analysis requirements specified at scoping, location and design phases are points of entry for ITS evaluation. They are where a separate ITS project development channel can merge with conventional project development. However, the internal agency project development processes, and the merger of ITS and non-ITS projects within a modal agency, is probably more vital to ITS consideration.

Because the federal regulations require so much effort for major construction projects, those regulations tend to formalize the agency process followed. However, informal decisions early in project development tend to be persistent, and these rarely involve formal alternatives enumerations and analyses. The process tends to be one of pursuing standard, agency-familiar, solutions to problems that are defined to be consistent with the agency mission in the first place. Alternatives are less apparent than convergence toward project details.

If ITS is associated with construction, at a scoping phase, then the specified alternatives analysis processes of NEPA, 4(f), or MIS can be used to pull in ITS alternatives. However, it is unrealistic to expect this to do anything but promulgate piecemeal, unintegrated ITS components unless the parallel process of ITS development is adopted and internalized by the sponsoring agencies. In fact, the MPO or the State, acting on their planning and program coordination responsibilities, could encourage a project sponsor to investigate ITS opportunities and ask them to engage other affected agencies in the process. It is better to view the situation as systematically allocated ITS projects riding on construction projects for programming purposes, than as construction projects that invent ITS alternatives.

In project development from concept to design, there is a continuum of needed ITS support from publicizing generic ITS benefits, to providing a methodology for analysis of specific ITS project investment impacts within local contexts. A complicated and specific methodology will not be successful in initiating consideration of ITS alternatives, but can come into play after there is a willingness to invest further project development resources. Therefore, whether linked to federal or local agency analysis requirements, there must be different levels of ITS-inclusive project development analysis for different project phases.

2.5.4 Alternatives Evaluation Categories

Based on the different kinds of alternatives and their evaluations, a need exists for separate procedures in the programming (cross-project analysis) and project development (project alternatives) methodologies, at roughly three levels of project development detail. If these categories were multiplied by the different kinds of agencies involved, associated with modal or geographical scale of interest, there is a potential for a large variety of tailored methodologies.

It remains to be seen, for ITS, how much these separate approaches can be combined. Table 2-1 enumerates the different kinds of methodology applications that have been discussed.

The table shows eight discrete categories of alternatives evaluation that may also categorize the ITS investment alternatives methodologies. The table does not show the significant differences that may exist between types of projects across the sponsoring agencies concerned with different modes, geographical scopes, and mixes of ITS-only or ITS-construction hybrids.

Table 2-1. Categories of Alternatives Evaluation Methodologies

Scale	Type	Objects	Agency
Long Range Plan	Inter-Project/ Project Development	Scenarios	MPO, state DOT, local agencies (formal or informal)
Transportation Improvement Program	Inter-Project	Projects, various phases	MPO, state DOT, local agencies (formal or informal)
Scoping: NEPA, MIS, 4(f)	Project Development	Project alternatives (significant construction)	Federal/local sponsors
Scoping: agency-internal	Project Development	Project alternatives	local sponsor
Location: NEPA, MIS, 4(f)	Project Development	Project alternatives (significant construction)	Federal/local sponsors
Location: agency-internal	Project Development	Project alternatives	local sponsor
Design: NEPA, MIS, 4(f)	Project Development	Project alternatives (significant construction)	Federal/local sponsors
Design: agency-internal	Project Development	Project alternatives	local sponsor

2.6 Focus of This Task

The following analysis categories for development of evaluation methodologies will be addressed in this task:

- A regional- and state-scaled TIP scoring process (a focus of this task and this Phase 1 Report).
- An MIS-type, scoping/location-scaled, hybrid project, alternatives evaluation methodology (focus of Phase 2 of this task).

- A small-scaled, hybrid project, alternatives evaluation methodology (can use results of Phase 2 of this task).
- A small-scaled, ITS-only project, alternatives evaluation methodology (can use results of Phase 2 of this task).

This report focuses on the inter-project scoring evaluation that deals with how projects are selected for inclusion in the TIPs. Two metropolitan regions, where many ITS components have been and are being deployed, were selected for study of what is currently done, leading to recommendations for improvements. The next phase of this task will provide more information on project alternatives analysis using a typical MIS corridor or subarea of a regional network as the basis for project scale. The alternatives are intended to be hybrids containing both ITS and construction, possibly multi-modal, alternatives so that the methodology will be general. It is expected that within the scope of this task, the methodology will still be preliminary and apply to scoping, possibly location-scaled, requirements. That leaves two other types of analysis not within task scope:

- A regional-scaled transportation plan scenario alternatives evaluation (not in this task, but may borrow some results).
- An MIS-type, design-scaled, hybrid project, alternatives evaluation methodology, useful for internal and programmatic evaluations.

While this task can contribute to all analyses involving ITS and hybrid projects or alternatives, design-scaled analyses will require more detail than any general methodology can provide, and regional scenario analysis requires a level of modeling and analysis beyond the scope of this task.

Section 3

Houston Process Description

3.1 Regional Background

The Houston-Galveston Metropolitan Area comprises eight counties: Brazoria, Chambers, Fort Bend, Galveston, Harris, Liberty, Montgomery and Waller; with an urban area of approximately 7,800 square miles, 3.7 million people (1990) and 18,000 lane miles of freeways and thoroughfares. It is the tenth largest urban area in the United States and the nation's fourth most populous city. By the year 2010, the population is expected to grow to approximately 5 million people, with daily vehicle miles traveled (VMT) expected to grow from 82 million in 1990 to 136 million.

The region is served by the Metropolitan Transit Authority of Harris County (METRO), Island Transit of Galveston and the Brazos Transit System. It is noteworthy that in 1978, Harris County voters created METRO and approved a local one-cent sales tax to be used in the construction and operation of a regional transit system. As of 1990, METRO operated 110 bus routes, 21 park & ride lots, 6 transit centers, and 808 peak period buses (not counting paratransit vans); 83 million riders were boarded. METRO is a significant partner in numerous conventional and ITS-related activities in the region, participating in planning and funding a Traffic Management Center (TranStar), construction and operation of HOV lanes on four area freeways, and creating a $120 million Regional Computerized Traffic Signal System (RCTSS) to link 2800 signals to TranStar. USDOT has recognized that the region "has a strong history of high occupancy vehicles and public transit innovation".

The Houston-Galveston Area Council (H-GAC) is designated by the Governor of Texas as the MPO for transportation planning in this region, and is made up of 149 local organizations. A Transportation Policy Council (TPC) provides policy guidance and overall coordination for multimodal transportation planning and development. Zoning authority within the region rests with the local municipalities. While the City of Houston does not have a zoning code, other cities within the H-GAC region do and actively plan for growth. Within the unincorporated counties and within the City of Houston, large master planned developments and neighborhoods are typical. Planning is conducted at the community or neighborhood level and is enforced through protective covenants attached to the real-estate deed.

The Houston-Galveston region is in District 12 of the Texas Department of Transportation (TxDOT), one of 25 state transportation planning areas. TxDOT is directed by the Texas Transportation Commission.

The Houston-Galveston area is a severe non-attainment area for ground level ozone and must therefore reduce HC and NOx emissions from all sources to achieve compliance with air quality standards by 2007. Transportation control measures to meet National Ambient Air Quality

Standard (NAAQS) requirements include transit services expansion, operational improvements to freeways and highways, and bicycle/pedestrian facilities improvements.

3.2 Planning Background

Transportation planning and programming activities are conducted by the H-GAC, TxDOT, METRO, and various local jurisdictions such as the Port of Houston Authority and local governments. H-GAC executes the transportation planning activities as mandated by federal law, through a Unified Planning Work Program (UPWP), a LRP and a TIP. The UPWP is prepared annually and describes the transportation planning activities which will take place within the region. Funding for the UPWP comes from federal, state and local funds. The state and regional planning processes are described below.

3.2.1 State Planning

TxDOT uses a ten year Project Development Plan (PDP) as their LRP for statewide transportation planning. The PDP is updated annually. Seventeen categories have been established in the PDP to reflect the various funding categories outlined by ISTEA, such as the National Highway System (NHS) and the STP, and for various activities that reflect the intended use of specified funds such as safety, preventive maintenance and bridges.

The Texas Transportation Commission has established six priorities for transportation planning, which are implemented in a construction program. The priorities are:

1. Preservation of the Capital Investment
2. Safety
3. Congestion Relief
4. Environmental Protection and Enhancement
5. Economic Development
6. Aesthetics

In compliance with the Final Metropolitan Planning Rule published in the Federal Register in October 1993, TxDOT is currently developing a Texas Transportation Plan to coordinate the planning and implementation of the state's transportation facilities and programs. This plan will address integration of highways, mass transit, railways, airports and bicycle/pedestrian systems by examining the long range needs of the entire state.

3.2.2 Regional Planning

"Access 2010: 1994 Update" is the region's Metropolitan Transportation Plan (MTP) [9] and meets federal requirements as the LRP, outlining strategies for improving mobility and air quality through the year 2010. It establishes ten goals for the metropolitan area:

1. Provide transportation facilities and services promoting orderly economic growth.

2. Coordinate transportation services and investments, determining transportation priorities based on needs and the ability to support them.
3. Contribute proportionately with other pollution sources to attainment of the NAAQS for ground level ozone in 2007 and maintenance of the standard thereafter.
4. Ensure that proposed projects have funding authority at the local, state and federal levels.
5. Achieve effective management of transportation supply and demand.
6. Provide cost effective and convenient choices of transportation for urban and suburban activities.
7. Provide metropolitan residents with good access to urban and suburban activities.
8. Achieve highway, transit and other transportation modes that are safe, efficient and economical.
9. Provide transportation facilities and services that produce positive impacts on the social, economic and physical environments of the region.
10. Provide a transportation planning process that is responsive to the needs and interests of the region with opportunity for public participation.

The measures described in the MTP are projected to comply or conform to the Texas SIP for reducing vehicle emissions, as mandated by the 1991 ISTEA and the 1990 CAAA. Although ITS is not explicitly mentioned in the stated goals, the MTP recognizes that ISTEA and CAAA constrain construction of added capacity for SOVs, and that Transportation System Management (TSM) and TDM are needed to increase the efficiency of the existing system--areas in which ITS components and ITS alternatives are integral. Also, from the ITS perspective, a draft TxDOT ITS Implementation Strategy document and a draft Regional ITS Strategic Plan exist (Fall 1995) but have not formally entered the planning process. Nevertheless, long range ITS planning has strongly influenced the region's transportation system, as evidenced by the commitment to a traffic management center mentioned earlier and by adoption of a TxDOT 10-year plan, adopted in 1989, to install a regional Computerized Transportation Management System (CTMS). The CTMS plan provides the rationale for funding numerous ITS components (e.g. changeable message signs, vehicle detection equipment) that are programmed in the yearly TIPs.

Because the region is in a severe non-attainment area, a CMS Implementation Plan has been prepared using federal planning funds and will be submitted to the H-GAC TPC for review early in 1996. Transportation control measures (TCMs) selected for analysis include traffic signal timing improvements, roadway pricing, motorist information systems and incident management techniques, each of which indicates use of ITS technologies. The plan specifically provides for integrated development of a regional ITS.

The TIP [10] is a cooperatively developed three-year program outlining transportation demand management, transit, highway and traffic improvements within the region. It is compiled annually under the guidance of the TPC and is approved by the Governor of Texas. Projects included in the TIP must be in the MTP and must conform to the state SIP. This requires that the TIP must identify TCMs that were committed to in the approved SIP and give priority to these

TCMs. EPA Conformity Rule (40 CFR Part 51) also requires that the TIP provide for the timely implementation of the TCMs. Once the TIP is approved, it is included with TIPs from other regions of the state in a State Transportation Improvement Plan.

3.3 Funding

For areas in compliance with the clean air act, transportation funding comes from Federal funds; e.g. for Interstate Highways (Construction or Maintenance), the NHS, the STP; FTA Sections 3, 9, and other categories; and from state and local funds. In non-attainment areas, additional Federal funding for CMAQ is made available by legislation. For FY95- FY97, the region will receive approximately $159 million in CMAQ funds. This has a large effect on how the region allocates its funds, although it does not necessarily mean that the regional transportation budget increases, since TxDot balances allocations across the state to achieve equity among regions.

In Houston, TxDOT and the H-GAC, through the TPC, determine how projects will be selected for funding [9,10]. They have decided that road construction will be funded by the Federal Highway NHS and STP categories plus state and local monies, transit will be funded by Federal Transit and local monies, and ITS and other projects that have air quality-related benefits will be funded by CMAQ. This results in fencing the CMAQ funding from some competition (from transit projects for instance), and also eliminating competition from non-construction projects (for example a traffic management project) for NHS and STP funds. Since Houston is among the leaders in deploying regional Advanced Traffic Management Systems (ATMS) and Advanced Traveler Information Systems (ATIS) and other advanced technologies, this has proven to be an effective policy, and has allowed the region to implement their ITS initiatives in timely fashion. In particular, CMAQ has provided the money for Houston to accelerate and expand their initial ITS activities, such as the CTMS and TranStar, to what they are today.

In other regions of the state, where CMAQ funds are not authorized, ITS projects are funded from NHS and other categories, as agreed to by TxDOT and the local MPOs.

A funding summary for the 1995-97 H-GAC TIP is shown in the table below:

Table 3-1. Three-Year TIP Funding Totals

Funding Category	**3-Year Total, $ Millions**
FHWA Administered Highway Funds	
Interstate	61.64
National Highway System	381.56
STP Safety	8.28
STP Metro Mobility	114.80
STP Urban Mobility	13.92
STP Rural Mobility	13.45
STP Rehabilitation	19.05
STP Railroad Grade Separation	7.90
CMAQ	198.22
On Bridge	30.42
Off Bridge	11.20
Commission Strategic Priority	65.32
Demonstration Projects	59.40
Ferry Boat	16.95
Subtotal FHWA Programs	1,002.11
State Highway Programs	127.80
Total FHWA and State Highway Programs	1,129.92
FTA Administered Transit Funds	
Section 3	558.14
Section 9	100.84
Section 16	0.35
Section 18	0.93
Section 26	10.49
Misc.	1.70
Total Transit Funds	672.45
Grand Total, Highways and Transit	1,802.37

3.4 TIP Project Selection

TxDOT has a project evaluation methodology for discriminating between the merits of construction projects that is used statewide for selecting projects for NHS funds. Houston is in District 12 for this allocation, and may or may not receive NHS Mobility funds in a given year. (For FY 96-98 over $762M is programmed.) We note that no NHS Traffic Management funds are received by the Houston region as a result of the policy decision that CMAQ funds must be used for traffic management projects there. A methodology for evaluating added capacity, roadway and transit projects is used by H-GAC, in cooperation with TxDOT and METRO, for evaluating STP and FTA Section 9 funds. CMAQ projects are evaluated by H-GAC. A discussion of these project ranking techniques follows.

3.4.1 State-Level Selection in Texas

The vehicle for achieving the state priorities for transportation is called the Transportation Construction Program which contains projects for preservation, safety, mobility, systems, special need, Federal demonstrations and strategic priority categories. Mobility is the category in which NHS and STP projects are considered.

TxDOT ranks NHS Mobility (added capacity) projects using a Cost Effectiveness Index (CEI) which calculates the number of days it would take user benefits to pay for a proposed facility; i.e. CEI = (Construction plus Right-of-Way Costs)/ (Benefits per day). Having obtained CEI numbers for all eligible projects across the state, TxDOT allocates the available NHS funding to the highest ranking projects.

3.4.2 Regional Selection in Houston

For Federal STP Mobility funds, the allocation is made by the H-GAC staff on the basis of a score made up of three components––Qualitative Factors (25 points), Cost Effectiveness (45 points) and Air Quality (30 points). Qualitative Factors include economic development and intermodalism/multimodalism, regional and local considerations, and safety. Cost Effectiveness is the benefit/cost ratio for travel time savings of motorists due to the improvement divided by the annualized federally-funded portion of the project cost. The benefit/cost number is then normalized to provide a point score. Air Quality is measured in terms of reduction of pounds of pollutants resulting from vehicle miles removed from the transportation system, normalized to a point score.

METRO scores transit projects using the same three component scoring, except that Qualitative Factors are determined by special needs, regional & local considerations, relief to congestion in a congested corridor, and support to a State-mandated activity. Only FTA Section 9 funds are scored. FTA Section 3 funds are discretionary and METRO uses some of these monies to fund the RCTSS, a set of 2800 intersections that will eventually be actively controlled with signals that are centrally, and adaptively, set. Section 3 funds are also used for developing an Automatic Vehicle Locator (AVL) for buses, and for METRO's contribution to the regional Transportation Management Center. FTA Section 26 funds demonstration projects such as the Next Generation Bus and operational tests such as the Smart Commuter ITS in Houston.

H-GAC project technical scoring in the TIP prioritization process occurs in the framework of table 3-2:

Table 3-2. Examples of H-GAC TIP Technical Scoring

STP Mobility Projects				
Project #	Qualitative (0-25 points)	Benefit/Cost Effectiveness (0-45 points)	Air Quality Effectiveness (0-30 points)	Total Points (0-100 points)
950101 Construct new Monticello Road extension	11	45	30	86
950145 Widen US 90A	18	44	0	62

CMAQ Projects				
Project #	Qualitative (0-25 points)	Air Quality Impact (0-40 points)	Air Quality Effectiveness (0-35 points)	Total Points (0-100 points)
950054 Port of Houston intermodal access improvement	12	40	34	86
950180 Add CTMS to section of IH 45S	16	34	32	82

H-GAC scores all CMAQ-funded projects using a project ranking scheme which awards 25 points for Qualitative Factors based on support to congestion mitigation activities, such as ITS or HOV lanes, congestion relief in a congested corridor, regional and local considerations, and support to a State-mandated activity. Air Quality Impact is determined by calculating total pounds of emissions (VOC and NOx) reduced by the proposed improvement, normalized to a maximum score of 40 points. The Air Quality Effectiveness points are the measure of annual pounds of emissions reduced by completing the proposed activity, divided by the annualized project cost, and normalized to a score between 0 and 35.

Current projects funded by this process are part of the area-wide CTMS, a cooperative effort between TxDOT, METRO, the City of Houston and Harris County. Each year, selected sections of roadway are provided with a surveillance, communications and control (where warranted) system, linked to a Central Control Facility by fiber optic cable. In the 1995 TIP, thirteen CTMS projects were funded for a total of 54.5 million dollars.

The Houston region is also the location of a national ITS Priority Corridor, designated by the USDOT, in 1993, to become a test bed for ITS deployment. Funding from this program has been used for planning various projects within the region and is listed in the annual TIPs, but is neither scored nor prioritized by H-GAC or TxDOT, since it is a demonstration program funded through Title IV (Research) of the ISTEA. Among the projects that are planned is a dynamic lane assignment system for freeway frontage roads.

Section 4
Seattle Process Description

4.1 Regional Background

The four-county area included in this case for transportation planning purposes consists of King, Kitsap, Pierce and Snohomish counties. These include three of the four urbanized areas in the consolidated metropolitan statistical area: Bremerton (Kitsap County), Seattle/Everett (King and Snohomish) and Tacoma (Pierce). Population of the region is forecast to grow from 2.5 million people in 1990 to 4.1 million in 2020.

Long-range transportation planning for the four-county region is administered by the Puget Sound Regional Council (PSRC) as the MPO. The PSRC also has state-chartered responsibilities for growth management planning. The PSRC lists 57 county, city, township and tribal jurisdictions as members. On the MPO policy board, the Washington State Department of Transportation (WSDOT) and ports are also represented.

WSDOT is organized into regions. The WSDOT regions have the primary responsibility for program and project development, that become integrated in the statewide plans, and are programmed into the MPO plans. The PSRC region splits between two WSDOT regional office jurisdictions: Snohomish and King counties in the Northwest region, and Kitsap and Pierce counties in the Olympic region. To coordinate with the PSRC on planning and programming issues, the WSDOT has established the Office of Urban Mobility for the urbanized area. WSDOT also has a statewide ITS Program Manager assigned in Seattle.

Population is centered on Puget Sound, with mountainous parkland to the eastern interior of King, Pierce and Snohomish counties. The main north-south urban travel corridor is on the eastern side of the Sound, and centers on I-5 west of Lake Washington, through Seattle, and on I-405 east of Lake Washington through Bellevue. Lake Washington also creates two major east-west bridge crossings on the Seattle-Bellevue axis, on I-90 and on State Route 520. Ferry service is active between Seattle and Kitsap County on the western side of the Sound. There are five designated transit funding recipients in the region: Kitsap Transit, Metropolitan King County (Metro), and Pierce transit in the three counties as well as Community Transit (Snohomish) and Everett Transit (Snohomish).

VMT in the region have increased faster than population. Although total transit ridership has increased, transit mode share has declined. In 1990, 20.2 million VMT occurred in the PM peak period, with 7.5% transit work trip mode share and 19.7% carpool. Forecast as a "trend" for 2020 (without changes beyond the 1996 TIP) are 32.6 million VMT in the PM peak (over a 50% increase), with only small percentage increases to 7.7% transit work trip mode share and 20.6% carpool. Improvements in transportation management and capacity are needed to meet increased demand.

The region is motivated also by non-attainment of clean air standards. The region is classified as non-attainment for carbon monoxide (CO) in the urbanized portions of King, Pierce and Snohomish counties. There are three moderate particulate non-attainment areas also in that corridor. Most of the region south and east is designated as a marginal ozone non-attainment area, excluding Kitsap County. To meet air quality requirements, congestion management and other vehicle trip reduction strategies must be used as part of the regional planning and programming processes.

4.2 Planning Background

The primary planning and programming activities through which ITS can be traced are conducted by WSDOT and local jurisdictions and transit agencies. PSRC executes the transportation planning activities through a UPWP, a Vision plan, a long range transportation plan, and a TIP. All transit agencies within the region are involved in some degree in ITS development and participate in regional transit coordination through such forums as the PSRC's Transportation Operators Committee. Metro has a compendium of ITS and related projects in its Technology and Transit document [11].

4.2.1 State Planning

WSDOT has a statewide transportation plan and TIP that feed into the comparable MPO products. The state transportation plan is called the Statewide Multimodal Transportation Plan [12] or Transportation System Plan (TSP). A primary element of the multimodal plan is the State Highway System Plan [13].

The TSP now embodies 1991 State legislative recommendations to make project programming more systematic. The Revised Code of Washington (at RCW 47.05) is now the legislative basis for the Priority Programming process. The TSP has a 20 year horizon, but is updated biennially, to phase-in with the TIP cycle of both the state and the PSRC. The state and PSRC project programming processes are neither top-down, nor bottom-up exclusively. The way in which WSDOT is progressing with its ITS program is similar.

The Washington Transportation Commission (WTC), the executive-appointed governing board of WSDOT, creates the Transportation Policy Plan for Washington State, at the "vision plan" scale. This, along with the state Growth Management Act and the federal policy requirements, nominally shapes the TSP in a policy-driven, top-down way. Policies, and particularly the WTC budget allocations, stipulate specific projects that are developed bottom-up at the WSDOT regional level, and then enter the LRPs and TIPs statewide and regionally. The WTC, through technical support staff in the central WSDOT offices then filter and prioritize the candidate projects [14,15]. The overall process is diagrammed by WSDOT in Figure 4-1.

Since the TSP and TIP are fiscally constrained, projects have to be scored and prioritized for inclusion. At the TSP level screening is done in concert with the MPOs and other regional

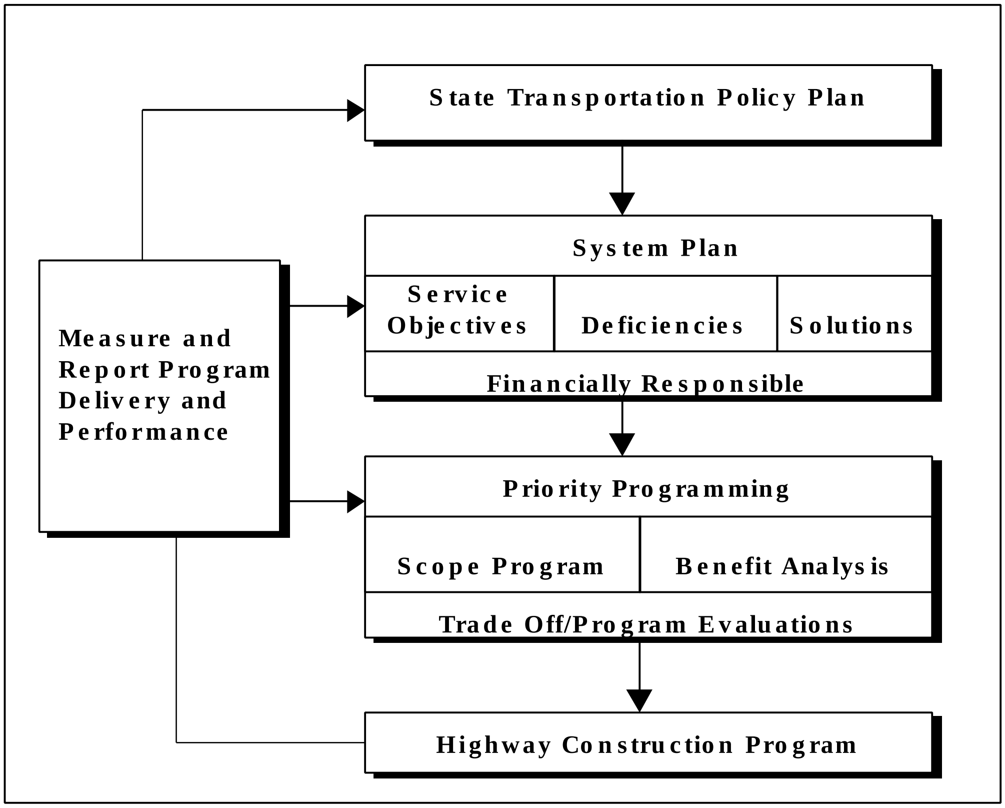

Figure 4-1. WSDOT Transportation Programming Process

transportation planning organizations (e.g., transit authorities). WSDOT distinguishes between the state-owned components (highways, ferries and state airports) and the state-interest components (rail, ports, non-motorized and transit). The latter will be programmed by other agencies and have partial or no state funding.

The WTC has adopted a functionally-oriented budget categorization that plays an important role in mapping legislative policy emphases to transportation program types through the fiscal constraints. The "service objective needs" measured in dollar terms are defined at $30 billion statewide over 20 years. Since the "financially constrained needs" are reduced to $18.1 billion, there clearly has to be some filtering through the TSP process.

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The budget categories, associated with transportation objectives are:

- Maintenance
- Traffic Operations
- Preservation
- Improvement
  - Mobility
  - Safety
  - Economic Initiatives
  - Environmental Retrofit

Within these categories are action strategies, many of which relate to ITS. For instance, under Maintenance is "minimize travel delay time due to emergency conditions", that could be met by traveler information and incident management systems. Under Traffic Operations are:

- Increase freeway efficiency through use of surveillance, control and driver information (SC&DI) systems and quick incident response.

- Improve overall system efficiency through coordinated traffic signal systems and advanced technology testing and deployment, i.e., Intelligent Highway Vehicle Systems (IVHS)

And under Improvement is "Complete the Freeway Core HOV Lane System in the Puget Sound Region.". There are other, more conventional objectives such as Level of Service (LOS) C on rural highways and LOS D on urban highways that generate capacity expansions. Such statements and measures constitute the service objectives and deficiency indicators that are matched to project solutions in the TSP. The Priority Programming process then moves TSP projects into the TIP. This is done by a scoring based on project benefit measures as will be described in the TIP selection section, below.

The development of ITS projects by WSDOT is a strategic process that parallels the TSP. WSDOT became an early advocate of ITS, progressing from freeway management projects in the 1980's. WSDOT then sponsored the Venture Washington IVHS Strategic Plan for Washington State [16]. The Venture Washington strategic plan covers a 20-year horizon. This plan performed a uniform matching process of needs to technologies, stratified by different kinds of analysis regions in the state. The result of the Venture Washington plan is a set of "project areas" allocated as most effective in the set of analysis regions. The analysis regions used are: Central Puget Sound, Spokane, Vancouver, Other [mid-sized] Urban Areas, and Intercity/Rural.

These analysis regions generally overlap more than one WSDOT region. The Venture Washington Plan results are now guiding the WSDOT regions in development of specific ITS projects that will then enter the TSP and TIP processes. The statewide emphasis on ITS will be reflected in the dollar amounts allocated to the Traffic Operations budget category, although ITS can be associated with construction projects under Improvements as well. The linkage of ITS and construction is in the designation of an Integrated Highway System (IHS), of specific freeway and arterial routes that will receive ITS treatment. The IHS has a phased implementation plan to 2010 in the Seattle region.

In Venture Washington terms, "projects" are defined as composites of user services sub-categories and "techniques" (technology bundles). The user service applications relate to benefits and policy goal effectiveness, while the techniques define projects in terms that can be costed. In the final prioritizations, a still more general set of "project areas" are allocated by analysis region.

The allocation of project areas to the analysis regions was done through a two-stage evaluation process. The first stage used a weighted set of criteria to rank relative effectiveness. In the second stage, benefit/cost (B/C) ratios were developed to further specify the high priority project areas. The effectiveness criteria used in the first stage are:

- Congestion
- SOV Reduction
- Mobility-Residents
- Mobility-Nonresidents
- Mobility-Commercial
- Economic Development
- Safety
- Environment
- Implementation

These criteria were weighted in value for each region, according to the different regional characteristics and stated policy goals for those regions. The project areas selected for emphasis in the Central Puget Sound analysis region (effectively the WSDOT Urban Mobility Office and PSRC region) are:

- Traffic Control
- Trip Planning—Pre-Trip
- Trip Guidance—en route
- Incident Detection and Management
- Freeway Ramp Metering
- Road Use (Congestion) Pricing
- TDM Support

The Venture Washington plan covers the whole scope of ITS deployment, from architecture, to alternatives selection through benefit-cost analysis, to organization and marketing. The strategic plan makes a distinction between IVHS *infrastructure* and *projects*. Infrastructure is the surveillance, communications and data processing capabilities that underlie projects. Projects are associated with the applications that deliver user services.

Since the WSDOT regional ITS projects will reenter the Priority Programming process through the TSP and TIP, along with other kinds of projects, they will be subjected to other stages of prioritization and selection. However, some ITS development has been under special (e.g., EDP funding) that goes directly to WSDOT and has been outside the normal process. The EDPs affecting the Seattle area are the (combined) I-5 Seattle to Vancouver and I-90 Seattle to Spokane corridor study, and the completed Seattle to Portland corridor study. Further, of 15 listed "IVHS Demonstration Projects" now active or completed by WSDOT, only two, the North Seattle ATMS and Travel Aid, are run by a WSDOT regional offices while the others are run from central WSDOT offices or by transit agencies.

The Venture Washington plan does not, by itself, coordinate ITS projects in the regions, or interregionally, when they come back through the programming process. WSDOT states that there is a "gap" in this regard, when the strategic plan is allocated to projects for programming purposes. This integration gap is overcome by systematic project management oversight. In the case of the Seattle to Portland Corridor EDP, it was stated that integration relied strongly on a University of Washington "architecture guru". In other cases, for instance the freeway management system, whose infrastructure is being built piecemeal, the WSDOT Northwest Regional Traffic Operations and Freeway Operations engineers work to ensure conformity to the overall system plan. An HOV system plan for the Seattle area is also tying together that system and its ITS components.

4.2.2 Regional Planning

The PSRC board has a vision plan [17] and its transportation element, the MTP [18] that satisfies the transportation plan requirements. The vision plan focuses on growth, economic, and transportation strategies for the region and derives from growth planning started in 1987 and an EIS on alternative growth patterns. To support this vision plan, transportation improvements and programs embodied in the MTP will be focused on establishing a more balanced transportation system, shifting emphasis from highways and single occupancy vehicle movement to transit, people and goods movement. A balanced system would provide opportunities for selecting from different travel options, including private automobile, public transit, ride-sharing, walking, and biking, to move around and throughout the region. The current MTP has a horizon of 2020 (25 years).

The PSRC Vision 2020 Plan contains 8 elements:

1) Urban growth areas
2) Contiguous and orderly development
3) Regional capital facilities
4) Housing
5) Rural areas

6) Open space, resource protection and critical areas
7) Economics
8) Transportation

There are several supportive policies contained within each of the eight elements. Of the 40 multicounty transportation policies in the MTP, four can be either directly or indirectly linked to ITS. These policies support ITS approaches in terms of gathering transportation information or establishing transportation system management activities. Within the text the most direct statement is: "System management actions include...applying Intelligent Transportation System (ITS) technology...".

The PSRC MTP reiterates transportation elements of the vision plan and contains, a section on ITS. This section is keyed to the national ITS applications of ATMS, ATIS, Advanced Public Transportation Systems (APTS), CVO and Advanced Vehicle Control Systems (AVCS). Regional projects corresponding to these applications are then listed, followed by future programs and research. The MTP states: "As ITS is more fully developed in the central Puget Sound Region, emphasis will be placed on establishing an integrated information system...". In the summary description of improvements, the MTP lists ITS specifically under System Preservation and Management.

The evaluative role of the MTP is to analyze alternative scenarios of regional development. Some modeled performance predictions in the three scenarios are compared below:

Table 4-1. PSRC Metropolitan Transportation Plan Forecasts

Indicator	2020 Trend	2020 MTP	2020 Optimum
Daily VMT (mill.)	103	100	90
VMT in PM Peak	33	31	29
% increase in delay hours in PM peak over 1995	340%	242%	26%
% Trips by Transit	3.9	5.9	10.9

(From PSRC MTP, Table 5)

Motivated by service deficiencies in the trend case to 2020, the MTP analyzes two other cases, the "2020 MTP" and "2020 Optimum Performance Strategy". The 2020 MTP scenario implements the fiscally constrained MTP projects. The Optimum Performance Strategy uses pricing strategies to manage demand, shift modes and help finance the full regional needs package. It is evident that the pricing strategy has significant impact. Elements of a transportation pricing system will use ITS, but ITS is not explicitly mentioned as part of the scenario.

The substance of the MTP is the list of fiscally constrained non-capital actions and capital projects or programs. In the former category, ITS is implicit in the pursuit of the pricing strategy, and in the CMS implementation scheduled to start in late 1995.

The MTP lists 141 capital projects and programs. The majority of these are WSDOT sponsored roadway projects, listed by county. Eight projects are "preliminary phasing assumptions for high capacity transit" (i.e., non-definitive plans for busways or rail transit). Thirteen projects are WSDOT sponsored transit. One project is for intermodal freight and goods. Eight projects are WSDOT sponsored ITS. However, ITS is included in many of the WSDOT roadway projects, primarily as an adjunct to HOV lane additions on major highways. ITS is also involved in the regional fare integration program (i.e., Smart Card) listed under the high capacity transit category. The eight WSDOT ITS projects, that have developed from the Venture Washington planning, are:

1) North Seattle ATMS
2) Traffic Data Acquisition and Distribution
3) Seattle-Portland Intercity Corridor Study and Communication Plan (an EDP)
4) Seattle to Vancouver and Seattle to Spokane ITS Corridor (an EDP)
5) Puget Sound Help Me (PuSHME) Operational Test
6) In-vehicle signing and Variable Speed Limit Demonstration (TravelAID)
7) Seattle Wide Area Information for Travelers (SWIFT)
8) Ferry System Automatic Fare Payment

Projects that are incorporated into the MTP may then advance to the PSRC TIP. Scoring for inclusion in the TIP is described further below, and the process is structured around funding categories.

PSRC is also developing a Congestion Management System (CMS) Work Plan which is heavily dependent upon ITS for its performance monitoring element.

4.3 Funding

4.3.1 State Funding

The WTC sets programming priorities through the functional budget categories. Within these categories, projects are prioritized in the TSP and TIP. The functional categories used by the state are more convenient for mapping the state policies to types of transportation programs, but do not map directly to federal-aid funding categories. ITS will be contained mostly in TSM (category Q), but may also appear in Safety (I2) or associated with Mobility Improvements (II).

Over its 20 year horizon, the TSP lists a fiscally constrained program of $18.07 billion. There are $12.15 billion of projects that are prioritized, but outside of budget limits. Of the latter, the bulk are in the Mobility Improvement (i.e., capacity) category.

Some idea of the state policy priorities may be gained from the dollar amounts within the fiscally constrained TSP. Of the $18.07 billion total, only $610 million is in the TSM category, the smallest item. The Safety and Mobility Improvement categories, that could contribute to some ITS components, total $8.69 billion.

4.3.2 Regional Funding

All transportation projects for the PSRC region that are included in the TIP go through the MPO, but there are a variety of sources and programming categories for projects in this process. These are enumerated in Attachment A to "Policy Framework for 1995 ISTEA TIP Process" [20]. The programming categories are:

I. Regionally managed programs
   - A. Regional priority programming
     - STP
     - CMAQ (excluding Kitsap County)
     - FTA
   - B. Countywide priority programming (via countywide policy boards)
     - STP
     - CMAQ (excluding Kitsap County)

II. State managed programs
   - A. Federal Interstate, etc.
   - B. State-only funds
   - C. WSDOT New Partners

III. State competitive programs
   - A. STP (competitive)
   - B. STP (enhancements)

IV. Non-federal local
   - A. Regionally significant with potential air quality impacts

This list represents at least four distinct ways for projects to enter into consideration for the TIP. Although the TIP ultimately must be integrated and approved by the PSRC Executive Board, any technical project formulation and selection will occur in the four different ways.

Further seven of the eight ITS projects excluding the Ferry system) developed from Venture Washington and implemented by WSDOT bypassed all the regular channels, were funded by specially earmarked funds, and were added to the MTP only after FHWA selection for funding. The ITS components in the PSRC-prioritized STP and CMAQ process tend to be smaller scaled and hybrid ITS-conventional projects, although the smaller scaled characterization would apply to all projects selected through the process. The fiscally-constrained dollar amounts involved in each stream, as listed in the 1996-1998 TIP are shown in the table below:

Table 4-2. Funding of 1995 PSRC TIP

PSRC TIP Program Categories	1995-1998 $ Millions
STP	115.0
CMAQ	46.2
FTA	131.5
Total, MPO-managed	292.7
State-Managed	363.9
Regional Total	656.6

4.4 TIP Project Selection

4.4.1 WSDOT TIP

The WSDOT TIP that serves statewide programming and feeds the PSRC TIP, is formulated from the priority programming process under RCW 47.05. The general principles for this follow from the TSP programming. Starting in 1996, WSDOT will be formulating a six year TIP as an intermediate programming step between the TSP and the biennial budgeting that phases with the MPO TIPs. It is intended that the six year plans will have an "available revenues" fiscally constrained version, and other versions based on enhanced revenue assumptions. However, it is only the two-year program that is committed to the budget.

The two-year state TIP element is based heavily on benefit-cost analysis of candidate projects from the TSP. WSDOT provides instructional information to the regions for the benefit-cost calculations and a worksheet on the proposed project. For mobility improvements (e.g., highway construction) AASHTO guidelines are referred to for benefit calculations. For ITS projects, the methodology developed in the Venture Washington plan is cited as the basis for analysis on the forms completed by the regions.

Most of the prioritization focus is on the capacity improvements under the mobility program. As was seen in the TSP budgets, these are the most constrained programs, and among the largest investments. Therefore, they have been the focus of most of the benefit-cost methodology development. This has led to the Prioritization of Capacity Improvements Study (PCIS) that has been completed only in 1995 [19]. The final Phase III development of the methodology was used by WSDOT for the latest, 1995-1997 biennium.

4.4.2 PSRC TIP

The regional TIP is updated biennially by the PSRC. The previous update was in 1993, and the latest in 1995 for the three year period 1996-98. The PSRC conducts a major amendment in the intervening years to allow for project scope changes and the inclusion of nonfederal projects to meet air quality conformity requirements.

The PSRC Policy Framework specifies two ways in which the regional policies can affect regional development through projects in the TIP. The first way is the scoring process for the regional priority programming of the MPO's STP and CMAQ funds. The second way is through levying of certification requirements on city and county plans that are then reflected in the countywide priority TIP elements. The requirements on city and county projects are [17]:

> "All projects submitted by cities/counties after 31 December 1996, will be eligible for TIP inclusion only if they are consistent with a respective transportation element of a city/county plan that has been certified by the Regional Council as consistent with the MTP."

The TIP formulation process is partitioned according to the regional funding and programming categories listed earlier. PSRC performs project scoring only on the CMAQ and STP programs under Regional Priority Programming.

STP and CMAQ projects are progressed into the annual TIP update through what the MPO calls a two-step process, but the process is easier to present by enumerating several steps:

- Project sponsors complete a questionnaire describing the project at an initial level.
- Projects are reviewed by MPO staff for category eligibility, modal categorization and initial selection to create a list equivalent to 200% of available funding.
- The "first stage" list is reviewed and advanced by the Regional Project Evaluation Committee.
- Sponsors supply additional information on screened projects to enable numerical scoring.

- MPO staff perform an evaluation over several weighted criteria that give projects a numerical score within their funding category. Ranked projects are listed against cumulative costs.
- The Regional Project Evaluation Committee considers the "second stage" scored lists and recommends a TIP package for the regional STP and CMAQ categories.
- The resultant package goes to the Policy Board, integrated with other packages for approval.

The second stage project scores are a weighted sum of the scores on ten technical criteria, plus "policy consideration" and "innovative". The policy considerations and innovative criteria receive a yes/no evaluation and are available on the scoring sheets for auxiliary consideration in the approval.

The ten technical criteria are weighted differently for STP and CMAQ projects, but each get 3 points for a "high" rating, 2 points for a "medium" rating, 1 point for a "low" rating and 0 points for "not applicable" (or no impact). The ten technical criteria and their weights are:

Table 4-3. Project Technical Scoring Weights

Criterion	STP Weight	CMAQ Weight
Preservation	4	3
Traffic congestion	4	3
Mobility/connectivity	4	3
Safety and security	4	3
Efficiency and reliability	4	3
Accessibility	4	3
Economic benefit	4	3
Air quality/energy	4	13
Other environmental	4	3
Benefit/Cost proxy	4	3

The last criterion, the Benefit/Cost proxy, consists of adding the other scores, dividing by project cost, and normalizing to a score between 0 and 10. Therefore, the approach is not as quantitative as the WSDOT approach and has no direct relation to ITS methodologies from The Venture Washington effort. The Policy and Innovative criteria are not included in the numerical scores. The Policy criterion itself has 6 components, each responded to with a "yes" or "no". The policy components are: coordination, timing, [meets] legislative requirements, social/economic impacts (for transport disadvantaged), additional funds (beyond minimal match), and supportive (of) land use (goals). The Innovative criterion also receives a "yes" or "no".

The result of the 1995 TIP scoring is 32 STP projects and 13 CMAQ projects. Of the STP projects, 17 are for roadway, including HOV construction and on the Interstate Highway System (IHS). Only one project, for $1.3 million, can be identified distinctly as ITS: The Eastside TMS project that ranked 13th on the list. The highest ranking project was for an EIS for new limited access highway construction associated with new development. Therefore, ITS is mostly mixed into hybrid-construction projects within STP at the MPO level.

Of the CMAQ projects, the following six can be identified as ITS, with dollar amounts and scores (the first ranks 3rd overall):

Table 4-4. PSRC TIP CMAQ Projects Identifiable as ITS

Project	$ Mil.	Score
EZRider customer information systems, including real time traffic data.	4.108	81
Multimodal data integration for regional CMS.	0.5	80-92
Arterial corridor improvements to enhance shift from SOV, includes signal priority.	3.287	71
Regional fare integration/Smart Card.	8.03	67
Regional coordination of AVI and CMS, including signal prioritization. Related to IHS.	4.757	65
Seattle Enhanced Traffic Management Center. Component of IHS.	1.0	63

Note that the second project, for the CMS data integration, has a ranged score. This is due to uncertainty in the quantitative air quality impact measure. This is the only score, among the STP and CMAQ projects, that has such an explicit range, implying no uncertainty in any of the qualitative scores, or the other, quantitative, CMAQ air quality measures. If any project is at the numerical border of inclusion in the TIP, the decision may go to debate in the Regional Project Evaluation Committee. [Note: CMAQ guidance allows for the funding of ISTEA management system development (e.g., for CMS development).]

For regional projects, those with greater regional benefits scored the best overall. When a project had multiple sponsors, had multimodal benefits, or covered a larger area, it tended to rise above projects with more limited scope.

Section 5

Comparison of Case Studies

5.1 Regional Context Comparisons

The Houston and Seattle regions differ in size, topography, demography and climate. The state and regional planning institutions, however, are structurally consistent. Indeed, state DOT structures are similar across the United States and the MPO structure has evolved uniformly under federal requirements. Functional differences regarding transportation planning and interest in ITS are in details that have evolved historically and that have to be uncovered by close investigation of how the planning processes work. Therefore, it is difficult to say how the two case studies represent, or do not, the universe of metropolitan areas, or state, regional and local relations.

Regarding stipulations under the CAAA, Houston is in severe ozone non-attainment and Seattle is in moderate non-attainment for ozone, along with moderate CO non-attainment and moderate non-attainment for particulates (PM_{10}). Both cases are sufficient to motivate management strategies, that in turn are associated with ITS initiatives.

Congestion is difficult to measure in any simple way. Houston is less dense than Seattle, Houston has more VMT in total and per capita, and Seattle has a greater proportion of VMT concentrated on its freeways. According to the congestion index used by the Texas Transportation Institute[1], Houston rates 1.12 and Seattle 1.22, indicating that both regions have congestion problems with relatively more congested travel in the latter case. But by this index, Houston has declined in congestion by 4%, between 1982 and 1992, while Seattle has increased by 28%. Seattle is more topographically constrained regarding new lane construction and can be expected to put more emphasis on alternative solutions.

5.2 Planning Comparisons

The City of Houston has a more conservative approach toward control of development, relying on the market to determine growth patterns and individual land use characteristics. Seattle, in contrast, has a relatively strong growth management policy. These differences begin to be allocated down through the transportation planning process. Seattle has a Vision Plan to articulate growth scenarios and their transportation elements, Houston does not. By the time the explicit policies in Seattle, and the implicit ones in Houston, are represented in projects in the respective LRPs, the differences are less obvious. Both areas pursue similar types of projects.

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[1] The Texas Transportation Institute's Roadway Congestion Index is a relative composite measure of congestion across freeways and principal arterials, which is calculated by a formula which accounts for the vehicle kilometers traveled on and the lane-kilometers (system length) of both roadway types.

Both regions and states have the required, intermodal, long range plans. The TxDOT PDP has a ten-year horizon and annual update, compared to the WSDOT TSP with 20-year horizon and biennial update. Both states, under authority of their transportation commissions, prioritize projects for inclusion in the long range plans and for advancement into TIPs, and these processes create one of the primary pipelines for ITS projects, even in the urbanized regions.

Both states have strategic approaches to development of ITS projects, having evolved from significant experience in freeway management systems and operation of Transportation Management Centers in the two urban regions. WSDOT is slightly ahead in having created an ITS Strategic Plan in 1993, and with a statewide ITS project manager to implement it. This plan is now being used to allocate ITS application priorities to specific projects developed in WSDOT regions, and the Urban Mobility Office that coordinates specifically with the Seattle MPO. TxDOT has an ITS Implementation Strategy and a Regional ITS Strategic Plan, but these have not yet formally entered the planning process.

The regional long range plans (MTPs in both cases) contain policy statements and project lists. The relation of the policy statements to ITS are about equally indirect in both cases. However, the Seattle MTP, carrying through the Vision Plan, puts somewhat more emphasis on the system management and information technologies elements relevant to ITS at the policy level. The Seattle region's CMS will incorporate significant ITS in its performance monitoring element. The Seattle MTP scenario analysis also emphasizes pricing strategies linked to ITS. The Houston region mentions pricing and other ITS measures through its Congestion Management Plan, motivated to address clean air non-attainment. At the more detailed level of textual reference to ITS and ITS projects in the long range plans, the differences between regions are not sharp.

The TIP in the Houston region has a three year horizon and an annual update. The TIP in the Seattle region is a five year program updated biennially. In both cases, as required, the TIP is a cooperative product of the state DOTs and constituencies of the MPOs, with MPO technical guidance. However, in the TxDOT case, the state TIP is created by combination of regional TIPs, while under WSDOT, the state TIP is separately prioritized as one channel into the Seattle regional TIP.

5.3 Funding Comparisons

Both states and regions have the ISTEA-allocated federal aid funding, including the CMAQ funds for non-attainment areas. Both have their local funding sources. Washington has a much greater proportional transfer of its motor fuel and vehicle tax receipts to local governments and mass transit than does Texas. Texas has a larger transfer to state non-highway purposes. The Houston and Seattle regions both have regional taxes for transit purposes.

The ways in which policies are reflected in prioritization categories, and thereby in projects are slightly different. TxDOT carries through seventeen categories that map ISTEA funding and programmatic categories, and then overlays six functional planning priorities. The latter six categories are closely comparable to the four major budget categories used by WSDOT, plus the four sub-categories under “Improvement”. WSDOT, however, carries their funding categories all the way through the budgeting and prioritization process, and submerges any direct mapping to the ISTEA federal funding categories. Thus, transportation funding categories in Washington are more directly mapped to functional prioritizations, including “operations” that relate to ITS programs. In Texas, the state tends to carry through the federal aid categories, and into the regional TIP allocations.

In both regions, project prioritization and scoring is tied to funding categories. The states control the obligation of federal aid funds, even the STP and CMAQ funds allocated under ISTEA formula to urban regions. As a result, there are differences in the degree to which the regions have been allowed control over matching types of projects to funds.

In Houston, the NHS and STP funds (other than dedicated to enhancements and safety) are dedicated to road construction, transit is limited to the FTA funds, and ITS is allowed exclusively under CMAQ, including the traffic management projects. This means that the CMAQ funds displace any NHS traffic management funds from being allocated by the state to the Houston region.

In the Seattle region, major ITS projects, such as the North Seattle ATMS, are programmed through WSDOT, using budget amounts set by the state functional categories. The STP and CMAQ funds allocated to the PSRC region are prioritized by the region, and both contain ITS projects, although most STP projects are for roadways.

It must be emphasized that an important avenue for funding and implementing, operating, and maintaining ITS initiatives is through the local and state (non-federally approved) channels. Such projects may never appear in the federally mandated planning documents. Many smaller-scaled signalization projects could potentially fall into this category. Or, ITS projects funded only through local sources (states, cities, counties, transit agencies, etc.) may appear in the planning documents as regionally significant projects with air quality impacts. While the extent of ITS deployment through these sources in Seattle and Houston is not known, it does not appear to dominate the portion of ITS that is partly federally funded or included in the TIP for other reasons. Because of the operational orientation of many ITS strategies and the fact that ITS can involve stakeholders that may not typically be involved in the transportation planning process (such as emergency services providers), these sources should not be overlooked in terms of affecting the ITS picture within a region.

5.4 Project Selection Comparisons

In both cases, the selection and prioritization of projects in the LRPs and TIPs are tied to funding categorizations. This is both a way of effecting policies for prioritization, as reflected in dollar amounts and permissible uses in each category, and a way of simplifying the selection process by reducing the range of comparisons to be made. Therefore, the funding differences already noted stipulate where and how ITS and other classes of projects can be evaluated relative to each other.

The funding allocations, and their control by different agencies, potentially create a number of different project prioritization and selection processes, even within the urban regions. In the Houston case, since ITS projects are funded exclusively through CMAQ funds that are prioritized by H-GAC, the process is more focused regarding ITS. However, APTS projects using the FTA funds additionally involve prior Metro project programming before coordination under H-GAC into the transportation plan and TIP.

In the Seattle region, at least four distinct funding and prioritization channels relevant to ITS lead into the consolidated regional transportation plan and TIP. These are as follows:

- PSRC prioritized CMAQ and STP funds,
- regional transit agency prioritized funds,
- countywide prioritized funds (e.g., for signal systems), and
- WSDOT prioritized funds.

Detailed information is known only for the state and MPO prioritization process, in both cases.

In both states, numerical indices are used to rank projects at the state transportation plan level, and to program them into TIPs, both within the fiscal constraints. In Texas, there is exclusive state focus on the NHS funds. These are prioritized by the Cost Effectiveness Index, focusing on highway user benefits. In Washington, each of the functional funding categories stipulates the evaluation of service objectives and solutions at the statewide transportation plan level, and of comparative benefits at the statewide TIP level. The amount of traffic exposed to level of service deficiencies tends to be a key criterion in all cases relevant to ITS. Without another level of data collection and analysis to validate results, it is not possible to compare the merits of the two processes. However, Washington and the PSRC CMS Work Plan do emphasize evaluative feedbacks in their process. It is also clear that significant ITS projects have been prioritized through the WSDOT process. In Texas, the ITS focus has been on the H-GAC CMAQ prioritization process.

The H-GAC process for CMAQ, and the PSRC process for CMAQ and STP prioritization are similar. The projects to be considered have to be initiated by various sponsors using their own project advancement approaches. Although an MPO may initiate projects through its UPWP, sponsors are generally constituents of the MPO. Therefore, these sponsor processes, separate from the MPO’s TIP project scoring, are necessary conditions for getting ITS considered. Further, the MPOs rely on data provided by the sponsors for project evaluation. Once the projects get to the H-GAC or PSRC evaluation process, they are subjected to uniform scoring schemes. In both cases there are a set of qualitative factors, converted into weighted numerical scores, and quantitative factors similarly converted. There are only differences in the numerical distributions used, and PSRC additionally has six “policy” criteria that are “yes” or “no” rated.

Because underlying quantitative and qualitative data on the projects are all scaled into scoring indices, there is no clearcut distinction of how quantitative or qualitative the scores really are. This blurring is necessary in the comparison of projects with widely varying degrees of analysis behind them. Costs and the effectiveness indices based on traffic volumes and LOS tend to be the most numerically based. It is only in the case of air quality impacts, via emissions change estimates, that are highly weighted in the CMAQ scoring, that the quantitative nature can be emphasized. This is because, in both cases, the MPOs are also responsible for regional air quality modeling, and have the capability to provide an independent, and uniform, measure for the projects. But it is also true, in both cases, that the ability to model differential emissions impacts of projects, particularly of the ITS type, is not well developed.

Despite the expected variation in results for all scoring measures, there was only one project in the PSRC CMAQ scoring where an air quality impact measure range was given. There was no recognition of uncertainty, or sensitivity to numerical score variation, in any other case. Under the circumstances, a lack of validated numerical evaluation of ITS projects is no particular handicap relative to other kinds of projects.

In the end, it is the combination of differences in agency dedication to ITS, decision maker awareness and understanding of ITS, regional context, policy emphasis (funding and otherwise), and prioritization processes, that lead to differences in the outcome of generating and constructing ITS projects. It is very difficult to say how these factors weigh. The differences may be due to regional transportation system characteristics, such as congestion or limitations on construction in Seattle. Funding constraints imposed on ITS have also affected its level of development. One reason that ITS may not be funded is that decision makers lack a solid understanding of how ITS fits into the regional transportation picture. Better information on ITS benefits and an outreach program for local and state decision-makers are needed to improve the standing of ITS-related projects among all transportation modes, systems, and services.

None of the project selection process can reflect ITS effectiveness through system integration, either of ITS alone or across the entire transportation system. There is a concern that the piecemeal nature of project programming discounts the effectiveness scoring of an ultimately integrated ITS. In reality, the looseness and qualitative nature of ITS scoring seems to compensate for this, since there is a large degree of perception in the scoring, and that perception may envisage whole systems.

In both cases, the existence of strategic plans, and efforts under EDPs, represent ITS integration efforts. Projects, particularly when they are pieces of an ITS programmed with discrete construction projects, cannot by themselves reflect integration. But it is apparent in both regions that projects, such as surveillance, detection, information and control components associated with HOV segments, are proceeding according to overall traffic management plans. Both regions seem to be at a phase where integration proceeds less from a formal architecture allocation, than from the cognizance of key oversight staff and the functional necessity of integration of freeway management systems. A more formal integration, for different kinds of projects over a wider variety of jurisdictions, is yet to emerge.

Section 6
Recommendations for Inter-Project Evaluations

This section contains preliminary recommendations for evaluating multiple projects addressing multiple transportation problems that are competing for limited funds in an urban area. Implications of the recommendations for ITS projects are discussed. The regional TIPs examined in the preceding sections of this report provide concrete examples of such evaluations, and the recommendations in this section are based largely on the CMAQ, STP, and NHS scoring procedures used in the two case studies. However, the recommendations could apply to some extent to other types of inter-project evaluations, within a state, regional, or agency context. *Please note that no attempt has been made to prescribe a scoring process for areas to use. The recommendations in this section should be viewed only as suggestions for scoring factors, with the primary emphasis on ensuring that any such process is sensitive to ITS impacts. It is also recognized that other factors besides scoring will ultimately affect the prioritization process.*

As discussed in section 5, policy decisions that deal with funding categorizations and allocations can be an effective way to promote regional priorities by reducing the range of comparisons that need to be made. However, in one region, policy decisions have led to restrictions on how ITS can be funded. Mitretek recommends that ITS be considered as a potential alternative for funding wherever federal rules allow, lest ITS be thought of only as a tool applicable to one specific funding line (such as CMAQ). The remaining recommendations and suggestions given here apply to the evaluation process only after funding decisions and policy-type prioritizations have been made.

It is recognized that the scoring procedures being used by MPO's for TIP selection and approval under the CMAQ and STP funding authorizations are relatively new and will continue to evolve as experience is gained with the process and ability to estimate the potential benefits of projects improves. Given the difficulty in making comparisons across vastly different projects, the unevenness of supporting project data, and the uncertainty inherent in making benefits estimates from a corresponding lack of tools, the scoring procedures used to date in the case studies are generally sound. As the modeling tools and other methods for objectively evaluating the expected impact of projects improves, these should be used to provide more quantitative information on which to base the evaluation process.

The review of the scoring procedures in Houston and Seattle did not reveal any obvious biases either for or against ITS projects. However, some important aspects of ITS strategies are not explicitly taken into account, such as the region-wide scale of congestion management. One area of concern is the lack of explicit treatment for project priority, particularly for those "projects" that are part of a bigger regional transportation program. This aspect will be discussed in sections 6.3 and 6.4. The following recommendations, which should be viewed as suggested improvements or augmentations to the general process, are categorized into qualitative factors, quantitative factors, overall scoring and weighting, and "other considerations".

6.1 Qualitative Factors

Qualitative factors are an important component of the overall process, since they offer a mechanism for taking regional priorities into account and can compensate for the lack of available quantitative data. This section offers general recommendations and discusses the implications of the qualitative scoring for ITS projects.

The factors that should be qualitatively scored will vary from area to area based on regional goals, objectives, and priorities. The following criteria should be considered for inclusion:

(1) Responsiveness to or consistency with the regional transportation policies, goals, and objectives.

Several evaluation criteria might be used to address the various regional goals and objectives. For example, a regional goal to increase the use of transit might affect the scoring of a project to give arterial signal preemption to buses.

<u>Implications for ITS Projects</u>: Most regions have adopted ISTEA-like goals, which in principle, favor ITS strategies because they promote system management ("doing the best you can with your current system") before resorting to SOV-capacity expansion, particularly in non-attainment areas.

(2) Anticipated environmental impact of the proposed improvement.

The availability of environmental impact data will likely vary across projects, so judgment will have to be applied when scoring. Depending on the phase of the project, some environmental documentation may exist to aid this part of the evaluation.

<u>Implications for ITS Projects</u>: ITS-only improvements, such as an adaptive traffic signal system, are not likely to have significant effects on the environment––air quality, need for additional right-of-way, natural environment, etc. Hybrid projects (those that combine construction activities with ITS improvements), on the other hand, will have to be evaluated more carefully in this regard.

(3) Expected regional impact (based on adopted performance measures).

This factor would consider both the overall scope and the level of benefits that are expected from a particular project.

<u>Implications for ITS Projects</u>: Some ITS strategies offer potentially important regional impacts to a large number of travelers over a wide area, such as a large signal system upgrade or a freeway and incident management system. Other ITS solutions, such as traveler information, may provide small benefits to many travelers rather than big benefits to few travelers.

(4) Ability of the proposed improvement to respond to and manage traffic incidents or changing traffic situations.

Implications for ITS Projects: An extra lane of pavement can not do much to dynamically respond to these types of changes, whereas this is a major attribute of ITS strategies. This criterion can capture the ability to effectively manage the existing transportation system under the influence of changes in demand or supply, and how well the proposed project can manage both recurrent and non-recurrent delays. As improved modeling techniques are developed to capture the expected benefit to be achieved from this attribute, the results can be folded into the quantitative portion of the process. At present, it may be best to keep this as a qualitative criterion.

(5) Ability of the proposed improvement to provide transportation system users with a new or improved service (including customer convenience).

Implications for ITS Projects: Some ITS strategies, such as provision of traveler information, electronic fare payment systems, and real-time transit information, offer a new or improved service to transportation system users. While translation of this type of service into monetary benefits remains elusive, some credit should be given to these service improvements, so long as they are consistent with agency missions.

(6) Ability of the proposed improvement to support multiple uses for the t ransportation system or across different agencies, including the ability to provide traffic operations and planning data.

Implications for ITS Projects: This criterion addresses the need to consider secondary uses of various system improvements, and is applicable to the information sharing that many ITS strategies offer. Two examples are network surveillance and transit vehicle tracking. The information provided from network surveillance equipment (e.g., traffic counts and speeds) can be used for many purposes, including control and management of the traffic signals, incident management, demand management, emissions management, and traveler information (including route guidance). The surveillance information can also be saved as historical data for planning purposes or for evaluating the effectiveness of previous system enhancements. Transit vehicle tracking provides several useful functions: it facilitates more efficient public transportation management (including dynamic route modification and personalized public transit), can provide data useful for travel information purposes (schedule adherence data), and also enhances public travel security (location information can be provided to the police in an emergency or incident). One of purposes for developing an ITS architecture is to leverage these potential efficiencies.

6.2 Quantitative Factors

Quantitative evaluation factors should be considered in the overall scoring process to the extent possible. The following subsections offer general recommendations and discuss the implications of quantitative scoring for ITS projects. The quantitative factors will typically need to be normalized and can be weighted according to regional policies. The uncertainty (or risk) inherent in estimating costs and benefits is an important topic, and the current ability of transportation agencies to treat this uncertainty is inadequate. Additional work is needed to improve risk assessment capabilities.

Quantitative scoring (particularly in estimating benefits) should be used only where the underlying data is reasonably reliable and the ability to model the impacts are developed. As tools for estimating the impacts of different types of transportation strategies are improved, the ability to rely on these models will increase. Where data and tools are sufficient, the following quantitative factors should be considered:

(1) Cost effectiveness (or benefit-cost) ratio.

This criterion is typically based on time savings to travelers, but could include other factors such as savings due to reduction in accidents, etc. A relative measure is necessary because of the nature of cross-project comparisons.

<u>Implications for ITS Projects</u>: One difficulty that handicaps inclusion of ITS into the planning process is that the planning process is typically based on looking at "average" travel conditions (albeit for different times of day including the peak) for an "average" or typical weekday. However, ITS strategies will be more beneficial at handling variability in traffic conditions (both for recurrent and non-recurrent delay situations). By only considering average conditions, the benefits that can be accrued by ITS due to variability will be underestimated (left out). As a first step, data on transportation system variability and accidents could be collected and used as an indication of the applicability of ITS.

Another concern is that independently scoring smaller segments of an overall ITS system might not be a comprehensive approach. Many ITS strategies are regional in nature, or at least corridor-based, and the impacts are best evaluated at that level.

(2) Air quality impact or effectiveness.

This criterion addresses the ability of a proposed project to improve air quality. It would typically be of greater concern for non-attainment areas.

<u>Implications for ITS Projects</u>: The impact of various ITS strategies on air quality are generally thought to be small and positive, though the effects are very difficult to accurately model given currently available tools. The latent demand issue (of encouraging more travel by having a more efficient system) further confounds this evaluation.

(3) Estimated cost savings (or revenue increases) to transportation agencies.

The focus of most evaluation is on transportation system u sers; however, some improvements will provide cost savings directly to the transportation agencies (typically in the area of operations) or even other agencies (e.g., state patrol). If known or estimated ahead of time, these should be considered somewhere in the scoring process, perhaps by factoring it into the cost effectiveness ratio or by including an additional qualitative factor. Implementation of automatic vehicle location and schedule adherence systems for transit authorities is an example of this kind of potential cost savings. Note that direct user and non-user benefits for travelers (in terms of cost savings) would likely already be included in quantitative factor 1, above; in any case, these benefits must not be overlooked. The intent of calling this third factor out separately is to draw attention to the fact that it may not typically be considered.

Implications for ITS Projects: The ITS strategies most likely to contribute to this factor are in the area of transit system operations and in the automation of functions previously done manually (toll collection, traveler information system, certain traffic management system functions, etc.).

Although project cost is typically not scored as an element by itself, it is a big consideration in the overall process, since not all the projects in competition for limited funds will be approved for programming in any given selection (if all projects were approved, the scoring would be moot). Another method for estimating the impact of various projects would be to rely on before and after studies of similar projects in the area. Unfortunately, this kind of data is not routinely collected, and such activities should be encouraged in the future.

6.3 Overall Scoring and Weighting Procedures

As illustrated in the above discussion, multiple factors need to be considered when scoring. The fact that many projects are likely to be evaluated points to the need for a weighting scheme and in some cases a normalization scheme in order to simplify the process. Weights can be set to reflect funding intent (e.g., air quality effectiveness was emphasized for CMAQ-funded projects) and regionally determined objectives, and cannot be prescribed by a general methodology. Consistent counting of benefits across projects and categories should be practiced wherever possible, using the weights to determine importance to any one category of funding. Balance is necessary in the overall process, so that discrimination either for or against certain types of transportation solutions does not inadvertently occur. *The overall goal of the inter-project evaluation process is to provide relevant information to the transportation decision makers. Mitretek recognizes that the final selection process will involve some trade-offs that cannot be documented in any scoring procedure.* These trade-off include other factors such as community support, agreement with state/local comprehensive plans, and consistency with economic development objectives, that influence the collaborative decision making process.

There are fundamental problems with typical scoring processes concerning project interdependence, score scaling, score weighting, and inclusion of non-scored criteria. Other techniques exist for facilitating selection processes, such as the Analytic Hierarchy Process, Delphi consensus and multi-attribute utility analysis. However, as long as participants are cognizant of the implicit problems, and as long as a policy-voting stage exists after a scoring stage, there is no compelling reason to believe that the use of these other techniques would better serve the TIP selection process than the scoring and weighting system currently used in the two case study areas.

With regard to the distinction between qualitative and quantitative factors, some of the current qualitative factors may become quantitative in the future as better data and tools become available. As pointed out in the previous section, this distinction already is blurred in the overall scoring.

Perhaps the most immediate concern that Mitretek has is that the TIP scoring process by itself may not be able to adequately reflect the fact that some projects should be given priority over others. Such projects would be considered to be regional priority projects. There are several reasons to consider prioritization as a factor in the overall selection process: (1) some projects are part of a larger regional implementation program, (2) as a programming document, the TIP should be responsive to regional priorities, and (3) the project may have been previously identified and promoted by other regional planning activities, such as a strategic deployment plan, a CMS plan, or perhaps the transportation plan. This priority filter should be independent of the technical score of a project being evaluated for inclusion in the TIP.

Because of this concern, Mitretek recommends that a regional priority rating be attached to projects as a separate consideration from the technical score. The projects would then be ordered first by overall priority, then by technical score, and presented to the policy board in this manner before final selections are made. Explicit consideration of priority will not necessarily make the final selection process easier, but it will ensure that issues of program continuity and regional priorities are kept visible. The priority rating scheme could have two or more levels, as agreed to locally, but the criteria should be carefully defined and documented. These criteria would need wide acceptance in order to be useful. For example, a higher priority rating could go to projects that are components of an on-going regional implementation program or have been previously identified and promoted by other regional planning activities. A lower priority rating might be given to newly proposed projects, which would have to compete for funds (TIP approval) based on their technical score. Of course, a regional priority rating system might not be appropriate for all regions and should only be used with careful judgment.

Given the overall nature of a TIP as a programming document, explicit consideration of priority is appropriate and should lessen the risk that the subjectivity involved in the current scoring process leads to sub-optimal regional decisions. There are many strategies for deciding how to fund priority projects relative to the remaining ones. Some regions might wish to select all high priority projects, as a general rule, and select the remainder as funds allow. Other regions might decide on a percentage of funds to go to the different priority levels. In any case, it is likely that such guidelines will need to allow flexibility.

Another possibility for handling projects that are actually part of a large implementation program is to assess the scoring factors for the regional program and attach these factors to all of the projects that stem from it rather than calculating new factors for each project. This might alleviate some of the concern about treating these projects independently, but still relies on a sound phasing schedule so that the (sub) projects are implemented in the correct order, given the availability of funds available for programming over a given time period.

Implications for ITS Projects: Due to their often regional scope, ITS projects or programs would likely benefit from such a priority scheme. For example, the CTMS (freeway surveillance, ramp metering, variable message signs, etc.) program in Houston eventually gets broken into many discrete segments over the full implementation period. These segments are then separately scored at the TIP level for CMAQ funding, although each segment is part of a broader system plan. Part of the need to break up the project into smaller segments for the TIP is because the installation of ITS components are often co-scheduled with construction activities. However, there is a concern that the scoring process may result in postponing or not implementing a critical link of the system. A more robust approach for ITS would be to decide on big projects (or programs) on a regional or system basis (evaluation could play a role in that decision), then to schedule or program their implementation in whatever segments make sense (according to a project development/phasing plan) and as the funds are available. The overall system plan should be bound by explicit limits (in terms of roadway coverage) however, and should not be looked at as a blanket approval that might implement ITS elements in areas where they are not cost effective.

6.4 Other Considerations

The extent to which regional decisions are being made and how they fit into the planning process is an important issue for ITS. The conventional planning process is probably not well suited to addressing multi-modal, multi-jurisdictional programs/projects with regional significance, such as the building of a regional transportation management center. Some areas (such as Houston and Seattle) have overcome this issue with cooperation and shared funding arrangements among the agencies.

For large regional projects, some type of progress tracking and documentation of this progress in the regional planning documents would generally be helpful to the understanding of the status of the regional transportation improvements. This would also provide further supporting documentation for any priority rating scheme that might be applied in the TIP-level inter-project evaluation.

Programming through the TIP can only give transportation improvements as good as the projects developed to go into the TIP. The TIP depends on a systematic development of ITS that will tend to occur in the transportation operating agencies with an interest in modal effectiveness and efficiency, rather than in a coordinating agency like an MPO. The failure to recognize the systematic priority and functional interdependency of ITS infrastructure and applications within the TIP can hinder implementation of ITS. These are the kinds of project dependencies that simple scoring cannot address.

6.5 Project Selection Process Comparisons

The following table displays, in simplified form, the relation of our recommendations to comparative features of the two case study project-prioritization processes:

Table 6-1. Summary of Recommendations and Case Study Comparisons

Attribute	Houston	Seattle	Mitretek Recommendation
Funding	ITS limited to CMAQ and FTA funds	ITS not limited: allocated primarily in state operations category and MPO-controlled STP and CMAQ	ITS should be eligible to use any funds allowed by federal rules
Qualitative Factors	Consistent with policy; e.g., congestion relief, economic development, safety, intermodalism ———	Consistent with policy; e.g., congestion relief, economic benefit, safety, innovation ———	(1) Consistent with policy, (2) Environmental impact, (3) Regional impact (4) Respond to changing conditions (5) Provide new services (6) Support multiple uses of services or data
Quantitative Factors	Benefit/cost and air quality effects ———	Benefit/cost and air quality effects ———	(1) Benefit/cost, (2) Air quality effects (3) Cost savings to transportation agencies
Overall Scoring	Nominally independent scoring across projects	Nominally independent scoring across projects	Flag regional priority projects, independent of technical scoring
Other Considerations	———	———	Add capability to track yearly progress of large regional projects

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Glossary

AASHTO	American Association of State Highway and Transportation Officials
APTS	Advanced Public Transportation Systems
ATIS	Advanced Traveler Information Systems
ATMS	Advanced Traffic Management Systems
AVCS	Advanced Vehicle Control System s
AVL	Automatic Vehicle Location
B/C	Benefit/Cost
CAAA	Clean Air Act Amendments of 1990
CEI	Cost Effectiveness Index
CFR	Code of Federal Regulations
CIP	Capital Improvement Program
CMAQ	Congestion Mitigation and Air Quality
CMS	Congestion Management Syst em
CO	Carbon Monoxide
CTMS	Computerized Transportation Management System
CVO	Commercial Vehicle Operations
DOT	Department of Transportation
DPW	Department of Public Works
EA	Environmental Assessment
EDP	Early Deployment Plan
EIS	Environmental Impact Stat ement
FHWA	Federal Highway Administration
FONSI	Finding of No Significant Impact
FTA	Federal Transit Administration
H-GAC	Houston-Galveston Area Council
HOV	High Occupancy Vehicle
IHS	Interstate Highway System
IP	Inter-Project
ISTEA	Intermodal Surface Transportation Efficiency Act of 1991
ITS	Intelligent Transportation Systems
IVHS	Intelligent Vehicle Highway Systems
JPO	Joint Program Office
LOS	Level of Service
LRP	Long Range Plan

METRO	Metropolitan Transit Authority of Harris County
MIS	Major Investment Study
MPO	Metropolitan Planning Organization
MTP	Metropolitan Transportation Plan
NAAQS	National Ambient Air Quality Standard
NEPA	National Environmental Protection Act of 1969
NHS	National Highway System
NGO	Non-governmental Organization
PCIS	Prioritization of Capacity Improvements Study
PD	Project Development
PDP	Project Development Plan
PSRC	Puget Sound Regional Council
PuSHME	Puget Sound Help Me (an operational test)
RCTSS	Regional Computerized Traffic Signal System
RCW	Revised Code of Washington
ROD	Record of Decision
SC&DI	Surveillance, Control and Driver Information
SIP	State Implementation Plan
SOV	Single Occupancy Vehicle
STP	Surface Transportation Program
SWIFT	Seattle Wide Area Information for Traveler
TCMs	Transportation Control Measures
TDM	Transportation Demand Management
TIP	Transportation Improvement Program
TPC	Transportation Policy Council
TSM	Transportation System Management
TSP	Transportation System Plan
TxDOT	Texas Department of Transportation
UPWP	Urban Planning Work Program
USC	United States Code
USDOT	United States Department of Transportation
VMT	Vehicle Miles Traveled
WSDOT	Washington State Department of Transportation
WTC	Washington Transportation Commission