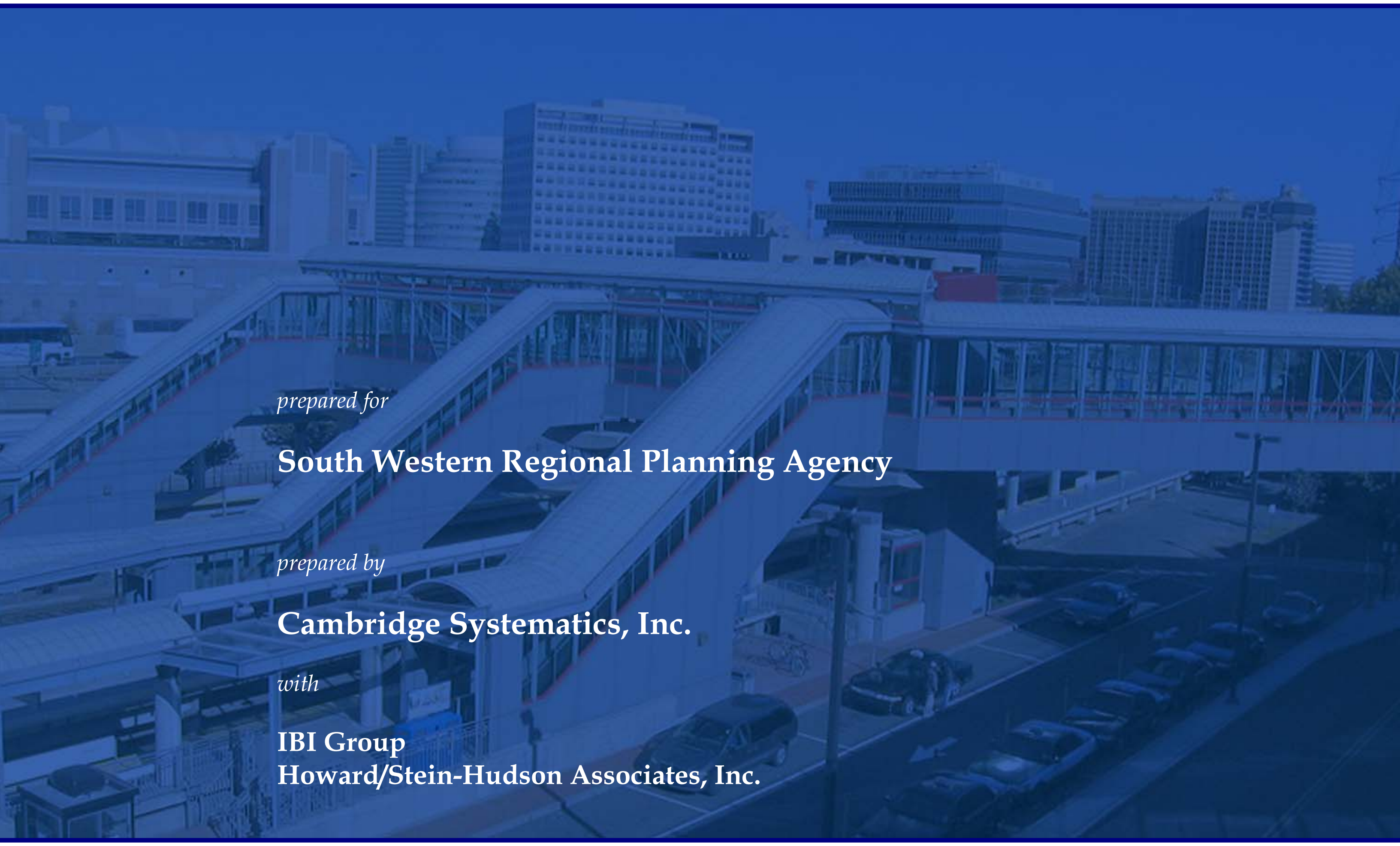
CAMBRIDGE SYSTEMATICS

South Western Region ITS Strategic Plan

Final Report



prepared for

South Western Regional Planning Agency

prepared by

Cambridge Systematics, Inc.

with

IBI Group
Howard/Stein-Hudson Associates, Inc.

SWRPA

July 2009

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This document was prepared in cooperation with the U.S. Department of Transportation, Federal Highway Administration and the Connecticut Department of Transportation. The opinions, findings, and conclusions expressed in this publication are those of the author and do not necessarily reflect the official views or policies of the South Western Regional Planning Agency, Connecticut Department of Transportation or the U.S. Department of Transportation.

1.0 Executive Summary

1.1 Overview

South Western Connecticut's transportation system is under severe pressure. Infrastructure is aging, while transportation facilities that were designed for a much smaller population must serve growing numbers of residents and workers today. With the transportation system at or exceeding capacity and limited opportunities for expansion due to physical and fiscal constrains, operational improvements represent an opportunity to reduce delays, mitigate congestion, and improve the safety and efficiency of the system.

On behalf of the South Western Region Metropolitan Planning Organization (SWRMPO), the South Western Regional Planning Agency (SWRPA) has undertaken a strategic assessment of new and enhanced opportunities for the implementation of intelligent transportation systems (ITS) applications in the South Western Region of Connecticut. ITS encompass a broad range of technologies that relieve congestion, improve safety and efficiency. This assessment was conducted with the goal of improving the safety and efficiency of the regional transportation network.

Flowing from the results of a Needs Assessment and Preliminary Screening, eight proposed ITS strategies were identified by the SWRPA ITS Technical Advisory Committee (TAC) for further study. As part of SWRPA's commitment to multi-modal transportation, four strategies aim to improve expressway and arterial management, while four strategies seek to enhance transit services. Planning budget estimates were generated for each of strategy, including capital costs as well as annual operating and maintenance expenses.

Using IDAS, a sophisticated modeling application, the cost estimates were evaluated against the expected benefits to travelers resulting from each package. In all, six of the eight packages were determined to have positive benefit-to-cost ratios. That is, for these six packages, the benefits exceed costs. As such, SWRPA recommends these six packages as means to meet identified needs and enhance safety and efficiency of Region's transportation system.

1.2 Project Objectives

The primary project objectives, as stated in the scope of work, are as follows:

- To educate Federal, state, and local policy-makers, as well as the general public, about the role of ITS in transportation systems design and the benefits of implementation
- To identify regional issues, concerns, and conditions that the Connecticut Department of Transportation (CT DOT) should consider in its development of a regional/statewide ITS;
- To establish ITS program policies that provide a framework for local and regional planning;
- To identify regional ITS program priorities and recommend specific projects for implementation over a 20-year period;
- To identify institutional and other challenges to plan implementation and propose strategies for meeting those challenges;
- To actively involve Federal, state, and local stakeholders in the development of the regional ITS plan; and
- To develop a strategic ITS Plan for the South Western Region.

This Plan recommends ITS implementation strategies, identifies critical policy issues, supports the regional ITS architecture developed by the Connecticut Department of Transportation (CT DOT), and positions the South Western Regional Planning Agency (SWRPA) to meet the national architecture requirements of both the Federal Highway Administration (FHWA) and the Federal Transit Administration (FTA).

1.3 Geographic Boundaries

The South Western Region is located in the southwestern corner of the Connecticut and includes eight municipalities: Darien, Greenwich, New Canaan, Norwalk, Stamford, Weston, Westport and Wilton. Four of the South Western Region's municipalities – Greenwich, Stamford, New Canaan and Wilton – share a border with Westchester County, New York. Key transportation facilities and corridors in this study area include Interstate I-95, the Merritt Parkway, US 1 and 7, and the New Haven, New Canaan and Danbury rail lines, stations and amenities.

1.4 Identification of Stakeholders

Stakeholders are defined as persons and organizations that have a vested interest in this planning process and its outcomes. Input from stakeholders, both public and private, is critical to the identification of the Region's ITS needs and the development of a strategic plan to meet those needs.

Opportunities for stakeholder involvement were numerous and integrated into every phase of this study. In order to ensure active participation in this study process, SWRPA placed an early emphasis on not only the identification of stakeholders, but on defining the roles that stakeholders could play in the study process. This following describes the process used to identify stakeholders and define their roles.

Process: Identification of Stakeholders

SWRPA used several sources of information to develop a comprehensive list of stakeholders. Some sources, such as lists of organization participating in past planning processes undertaken by SWRPA and similar organizations, were used to pinpoint specific persons and organizations with an interest in transportation or intelligent transportation systems. Other sources, such as model ITS architecture diagrams, were used to identify the types of organizations whose involvement would be critical to the development of a successful ITS strategic plan.

Types of stakeholders contacted about participation in this study included local, state and federal agencies with vested interests in the following land use planning and regulation, passenger and freight transportation, economic development, travel and tourism, infrastructure development, education, and public safety and incident management. Private organizations were also contacted. Such private organizations included major employers, business councils and chambers of commerce, relevant trade and membership organizations, educational and cultural institutions, transportation providers, transportation management organizations, citizen and public interest groups, and civic organizations. A list of stakeholders is included as Appendix A to this memorandum.

Role of Stakeholders

Once identified, stakeholders were placed into two categories: candidates for participation on the project Technical Advisory Committee (TAC) and candidates for participation on general or targeted stakeholder working groups. Organizations invited to participate at the TAC level are those entities with a role in the design, implementation or operation of ITS within the study area. Representatives of those organizations were selected for TAC participation on the basis of their ITS or ITS-related planning, engineering and/or information systems technology expertise.

Technical Advisory Committee.

As noted above, TAC members bring a wealth of ITS and ITS-related planning, engineering and information technology expertise to the project. Additionally, TAC members represent a broad spectrum of interests that may directly benefit from the further deployment of ITS in the South Western Region. Interests represented include federal, state and local transportation agencies, transit providers, transportation management organizations, commercial vehicle operators and emergency management agencies. Specific organizations represented on the TAC include SWRPA, the Connecticut Department of Transportation, the Federal Highway Administration, the Federal Transit Administration, the City of Stamford, the City of Norwalk, the Town of Greenwich, Westport Fire Department, Norwalk Police Department, the Connecticut Department of Emergency Management and Homeland Security, MetroPool, the Connecticut Motor Transport Association, CT Transit, Norwalk Transit District and Metro-North Commuter Railroad. TAC members play a role in all aspects of the study including consultant selection, review of study projects and establishing project priorities.

General Stakeholders' Working Group.

Like organizations represented on the TAC, general stakeholders have an interest in the outcomes of this project. Unlike the TAC, these stakeholders are not required to have specific technical expertise or direct responsibility for ITS deployment. The general stakeholders' working group includes representatives of the same types of organizations represented on the TAC as well as representatives of special interest groups, civic organizations, the business community and interested citizens. This working group provided guidance to SWRPA and the TAC during several stages of the planning process. Such guidance helped SWRPA identify the needs and expectations of the traveling public. SWRPA solicited participation in working group activities by invitation and by public notice.

2.0 Methodology

This study used an approach blending quantitative and qualitative methods. This approach allows consideration of best practices and lessons learned by metropolitan areas in addition to performance and cost-oriented data. The following steps were undertaken to create a framework for the evaluation of ITS solutions that may benefit the Region:

- Set ITS program goals:
  - Identify regional transportation needs.
  - Examine the list of identified needs along with the list of ITS solutions to prioritize the eight planning factors.
  - Order planning factors to form the basis for a prioritized list of goals.
- Conduct a preliminary screen of ITS Market Packages:
  - Use the eight planning factors endorsed by the US Department of Transportation and articulated in the Region's Long Range Transportation Plan as goals against which to screen ITS market packages and solutions.
  - Use this screening process to sort ITS market packages into three tiers:
    - » (1) "must have" strategies that appear appropriate for near-term deployment;
    - » (2) beneficial strategies suitable for future deployment; and
    - » (3) strategies that may be eliminated from further consideration.

  This preliminary screen took the form of a two-step Matrix Analysis. The first step involved the identification of relationships between the National ITS Market Packages and the planning factors identified in the most recent federal transportation authorization statute, SAFETEA-LU. Using best professional judgment, SWRPA staff and study stakeholders assessed the direct relationship between 85 National ITS Market Packages and the SAFETEA-LU planning factors. The market packages were then sorted into three categories on the basis of cumulative impacts and 15 of the market packages were eliminated from consideration.

  The second step involved the identification of relationships between the National ITS Market Packages and criteria set by SWRPA staff and selected stakeholders. These criteria are more specific than the broad planning factors and introduce real constraints and externalities into the strategy selection process. As with step one of the process, best professional judgment was used to assess the strength of any direct relationship between selection criteria and National ITS Market Packages.

A list of planning factors is included in Appendix B to this document.

- Conduct an environmental screen.
  - Predict the potential benefits to the Region of selected ITS deployments through examination of the experiences of other, similar metropolitan areas.
  - Select three (3) to five (5) metropolitan areas as subjects for this case study and review existing qualitative and quantitative data to assess the performance of ITS deployments.
  - Criteria used to select metropolitan areas for comparison include demographics, transportation data, infrastructure and service characteristics, and transportation needs and goals.
- Model the impacts of selected ITS deployments.
  - Use computer model to quantitatively evaluate the impacts of selected ITS strategies.
  - Include preliminary budget estimates and cost-benefit analysis.
- Prepare Financial and Implementation Plans for the selected ITS deployments.
  - Plan represents conceptual planning level estimates.

Stakeholder consultation was a component of all phases of evaluation. Such consultation ensures that goals and objectives not generally measured through quantitative evaluation – such as customer preference, customer satisfaction and perceived impacts – are factored into evaluation and the development of the recommended program of improvements.

3.0 Regional ITS Needs

This section summarizes the findings of initial data collection and analysis activities conducted to support development of a strategic intelligent transportation systems plan for Connecticut's South Western Region. It includes an inventory of key facilities, a description of the data collected and the analysis performed in the identification of needs.

3.1 Identification of Primary and Secondary Study Area and Key Facilities

The South Western Region functions as a critical part of both the Bridgeport-Stamford Urbanized Area and the Greater New York Metropolitan Area. This relationship is clearly illustrated by employment and journey-to-work data, travel trends and the design of current and planned transportation facilities and services.

The relationships between the South Western Region and its neighbors helped shape the geographic scope of this study. Two broad study areas have been identified: the primary study area and the secondary study area. The primary study area is defined by those municipalities that comprise the South Western Region Metropolitan Planning Organization and have membership in the South Western Regional Planning Agency.

The secondary study area includes municipalities, regional planning organizations, transportation providers and metropolitan planning organizations that are located within the Bridgeport-Stamford Urbanized Area or are members of the New York Metropolitan Transportation Council.

Primary Study Area: Connecticut's South Western Region

The South Western Region is located in the southwestern Fairfield County, Connecticut and includes eight municipalities: Darien, Greenwich, New Canaan, Norwalk, Stamford, Weston, Westport and Wilton. The South Western Regional Planning Agency (SWRPA) is the designated regional planning organization for these eight municipalities.

These municipalities also comprise the South Western Region Metropolitan Planning Organization (SWRMPO) which relies on staff support from SWRPA.

The Region's state and local highway system includes more than 1,500 miles of roads, almost 800 road and rail bridges, 22 at-grade rail/highway crossings, more than 800 traffic signals, 5 commuter park and ride lots, and thousands of public parking spaces. The major transportation corridors in the South Western Region are Interstate 95, the Merritt Parkway (CT 15), US 7 and US 1. Interstate 95 and the Merritt Parkway are limited access highways, while US 1 and 7 are arterial highways. All of these roadways experience significant demand during all hours of the day. With the exception of the Merritt Parkway, which limits access to non-commercial passenger vehicles, these roadways carry a significant amount of freight in and through the South Western Region.

The South Western Region also has well-developed rail infrastructure. Metro-North Railroad's New Haven line runs parallel to Interstate 95 through the Region's coastal communities and connects the Region with New York City to the west and New Haven to the east. Amtrak's Northeast Corridor service also runs on this line, providing the region with passenger service to points along the eastern seaboard including Boston, Philadelphia and Washington, D.C.

Metro-North Railroad also offers branch line service in the Region. Passengers may connect to service along the New Canaan Branch from Stamford and to service along the Danbury Branch from South Norwalk. Commuter rail stations are located in seven of the Region's eight municipalities. Some stations, such as Stamford and South Norwalk, function as hub stations offering connections to corporate commuter shuttles, commuter connections shuttles and fixed route bus transit service. Other stations, such as Rowayton and Greens Farms, primarily serve persons who live and work in the neighborhoods immediately adjacent to the stations.

Transit buses also provide numerous services to persons living and working in the South Western Region. Local fixed route services are focused in Norwalk and Stamford and also serve Darien, Greenwich, Westport and Wilton. Regional fixed route services connect Norwalk and Stamford with the cities of Bridgeport, Danbury and White Plains. Demand responsive transit services are provided throughout the region.

Secondary Study Area

The secondary study area includes municipalities, regional planning organizations, transportation providers and metropolitan planning organizations that are located within the Bridgeport-Stamford Urbanized Area or in the area served by the New York Metropolitan Transportation Council. For the purposes of this study, the geographic sub-regions within the secondary study area will be referenced by metropolitan planning organization (MPO) boundaries.

Housatonic Valley Region

The Housatonic Valley Region consists of ten municipalities in the northern part of Fairfield County. These municipalities are Bethel, Bridgewater, Brookfield, Danbury, New Fairfield, New Milford, Newtown, Redding, Ridgefield and Sherman. Danbury, located at the intersection of US 7 and Interstate 84, functions as the regional center.

The Housatonic Valley Region is served by several major transportation corridors including Interstate 84, which offers east-west access between Hartford and Scranton, and US 6 and 7. Commuter rail service is offered on Metro-North Railroad's Danbury branch line which includes stations in Danbury, Bethel and Redding. The Housatonic Valley Region also is a short distance from Metro-North Railroad's Harlem Line which provides service to points in Westchester and Putnam Counties and New York City.

Fixed route bus service is provided within the City of Danbury. Additionally, an interregional bus offers service in the US 7 corridor between Danbury and Norwalk and commuter shuttles transport persons from commuter lots in the Housatonic Valley to Harlem Branch Line rail services operating from the Katonah (NY) Rail Station.

Short-haul freight rail service also is available. Several operators, including the Housatonic and Providence & Worcester Railroads, operate shortline service within the region and to adjacent areas in the northeast. Aggregates and lumber are the primary commodities moved by rail in the Housatonic Valley Region.

Greater Bridgeport/Valley Region

The Greater Bridgeport/Valley Region consists of ten (10) municipalities: Ansonia, Bridgeport, Derby, Easton, Fairfield, Monroe, Seymour, Shelton, Stratford and Trumbull. Bridgeport, the largest city in Fairfield County, is the regional center.

As in the South Western Region, Interstate 95, the Merritt Parkway and US 1 are among the major transportation corridors. Additional US 8 and CT 34 carry significant volumes of passenger and freight traffic to and through the region.

The Greater Bridgeport/Valley Region also has good transit access. The region is served both by Metro-North Railroad's New Haven Line and Waterbury Branch Line which offers connecting service from Bridgeport to Ansonia, Derby, Naugatuck, Seymour, and Waterbury. Both rail lines serve the Bridgeport Intermodal Center which functions as a connecting point to fixed route bus services operating within the City of Bridgeport and to Coastal Link interregional service to Milford and Norwalk. Passenger and car ferry service to Port Jefferson, New York (on Long Island), also is provided from a terminal adjacent to the Intermodal Center.

New York Metropolitan Region

Encompassing the five boroughs of New York and the suburban counties of Nassau, Suffolk, Westchester, Rockland and Putnam, the New York Metropolitan Region is both the most populous region in the primary and secondary study areas and the region with the most developed transportation system. Major transportation corridors connecting the New York Metropolitan Region with the South Western Region include Interstates 84, 95, 287 and 684 and the Hutchinson River Parkway.

Several rail lines enhance connectivity between the New York Metropolitan and the South Western Regions including Metro-North Railroad's New Haven and Harlem Lines, the Long Island Railroad and Amtrak's Northeast Corridor service. The I-Bus bus links the business districts of Stamford and Greenwich with White Plains, New York.

The New York Metropolitan Region has numerous airports that are available to residents and businesses of the South Western Region. The John F. Kennedy Airport, the LaGuardia International Airport and the Westchester County Airport are the major commercial airports serving the Region with passenger and cargo service available to points around the world.

3.2 IDENTIFICATION OF EXISTING AND PLANNED ITS DEPLOYMENTS

Data collection activities were conducted early in the study process and focused on two primary tasks: (1) assembling of an inventory of existing and planned transportation infrastructure, facilities and services; and (2) the assessment of regional needs and opportunities for the further deployment of ITS in the primary study area. Information collected and assembled during the data collection phase also supported other project tasks including strategy evaluation, the development of a recommended program of improvements and the identification of emerging ITS-related policy issues.

Data Collection Methods

Previously published transportation plans were the main source of data about the characteristics of the existing transportation system, planned improvements, transportation system needs and goals. Strategic and long-range planning studies, ITS deployment plans and architectures, transit studies and other transportation planning and policy documents were reviewed. Critical data about existing and planned infrastructure, facilities and services were catalogued and mapped. Information about transportation system needs and goals will be used to aid identification of policy issues, development of a recommended program and strategy valuation.

Plans and studies reviewed include:

Regional and State Plans

- South Western Region Long Range Transportation Plan , 2004-2030
- Transportation Improvement Program, FFY 2005-2009
- Greater Bridgeport Regional Transportation Plan, 2004 - 2028
- HVCEO Regional Transportation Plan, 2004 - 2030
- SWRPA Congestion Mitigation Systems Plan - Vision 2020
- Twenty-year Strategic Plan for Transportation in the Coastal Corridor Transportation Investment Area, 2001
- Transportation: A Strategic Investment, An Action Plan for Connecticut, 2003-2023
- Connecticut Master Transportation Plan, 2005
- Mobility for the Millennium, A Transportation Plan for the New York Region, 1999

ITS Plans

- Feasibility Study For Regional Intelligent Transportation Systems (ITS) and Engineering Concept Plan (Bridgeport)
- Intelligent Transportation Systems "ITS" A Strategic Plan for the Capitol Region
- Intelligent Transportation Systems Strategic Deployment Plan – New Haven-Meriden Area
- SWRPA Incident Management Team Reports

- CT DOT Regional ITS Architecture Documents
- CT DOT ITS/CVO Business Plan
- Lower Hudson Valley ITS Early Deployment Planning Study
- NYSDOT CVO Business Plan
- NY MOVES- Hudson Valley/ Poughkeepsie Region ITS Program
- Hudson Valley Transportation Management Center Programs
- NYMTC ITS Integration Strategy Report
- Regional ITS Architecture Development- A Case Study (NY/NJ/CT Region)

Transit Plans

- Greater Bridgeport Transit Authority AVL Demonstration Project
- Regional Transit Card Implementation Study
- Route 7 Corridor Travel Options Implementation Plan
- Danbury ITS Electrification Plan
- Public Transportation Plan
- Darien / Norwalk Railroad Parking Study
- Stamford Urban Transitway
- PANYNJ Smart Card Interfaces Study
- CT DOT Rail Fleet Plan

Other Transportation Plans

- NYMTC Truck Management Project
- I-95 Commuter Shoulders Operational Analysis (Exits 8 to 18)
- Needs Assessment and Conceptual Network Design Report
- Truck Stop and Rest Area Parking Study

Identification of ITS Deployments, Primary Study Area

Selected ITS deployments have already been made in both the primary and secondary study areas. Existing deployments aid both highway and transit operations, generally speaking, are under control of the Connecticut Department of Transportation, municipal departments of public works and transit agencies.

Within the South Western Region, highway and other roadway deployments represent the most common use of ITS. Currently, the Connecticut Department of

Transportation (CT DOT) operates and maintains ITS equipment supporting operation of closed circuit television (CCTV), changeable message signs (CMS), highway advisory radio (HAR), and interconnected signal systems along the I-95 corridor. CT DOT also provides Connecticut Highway Assistance Motorist Patrol (CHAMP) services on I-95. CT DOT operates a more limited system of ITS deployments in the CT 15 corridor.

These deployments are managed out of CT DOT's Bridgeport Operations Center and are enabled by a fiber optic trunk line that spans the length of I-95. This trunk line sends feeds to CCTV cameras and CMS. The traffic signal systems are operated via an aerial phone drop and have a telephone back-up system. In recent years, CT DOT has upgraded and added HAR stations to improve geographic coverage. Additional CCTV and CMS capabilities have been deployed.

CT DOT also has undertaken several initiatives to support and further improve ITS capabilities in the region. These initiatives include the update of traffic diversion plans, planning for the Greenwich weigh-in-motion project, development of a 511 system implementation plan, development of a plan for implementation of Commercial Vehicle Information Systems and Networks state-wide and implementation of a technology and information sharing initiative with the Connecticut State Police. CT DOT also participates in activities of the Transportation Operations Coordinating Committee (TRANSCOM) and the I-95 Corridor Coalition.

Recent TRANSCOM projects include the beta-testing and activation of the TRIPS 123 system which is designed to provide travelers with free real-time travel information and route-planning capabilities via the internet and telephone. TRIPS 123 also provides travelers with route-specific information via telephone, fax, e-mail or pager on a fee-for-service basis.

Several municipalities also have invested in ITS technologies to help them monitor and manage local arterials. Greenwich, Stamford and Norwalk all operate local Traffic Operations Centers. The Traffic Operations Centers operated by Greenwich and Norwalk have the capability to monitor traffic signal equipment and, in select locations, traffic cameras. In Stamford, the Traffic Operations Center also monitors traffic signal equipment and a network of CCTV cameras. The Stamford system also has signal pre-emption capabilities for traffic signals owned by the City. Pre-emption capabilities are used to support emergency management and response activities.

Additional highway and roadway deployments are planned. Such projects include:

- Deployment of continuous traffic counting and monitoring capabilities at the New York Stateline on I-95, I-84 and CT 15, at the US 7 & CT 15 interchange and other key locations to enable better monitoring and evaluation of roadway congestion and the impacts of maintenance, construction, enforcement, incident management programs and diversion plans. (Funding for this project has not been programmed.)

- Upgrade of existing signal systems to improve traffic signal coordination and timing.
- Study of a weigh-in-motion system for I-95 in Greenwich.

On the transit side, ITS projects are in the planning or design stages. Projects under consideration include those that are designed to primarily aid the operator and those projects designed to serve the user. Such projects include:

- Stamford Urban Transitway. A hybrid roadway-transit project, the Stamford Urban Transitway will use a variety of road and transit technologies to improve mobility, reduce travel delays and help travelers access real-time information about services and connections. Transit signal priority capability and information kiosks are among the ITS elements envisioned for this project.
- Regional Transit Card Implementation Plan. Released by SWRPA in late 2001, this implementation details the recommended approach for converting magnetic strip and token-based fare collection systems with a smart-card system. The plan recommends implementation across all modes to allow a single fare media to be used for all transportation and related services. Anticipated benefits include improved collection and analysis of ridership data, ease of transfer among services and across providers for the user, and the ability to offer a wider variety of pricing incentives to encourage use of transit.
- Darien/Norwalk Railroad Parking Study. Released by SWRPA in late 2004, this study recommends a program of station-specific improvements at the Noroton Heights and South Norwalk rail stations. ITS technologies – including CMS, automated vehicle location system and kiosks offering real-time travel information and trip planning assistance – are among the recommendations.

An inventory of existing ITS devices and infrastructure in the Region, organized by owner/operator, is included in Appendix C to this memorandum.

Identification of ITS Deployments, Secondary Study Area

From a roadway perspective, existing ITS components and deployments in the Greater Bridgeport and New York Metropolitan regions are quite similar to those found in the South Western Region. In the case of the Greater Bridgeport region, existing traffic operations center, CMS, HAR and CCTV capabilities are part of the same system that serves the South Western Region.

Across the state line, deployments are similar but responsibility for maintenance and operation are shared between a number of state and local agencies. The New York State Department of Transportation (NYSDOT) operates a Transportation Management Center, fixed and portable CMS, CCTV, traffic flow detectors and interconnected traffic signals along interstate highways, including I-95, I-87 and I-287, in Westchester County. The New York State Thruway Authority (NYSTA) operates ITS deployments on the Tappan Zee Bridge. NYSTA deployments include HAR, a travel advisory website and traffic cameras.

Just like South Western Region, ITS in the New York Metropolitan region has been implemented at the regional and local level. Westchester County operates interconnected traffic signal systems, fixed and portable CMS, and CCTV on county roads including the Bronx River and Sprain Brook Parkways. The Cities of New Rochelle, White Plains and Yonkers operate local interconnected traffic signal systems.

The Housatonic Valley Region has limited ITS deployments at this time. A number of deployments are planned including implementation of a Route 7 corridor communications plan to improve construction coordination, incident management, transportation security and multi-modal coordination and the deployment of continuous traffic counting and monitoring capabilities on I-84 at the New York Stateline to enable better monitoring and evaluation of roadway congestion and the impacts of maintenance, construction, enforcement, incident management programs and diversion plans.

On the transit side, the Greater Bridgeport Transit Authority (GBTA) has implemented an advanced traveler information system (ATIS) that provides static and real-time information to travelers through broadcast and interactive services. GBTA also has developed a deployment plan for an Automatic Vehicle Location (AVL)/Computer-Aided Dispatch (CAD) system. When launched, this system will have the capability to conduct automated passenger counting and automated fare collection, link on-board and public area security devices with emergency management centers, monitor and aid implementation of transit maintenance schedules, and monitor vehicle locations, travel speeds and travel times. Anticipated benefits include enhanced operational efficiency, improved security, access to better data for planning purposes, and enhanced multi-modal coordination. The Housatonic Area Regional Transit (HART) also plans ITS deployments. Transit signal priority treatments along major corridors and the installation of real-time travel information kiosks at its pulse point are the planned or future improvements identified at this time.

3.3 IDENTIFICATION OF NEEDS

The Region's transportation system is severely challenged. Simply stated, the Region's transportation infrastructure and many of its facilities were constructed before 1960 – many years prior to the explosive economic and population growth that began in the 1980s. As a result, these facilities are carrying more passengers and vehicles than their designers ever envisioned. In some cases, facilities are operating at twice their design capacity at certain locations and at certain times of day. Some services, such as commuter rail and intra-regional bus routes, also are operating in excess of their capacity.

A detailed analysis of existing conditions and projected demand for transportation services may be found in SWRPA's *Congestion Mitigation Systems "Vision 2020" Plan: Technical Memorandum No. 3: Existing Conditions*. Although many facilities and services are operating in excess of capacity at certain times of day, excess capacity does exist on alternate routes and at other times of day. In some cases, travel delays associated with congestion can be reduced through the implementation of operational improvements – including the deployment of ITS. The myriad plans and studies referenced above were reviewed to identify existing needs and planned improvements. A complete list of such needs is included in Appendix D to this document. This list of needs was then filtered, using the following questions to highlight certain needs and planned improvements:

- Does the identified need or planned improvement involve deployment of ITS?
- Can ITS be deployed to meet this need or achieve the same or similar benefits as the planned improvement?
- Can ITS be used to incrementally improve or strengthen the benefits of the planned improvement?

After reviewing each of the catalogued needs and planned improvements using these filters, a list of needs with ITS solutions and a list of planned improvements with ITS components were developed.

The following table presents existing transportation needs with potential ITS solutions:

Table 3.1 Examples, Existing Transportation Needs with ITS Solutions

Existing Transportation Needs	Primary Area(s) of Benefit
Expanded use of traffic systems management techniques to improve the safety and operation of major arterial roads, such as US 1, to reduce congestion and decrease accidents.	Congestion mitigation, safety and operations
Implement traffic monitoring capabilities on limited access highways and arterials.	Congestion mitigation, safety and operations
Study the feasibility and benefits of implementing congestion pricing and/or the use of managed lanes on I-95 and other limited access roadways	Congestion mitigation, safety and operations
Implement operational and capacity improvements in the US 7 corridor to further improve the safety and operation of the roadway.	Congestion mitigation, safety and operations
Implement traffic systems management techniques on arterial roadways such as US 1 and 7 to improve traffic flow and support priority treatment for transit vehicles.	Congestion mitigation, safety and operations
Evaluate CT 15 (Merritt Parkway) and its interchanges for safety and operational deficiencies.	Congestion mitigation, safety and operations
Evaluate CT 15 (Merritt Parkway) to identify opportunities for improved emergency access.	Safety
Conduct a detailed operational study of I-95 between Stamford and Norwalk to identify needed operational and safety improvements.	Congestion mitigation, safety and operations
Improve the efficiency and operation of existing bus service in the corridor.	Intermodal connections, customer satisfaction
Implement Weigh-In-Motion technology at the Greenwich weigh station.	Freight, safety, security
Improve availability of transit and transportation demand management program along the US 7 corridor.	Congestion management, intermodal connections, customer satisfaction
Implement CT DOT's statewide ITS initiatives, in particular, implementation of technologies aiding mobility, access to, and real time traveler information about the Region.	Congestion mitigation, safety and operations
Implement transit-supportive ITS technology such as automatic vehicle location systems, electronic ticketing and traveler information services to improve efficiency of operations and customer satisfaction.	Intermodal connections, safety and operations, customer satisfaction

Increase availability, quality and utility of commuter information and services through consolidation and coordination of existing transportation web sites and services and expanded use of the Internet and other direct-to-user technology.	Intermodal connections, customer satisfaction
Implement universal fare card, "SmartCard" technology, which covers all transportation services in the Region and is interoperable with services in New York and adjacent regions.	Intermodal connections, operations
Use ramp metering or more effective traffic signal system coordination to better control access to and exit from limited access highways.	Congestion mitigation, safety and operations
Expand incident management programs including those promoting "quick clearance" and enhanced information to notify travelers of incidents, anticipated delays and recommended diversion routes.	Congestion mitigation, safety and operations, security
Improve broadcast delivery, accuracy and timeliness of highway advisory radio alerts to ensure that alerts reach motorists on all state roadways.	Congestion mitigation, customer satisfaction
Explore the benefits of implementing congestion pricing and/or value pricing for transit and supporting facilities in both the presence and absence of similar highway programs.	Congestion mitigation, intermodal connections
Use ITS and other techniques to improve enforcement of truck and cargo safety and security programs.	Freight, safety, security
Explore opportunities for the movement of freight by means other than truck.	Freight, congestion mitigation, intermodal connections

Although not a complete list of the Region's identified transportation needs with ITS solutions, these examples highlight the general categories of needs and desired benefits. With regard to needs, operational improvements are among the most cited types of improvements. Roadway design improvements, traffic signal coordination, realignment of transit routes and connections, and incident management projects are examples of such improvements. The need for enhanced traveler information and incentive or price-based programs to alter commuter behavior are other commonly stated needs.

From the perspective of benefits, general transportation improvements – and by extension, ITS improvements – that can contribute to congestion mitigation, improve safety, enhance traveler information and promote intermodality are frequently noted in long range plans and transportation studies.

3.4 SUMMARY OF NEEDS

Numerous studies and plans have outlined existing conditions and projected demand within the South Western Region and for its neighbors. Generally speaking, the picture is one of growth: increasing numbers of jobs, increased demand for housing and, of course, increased demand for transportation facilities and services.

As demand for transportation facilities and services increases, so does the burden on aging and outdated infrastructure. Many plans and studies point to the need to invest in the maintenance, repair and upgrade of infrastructure. Other plans also emphasize the need for additional infrastructure and services. All plans and studies identify the need for projects that will mitigate congestion, increase safety, improve mobility and accessibility, and improve availability and access to information about travel conditions.

Opportunities for achieving such objectives and improving the quality of transportation services exist in the form of ITS. ITS and supporting technology can play a role in increasing transportation system efficiency and performance which, in turn, may help mitigate the imbalance between increasing demands and supply and aid in the achievement of regional transportation goals. ITS also aids communication between system operators and system users, providing both groups with the tools needed to make better informed decisions.

Review of regional transportation needs revealed many such opportunities: Congestion pricing and smart cards use the dynamics of market behavior and currency to influence the travel choices made by users. Vehicle location systems, real-time travel information and transit signal priority treatments can improve the performance, reliability and ease-of-use of bus and rail transit services. Custom travel alerts and the use of interactive media such as the internet can provide travelers with information about travel conditions before they leave home. As technologies are proven and become more affordable over time, numerous other possibilities are likely to emerge.

What opportunities are worthy of investment now? In the next five years? In the next ten years? These are questions that should be answered prior to planning or financing the deployment of any ITS solutions at the local or regional level. As such, the benefits of various ITS strategies and products follow as the next step in the selection process.

4.0 Matrix Analysis

Matrix analysis is the first component of the three-tiered evaluation process that was used to guide development of the South Western Region's ITS strategic plan. Matrix analysis is a screening tool that facilitates the identification of relationships between regional goals, nationally mandated planning factors and National ITS Market Packages. Using best professional judgment, staff identified the goals and planning factors impacted by deployment of each of the National ITS Market Packages. Market packages were then sorted into three categories on the basis of cumulative impacts.

This matching process is somewhat subjective as its basis lies in professional judgment, not in quantitative measurement. Its purpose, therefore, is not to create a bright line between market packages worthy of further evaluation and those that fail to address priority needs. The purpose is to provide a starting point for discussion of the relative merits of a broad variety of ITS market packages and applications.

A second matrix analysis using weighted goals/planning factors was used to recalculate the cumulative score of each market package. The results of such analysis were used to narrow the results in several ways. First, the weighted analysis showed a clear "break" between market package warranting further evaluation and those that are not strong candidates for deployment at this time.

The process of assigning weight to regional goals/planning factors allowed for the elimination of market packages that failed to address two or more of the most heavily weighted goals. The weighted analysis was used in combination with the adoption the parameters listed above. Best professional judgment was used to identify market packages that fell within the selected parameters. Surviving market packages were then assessed using the weighted matrix to calculate the potential impacts of these market packages.

4.1 First Matrix Analysis

Design of Matrix

The matrix matches regional goals/planning factors against national ITS market packages. Regional goals/planning factors are ordered along the horizontal axis, while National ITS market packages are ordered along the vertical axis.

Eight regional goals/planning factors have been selected:

- Promotes economic competitiveness;
- Improves safety of the transportation system;
- Improves security of the transportation system;
- Increases accessibility and mobility;
- Mitigates environmental impacts;
- Enhances integration and connectivity;
- Promotes efficient system management and operations; and
- Emphasizes preservation of the existing transportation system.

These regional goals/planning factors are placed in random order and have not been assigned weights or priorities. They reflect the goals identified in the South Western Region's Long Range Transportation Plan and the planning factors identified in federal SAFETEA-LU legislation.

Eighty-five (85) market packages were identified and are organized by service area:

- Archived data management (3);
- Public transportation (8);
- Traveler information (9)
- Traffic management (21);
- Vehicle safety (11);
- Commercial vehicle operations (13);
- Emergency management (10); and
- Maintenance and construction management (10).

These service areas also are randomly ordered.

Identification of relationships

Market packages were reviewed against each regional goal/planning factor. The number "1" indicates a positive, direct relationship between the market package and the regional goal/planning factor. No value was entered in the absence of a direct relationship.

The next step in the process was to estimate the cumulative impacts of each market package. This estimate was produced by tallying the number of regional goals/planning factors impacted by each market package. Matrix inputs and cumulative scores are represented in Appendix E.

Prioritization of candidate strategies

The next step was to reorder the market packages by cumulative score. Market packages were placed in descending order, with the highest scoring market packages at the top of the vertical axis. Appendix F illustrates this ranking of market packages.

Once ordered by cumulative score, market packages were grouped into three tiers. Cumulative score was one factor used to determine final placement. Other factors included the ability of the market package to address regional goals/planning factors, the availability of the technology, the potential for deployment at the local/regional level, and whether the benefits of deployment would be understood and supported by policy-makers and citizens. The value of potential investment in each technology also was considered. Value was defined as a function of the technology's proven benefits, ability to support other deployments and interoperability with other critical systems such as communications infrastructure.

Market packages also were analyzed by service areas to compare the relative impacts of categories of deployments. National ITS architecture standards were used to group market packages into service areas. Within each service area, the cumulative scores of market packages were averaged and service areas were ranked. The ordering of service areas by potential impact also was used as a factor to refine the assignment of market packages to the first, second or third tier.

First tier market packages represent "must have" strategies. Such strategies received high cumulative scores, support priority recommendations in the Long Range Transportation Plan and other studies endorsed by the MPO, and/or provide a foundation for or support other critical deployments. First tier strategies may be deployed in the short term as the technology is in place and the benefits are documented.

Second tier market packages are those that would benefit the region but are not ripe for deployment. These strategies received a solid cumulative score, and support recommendations in long range plans and studies endorsed by the MPO. Successful deployment of these strategies, however, is dependent on prior deployment of other ITS market packages and technology. Future deployment of these strategies is recommended.

Third tier market packages are those that do not address recommendations in long range plans or studies endorsed by the MPO, require deployment of technology that is not readily available, are not appropriate for deployment at the local or regional level, or are technologies for installation in personal vehicles. These market packages are not recommended for further evaluation at this time.

Results

Matrix analysis was used to identify direct relationships between national ITS market packages and regional goals/planning factors. Matrix inputs were used to estimate the potential benefits of the deployment of 85 different market packages distributed among eight service areas. The matrix was reordered several times to gain an initial understanding of the potential benefits of each technology. First, market packages were ordered solely on the basis of cumulative score. Then, additional assessments were made to refine the ordering of market packages and structure potential deployments in three tiers: "must have" technologies that should be considered for deployment in the near-term; beneficial deployments that are not ripe for near-term deployment but are worthy of further evaluation; and technologies with limited opportunity for local or regional deployment.

The relative value of service areas also was calculated by averaging the cumulative scores of market packages within a service area. The relative strength of a service area was, in some cases, used to influence the assignment of a market package to a tier. The following table compares the potential impacts ITS deployments in the region:

Table 4.1 ITS Deployment Comparison

Service Area	Average Score	% Goals addressed	Rank
Commercial Vehicle Operations	4.231	52.8%	1
Traffic Management	3.904	48.8%	2
Maintenance & construction management	3.900	48.75%	3
Emergency management	3.700	46.25%	4
Public transportation	3.625	45.32%	5
Traveler information	2.889	36.11%	6

Archived data management	2.000	25.50%	7
Vehicle safety	1.545	19.31%	8

The top four service areas – commercial vehicle operations, traffic management, maintenance and construction management, and emergency management -- align well with priority congestion mitigation and safety goals identified in several of the Region's Long Range Transportation Plan and other studies endorsed by the MPO.

Not surprisingly, all but eleven (11) of the 51 market packages in the first tier fall within the top four (4) service areas:

Table 4.2 Top Four Service Areas

Service Area	First Tier	Total in Service Area
Traffic Management	13	21
Commercial Vehicles Operation	11	13
Maintenance & Construction	8	10
Emergency Management	8	10

Eight (8) market packages within the Public Transportation service area and three (3) market packages within the Archived Data Management service area also are represented in the first tier. All market packages in the first tier should be considered for further evaluation.

The second tier is comprised of 19 additional market packages that may be worth further evaluation. These market packages may not be appropriate for deployment in the first five years covered by the strategic ITS plan, but may be suitable for future deployment. This tier includes eight (8) market packages within the Traveler Information service area, six (6) market packages within the Traffic Management service area, two (2) market packages within the Maintenance and Construction Management and Emergency Management service areas, and one (1) market package within the Commercial Vehicle Operations service area. Fifteen (15) market packages fall into the third tier and are not recommended for further evaluation. Eleven (11) of these market packages are classified within the Vehicle Safety service area. These market packages either involve automated highway technologies or the installation of technology in private vehicles. In many cases, successful deployment of these Vehicle Safety market packages requires simultaneous investment in infrastructure and personal technology. In both cases, the technologies required to deploy these market packages is neither proven, readily available, nor likely to be proven and readily available during the period covered by this strategic plan.

Next Steps

The information generated using this matrix analysis was only the first step of the evaluation process. The following steps included the final selection of specific market packages for quantitative evaluation, the development of an environmental screen and the quantitative evaluation of selected market strategies.

Preliminary market analysis removed 15 of 85 market packages from further consideration and identified the types of deployments that may have the greatest potential to impact the goals/planning factors identified in a variety of plans and studies. Seventy individual market packages, however, is still too large a pool to carry forward into the quantitative analysis phase. Therefore a second step of Matrix analysis was utilized.

4.2 SECOND STEP OF MATRIX ANALYSIS

The matrix analysis was approached as a two step process. The first step involved the identification of relationships between the National ITS Market Packages and the planning factors identified in the most recent federal transportation authorization statute, SAFETEA-LU. Using best professional judgment, staff and selected stakeholders assessed the direct relationship between 85 National ITS Market Packages and the SAFETEA-LU planning factors. The market packages were then sorted into three categories on the basis of cumulative impacts and 15 of the market packages were eliminated from consideration.

The second step involved the identification of relationships between the National ITS Market Packages and criteria set by staff and selected stakeholders. These criteria are more specific than the broad planning factors and introduced real constraints and externalities into the strategy selection process. As with step one of the process, best professional judgment was used to assess the strength of any direct relationship between selection criteria and National ITS Market Packages. The market packages were then sorted on the basis of cumulative impacts. Market packages that showed only a weak link with the Region's goals were eliminated. This section of the document outlines the second step of the matrix evaluation process and its results. It also identifies those strategies recommended for further evaluation.

4.3 PROCESS

Content and Structure of Matrix

As with the initial matrix analysis, this process focused on the identification of relationships between National ITS Market Packages and specified factors. To set up this process, staff and selected stakeholders needed to first identify the factors against which the remaining National ITS Market Packages would be measured. Using their knowledge of ITS, the Region, practical constraints and other externalities, the stakeholder group discussed the role of ITS in the future development of the Region's transportation network. From this discussion it became clear that ITS will play a number of roles – many of them supporting roles – in both the development of new and the enhancement of existing transportation projects. Staff and selected stakeholders determined that the factors should be used as a means of viewing ITS in relation to existing and planned projects, priorities and strategies.

Eight (8) factors were identified by the group:

- Presence of federal, state or local investment in infrastructure;
- Presence of a direct relationship between potential benefits of market package and performance measures listed in the Region's Congestion Mitigation System;
- Support for project programmed or likely to be programmed in the Transportation Improvement Program (TIP) during the next ten (10) years;
- Ability of technology to improve connectivity, promote intermodality and aid coordination;
- Ability to attract public and private capital or special grants to pay for investment in technology;
- Ability to attract and maintain political support;
- Consistency with regional ITS architectures or deployment plans implemented in adjacent regions; and
- Performance of market package in similar metropolitan areas

To create a matrix, these eight (8) factors were ordered along a horizontal axis, while ITS market packages surviving the initial screen were ordered along the vertical axis. Market packages were reviewed against each factor. The number "1" indicates a positive, direct relationship between the market package and the factor. A positive, direct relationship was found in all cases where a market package demonstrates the capability to impact achievement of the goal demonstrated by the factor, or where the market package met the condition stated in the factor. No value was entered in the absence of a direct relationship.

The next step in the process was to estimate the impacts of each market package. This estimate was produced by tallying the number of factors addressed by each market package. The results of the initial screen were combined with the results of this screen to create a cumulative score for each market package.

Prioritization of candidate strategies

Once matrix inputs and cumulative scores were identified, the next step was to reorder the market packages by cumulative score. Market packages were placed in descending order, with the highest scoring market packages at the top of the vertical axis.

Once ordered by cumulative score, market packages were grouped into three tiers. Cumulative score was one factor used to determine final placement.

Professional judgment was a critical factor: members of both the Technical Advisory Committee and peer organizations in other metropolitan areas provided technical input on the relative merit of many of the ITS market packages. The value of potential investment in each technology also was considered. Value was defined as a function of the technology's proven benefits, ability to support other deployments and interoperability with other critical systems such as communications infrastructure.

Market packages also were analyzed by service areas to compare the relative impacts of categories of deployments. National ITS architecture standards were used to group market packages into service areas. Within each service area, the cumulative scores of market packages were averaged and service areas were ranked. The ordering of service areas by potential impact also was used as a factor to refine the assignment of market packages to the first, second or third tier.

First tier market packages represent "must have" strategies. Such strategies support priority recommendations in the Long Range Transportation Plan and other studies endorsed by the MPO, address the additional goals and priorities identified by the Technical Advisory Committee described above in "1. Content and Structure of Matrix" and/or provide a foundation for or support other critical deployments. First tier strategies may be deployed in the short term as the technology is in place and the benefits are documented.

Second tier market packages are those that would benefit the region but are not ripe for deployment. These strategies support recommendations in long range plans and studies endorsed by the MPO and address the additional goals and priorities identified by the Technical Advisory Committee. Successful deployment of these strategies, however, is dependent on prior deployment of other ITS market packages and technology. Future deployment of these strategies is recommended.

Third tier market packages are those that do not address recommendations in long range plans or studies endorsed by the MPO, require deployment of technology that is not readily available, are not appropriate for deployment at the local or regional level. These market packages are not recommended for further evaluation at this time.

Once these levels of analysis were completed, best professional judgment was used to review first and second tier selections to determine which market packages should be further evaluated.

Results

Forty-five market packages were recommended for further evaluation. Generally speaking, the selected market packages support the majority of federal and regional transportation objectives and involve deployment of proven technology. As illustrated in the table below, market packages supporting traffic management, emergency management and public transportation comprise the majority of packages recommended for further evaluation. Market packages represent seven of the eight service areas.

Table 4.3 First Tier Service Areas

Service Area	First Tier	Total in Service Area
Traffic Management	11	21
Emergency Management	9	10
Public Transportation	8	8
Commercial Vehicles Operations	6	13
Maintenance & Construction	6	10
Archived Data Management	3	3
Traveler Information	2	9
Vehicle Safety	0	11

A complete summary of matrix evaluation results and priority for evaluation is available in Appendix G.

Given the clustering of market packages by service area, the 45 market packages recommended for further evaluation will be evaluated in combination rather than individually. Evaluation will be quantitative in nature and will involve assessment of cost, system performance and user benefits.

5.0 Environmental Screen

The environmental screen is the second component in the three phase assessment process. It is a qualitative assessment of the benefits and performance of ITS technologies deployed in metropolitan areas outside Connecticut. Selected areas are generally similar to the South Western Region in regards to demographics, development patterns and transportation systems. Data collection was conducted through a literature review and through telephone interviews with key personnel in the selected metropolitan areas. Data collection focused on information describing transportation needs, ITS deployments, system performance and customer satisfaction.

Five metropolitan areas were selected for review. A brief case study of each metropolitan area is presented along with the lessons learned. These lessons can help serve as guidance towards the selection of market packages for further evaluation and deployment in the South Western Region.

5.1 Selection of Comparable Metropolitan Areas

Parameters

The initial step in the process was to develop parameters for the selection of similar metropolitan areas. Relevant characteristics include demographics, travel statistics, presence of certain transportation facilities and services, geography and location. Metropolitan areas whose boundaries are co-terminus with those of a Primary Metropolitan Statistical Area (PMSA) were preferred to aid comparison of data. If suitable PMSAs are not available, individual counties within a larger metropolitan area were also acceptable.

Demographics

Demographic information was used to identify metropolitan areas with populations similar to that of the South Western Region. The United States Census was the primary source for this data.

Relevant demographic characteristics include, but are not limited to:

- Total population
- Population density
- Total number of households;
- Mean household size;
- Median household income;
- Per capita income;
- Number of residents in the workforce;
- Number of jobs;
- Poverty rate; and
- Experiencing population growth, not decline.

Travel Statistics

Examination of travel statistics enabled comparison of the travel choices made by residents of the South Western Region and selected metropolitan areas. This information was collected from a number of sources including the United States Census, long range transportation plans prepared by the designated metropolitan planning organization (MPO) and state departments of transportation.

Relevant travel statistics include, but are not limited to:

- Mean commute time;
- Mode choice;
- Percentage of households without a vehicle; and
- Commute patterns (i.e. suburb to central city, suburb to suburb, etc.).

Figures for regional vehicle miles traveled (VMT), the length (in hours) of morning evening peak periods, annual delay hours per capita, volume/capacity ratio on limited access highways, cost of congestion, and recurring versus non-recurring congestion were examine if data was available. Generally speaking, travel statistics provided the strongest basis for the comparison of metropolitan areas.

Transportation Facilities and Services

Information about the characteristics of each metropolitan area's transportation facilities and services provided context for the travel statistics. This information helped explain travel choices and demand. This information also provided a basis for the structural comparison of the South Western Region and the selected metropolitan areas. Ideally, selected metropolitan areas contained or were served by:

- A fixed guideway facility;
- No toll facilities;
- A transportation management association or similar organization;
- Local and regional bus transit services (fixed route); and
- At least one inter-modal facility.

Long range transportation plans or other transportation systems inventories prepared at the MPO or state level were the primary sources of information.

Geography and Location

Geography and location also were considered to the extent that development patterns, physical geography and climate impact availability or choice of travel options. Relevant characteristics include:

- Similar land use patterns, development, density and coverage;
- Similar topography and surface features;
- Linear geographic orientation;
- Proximity to a larger metropolitan area or central city; and
- Temperate climate.

Data sources include the United States Census, maps detailing transportation infrastructure and physical geography and land use.

Selection of Metropolitan Areas

Application of the parameters stated above yielded seven similar metropolitan areas/PMSAs: Mercer County, New Jersey / Trenton PMSA (New York-Northern New Jersey-Long Island CMSA); New Castle County, Delaware (Philadelphia-Wilmington-Atlantic City CMSA); Howard County, Maryland and

Fairfax County, Virginia (Washington, DC-Baltimore CMSA); Lake County, Illinois (Chicago-Gary-Lake County CMSA); Madison, Wisconsin MSA; and San Mateo County, California (San Francisco-Oakland-San Jose CMSA).

Five metropolitan areas – Mercer County, New Castle County, Howard County, Lake County, and San Mateo County – were chosen to demonstrate the applicability of this method. These five areas were selected for a number of reasons including similarity of demographic profiles, the presence of similar transportation facilities, similar geographies, and similar transportation needs[1].

Although total population figures vary somewhat, all six areas are characterized by similar population densities. Trenton and San Mateo experienced population growth during the 1990s on par with the South Western Region though not as strong as that experienced by the other three areas during the same period.

Table 5.1 Metropolitan Areas at a Glance

	South Western Region	Mercer County	New Castle County	Howard County	Lake County	San Mateo County
Population	353,556	350,761	500,265	247,842	644,356	707,161
Area (sq. mi.)	217.61	229.00	447.28	253.43	470.01	461.15
Density (persons/sq.mi.)	1,624.69	1,533.14	1,118.46	977.95	1,370.94	1,533.47
Population Growth 1990-2000 (%)	7.16%	7.65%	13.20%	32.30%	24.77%	8.86%

Howard County has a median household income most similar to that of the South Western Region followed by San Mateo and then Lake Counties. The other two regions have significantly lower median household incomes. All five areas have significantly lower per capita incomes. The latter figure should not be surprising given the South Western Region's exceptional personal incomes. Lake and San Mateo Counties are characterized as having a poverty rate similar to that of the South Western Region while the poverty rates in the other three areas vary.

[1] All demographic data from the Unites States Census, 2000 Census of Population and Housing, Summary File 3, unless otherwise noted.

Table 5.2 Metropolitan Area Incomes

	South Western Region	Mercer County	New Castle County	Howard County	Lake County	San Mateo County
Median Household Income	76,554	56,613	52,419	74,167	66,973	70,819
Per Capita Income in 1999	51,462	27,914	25,413	32,402	32,102	36,045
Population below poverty level	5.56%	8.65%	8.42%	3.87%	5.72%	5.83%

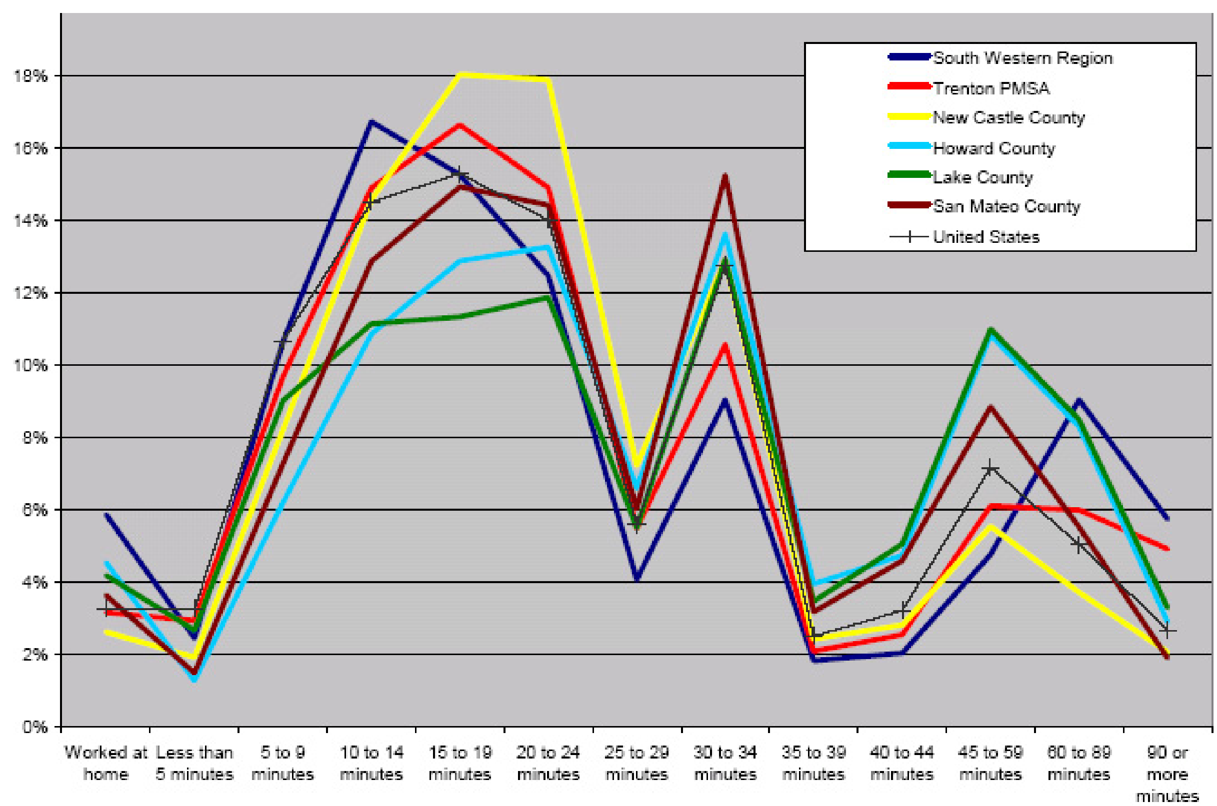
Table 5.3 Metropolitan Area Commutes

	South Western Region	Mercer County	New Castle County	Howard County	Lake County	San Mateo County
Total Workers	171,458	163,257	245,134	134,992	317,442	354,096
Drove Alone	69.10%	73.35%	78.96%	81.89%	76.36%	72.32%
Carpooled	8.40%	10.99%	10.95%	9.43%	10.18%	12.81%
Public Transportation	12.92%	6.88%	3.85%	2.54%	4.59%	7.35%
Walked or biked	3.02%	4.99%	2.94%	1.18%	3.08%	2.97%
Worked at home	5.87%	3.16%	2.62%	4.54%	4.19%	3.63%
Households with no vehicles available	6.24%	10.20%	7.65%	3.93%	4.33%	6.11%

Like the South Western Region, Mercer and San Mateo Counties are characterized as having a lower percentage of commuters who drive alone than the national average (75.7%)[2]. The percentage of commuters in carpools is roughly similar or slightly greater in all five metropolitan areas. Mercer and San Mateo Counties are characterized by a significant mode share for work trips by public transportation, notably railroad and also, in San Mateo County, subway trips. Lake County also is characterized by a large number of railroad commuters. In terms of households with no vehicle available, San Mateo and New Castle Counties are the most similar to the South Western Region while the others are somewhat disparate.

Commute times are distributed similarly in all five metropolitan areas with some notable differences. For instance, Lake, Howard, and San Mateo Counties all feature a sizable segment of commutes from 45 to 59 minutes in length with the South Western Region has the greatest proportion of commuters exceeding 60 minutes in length.

Figure 5.1 Travel Time to Work



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[2] The 2000 Census reports that nationally 75.69% of all workers commute by driving alone vs. 24.31% who use an alternate mode. Source: Unites States Census, 2000 Census of Population and Housing, Summary File 3

This pattern of ultra-long commutes may be attributed to two factors: significant congestion in or around each area and severe congestion in the central portions of adjacent central cities (i.e. New York, Washington, Chicago, San Francisco), the destination to which many of these areas' residents commute.

Table 5.4 Metropolitan Area Live/Work Data

	South Western Region	Mercer County	New Castle County	Howard County	Lake County	San Mateo County
Living in Central City (census defined)	60.61%	19.21%	17.83%	0%	6.22%	0%
Living in Remainder of are (suburb or rural area)	39.39%	80.79%	82.17%	100%	93.78%	100%
Worked in Area, in central city	42.18%	17.35%	27.35%	11.15%	17.12%	20.25%
Worked in are, outside central city	27.02%	51.53%	59.60%	57.28%	80.76%	58.48%
Worked outside area	30.80%	31.12%	13.06%	31.57%	2.12%	21.27%
Living in central city, working in central city	34.80%	7.14%	8.39%	0%	4.23%	0%
Living in central city, working in remainder of area	10.61%	8.28%	7.64%	0%	1.89%	0%
Living in central city, working outside area	15.20%	3.79%	1.80%	0%	.10%	0%
Living in remainder of area, working in a central city	7.38%	10.21%	18.95%	11.15%	12.89%	20.25%
Living in remainder of area, working in remainder of area	16.41%	43.25%	51.96%	57.28%	78.87%	58.48%
Living in remainder of area, working outside of area	15.60%	27.33%	11.26%	31.57%	2.02%	21.27%

Similar transportation facilities and services may be found in each metropolitan area. All five areas are served by a commuter rail system while San Mateo County is also served by a subway. All five areas are served by a bus system, though the operators vary from units of state government to units of county government to transit authorities.

Transportation management associations or similar organizations are present in all five areas. In New Castle, Lake, and San Mateo Counties, transportation management associations serve regions much larger than those served by comparable associations in Mercer and Howard Counties, which are area specific. Only the South Western Region does not contain any tolled roads or facilities. Mercer County contains a section of the New Jersey Turnpike, a toll road, as well as tolled bridges to neighboring Pennsylvania. New Castle County contains a tolled section of Interstate 95 and a major tolled bridge facility linking it with New Jersey. Howard County is connected to several tolled roadways leading into and around Baltimore. Lake County is bisected by the I-94 Tri-State Tollway that runs parallel to the lake shore. San Mateo County has tolls in effect on major bridges linking it with adjacent jurisdictions across San Francisco Bay.

In regards to location and geography, Mercer, New Castle, Howard and Lake Counties are located in temperate climate zones. All six areas are located adjacent to much larger central cities: New Castle County is located near Philadelphia; Mercer County is close to Philadelphia, Newark and New York; Howard County is between Baltimore and Washington; Lake County is adjacent to Chicago and Milwaukee; and San Mateo County is flanked by San Francisco and San Jose.

Similar to the South Western Region, Mercer and New Castle Counties are characterized by small-to-medium sized central cities surrounded by residential suburbs. On the other hand, Howard, Lake, and San Mateo Counties are composed mostly of suburbs and lack a strong central city. San Mateo County and the most developed portions of Wilmington-Newark and Lake County are linear in orientation. The geographies of San Mateo and Lake County are particularly similar to that of the South Western Region, with expressways, important arterials, and commuter railroads all running parallel to a coastline.

5.2 Assessment Methodology

Data collection was conducted through telephone interviews with key personnel in the selected metropolitan areas, examination of ITS planning documents when available, and analysis of ITS statistics available on US DOT's website. The interviews, conducted with leading practitioners of ITS in each selected metropolitan area, provided a valuable primary source of information and guidance.

Interviewees provided insight and experience that was not available from other sources such as ITS plans or other technical documents. Initial efforts to develop contacts in metropolitan areas focused on personnel working for metropolitan planning organizations (MPOs) and county planning and engineering departments serving the identified metropolitan areas. Each potential interviewee was contacted via phone, presented with a brief description of the overall project and the environmental screen portion, and given an option to participate. In some cases, initial contacts suggested other individuals working in their metropolitan area who they believed would be better able to provide information.

With input from the TAC, a data collection questionnaire was developed to serve as a basis for discussion with interviewees. The questionnaire covered a range of issues from a basic sketch of transportation needs in each region to experiences with post-deployment evaluations. Once the contact agreed to participate, the questionnaire and a link to the project webpage were distributed via email roughly a week in advance of the interview.

Because contacts were located around the nation, interviews were conducted by phone at a time convenient to the interviewee. Interviews lasted 20-25 minutes, slightly longer than what was anticipated during development of the questionnaire. This amount of time was sufficient to gain a good understanding of ITS activities in other metro areas but not so long as to overburden the interviewee. Following the interviews, each interviewee was sent a letter thanking them for their participation and inviting them to stay connected to the project via an email list. In two cases, interviewees were gracious enough to send along their region's ITS plans. In other cases, interviewees indicated that plan documents were available online.

Additional data was obtained from the US DOT's ITS Joint Program Office website[3]. This website makes available deployment statistics reported by various units of government in the largest metropolitan areas around the nation. Units of government reporting deployment data include municipalities, counties, local police and fire departments, transit agencies, metropolitan planning organizations, and state DOTs. All deployment statistics were accessed in December 2006 and contained data through 2004.

Unfortunately, it is difficult to make direct comparisons between the selected metropolitan areas using deployment statistics because roles and responsibilities for ITS vary across the nation. Additionally, data form some local jurisdictions is simply not available on the ITS Joint Program Office website. Therefore, deployment statistics will be used to elucidate and validate the information provided by interviewees, when appropriate.

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[3] http://www.its.dot.gov/index.htm

5.3 LEARNING FROM OTHER REGIONS

Interviewees in the five comparable metropolitan areas provided a range of responses to the questionnaire. Although the transportation needs identified (congestion, mobility) were similar in each metropolitan area, their ITS programs were varied in terms of planning methods used, roles and responsibilities, and deployment status. In spite of these variations, it seemed that ITS practitioners in the comparable metropolitan areas had dealt or were dealing with many of the same issues that face the South Western Region. The information gathered from each metropolitan area is presented below along with an assessment of the lessons learned.

Howard County, Maryland

Howard County, Maryland is a suburban area located between Baltimore and Washington, D.C. According to the 2000 Census, Howard County has a smaller population and lower density than the South Western Region with approximately similar median household income. Population growth was strong during the 1990s (+32.3%). Howard County commuters drive alone at a greater rate (81.9% vs. 69.1%) and use transit at a lower rate (2.5% vs. 12.9%) than do their counterparts in the South Western Region. Howard County is often characterized as a 'through jurisdiction' or 'in between place' with one-third of its residents working each in Baltimore, Washington, and the suburbs (including Howard County). Howard County is part of the Baltimore Metropolitan Council (BMC), an MPO serving 2.5 million people in and around Baltimore.

The initial contact in Howard County was made with the County's Department of Public Works. Upon their advice, further inquiry was directed towards Ms. Eileen Singleton at the BMC.

Ms. Singleton indicated that congestion and mobility issues had prompted the development of a strategic deployment plan. The plan, completed in 1998, was made possible with an early deployment grant from US DOT. The three highest priorities of the strategic deployment plan were traveler information, incident management, and information sharing. At the time of the interview, BMC was updating this plan under the moniker Management & Operations Strategic Deployment Plan. This plan was being developed per the recommendations of the BMC's standing ITS committee, which suggested that management and safety be the focus of future ITS planning efforts.

Ms. Singleton indicated that Howard County has only a limited number of ITS deployments. These deployments included approximately fifty traffic signals maintained by the County, signal preemption for emergency vehicles, red light cameras, and a traveler information system (NextBus) for Howard Transit, a

County supported transit service. An advanced traveler information system, originally managed by BMC, was now the responsibility of State of Maryland as part of its Coordinated Highways Action Response Team (CHART). The CHART program provides real-time traveler information, weather updates and weather related road closure information. The CHART program also includes a Statewide Operations Center hub that connects to satellite Traffic Control Centers around the state. Incident Management is coordinated at the regional (BMC) level through the Regional Operations Coordination Committee, which brings together transportation and emergency-response agencies to enhance interagency coordination.

Project selection and prioritization for the greater region was performed through a series of ranking exercises based on an established set of objectives. Objectives were defined in a User Services Plan that proceeded the ITS plan. According to the User Services objectives, a project is determined to be highly desirable for deployment if it: effectively addresses critical transportation programs; is considered easy to deploy; is cost-effective; and serves as a foundation for implementation of additional User Services. With these objectives in mind, stakeholders and BMC staff provided input at two user forums as to how User Services should be prioritized. Based on this input, User Services with the highest rankings were culled and a preliminary set of projects was developed in each identified User Service area.

This ‘unconstrained’ list of projects was then brought back to Stakeholders and BMC staff for further input and prioritization. At this level of analysis, projects are screened according to criteria deemed “important for successful deployment in the Baltimore metropolitan region” such as: continuation of existing or programmed deployment; foundation for other deployments; capital cost; operations, maintenance, and repair, and personnel cost; institutional issues; public/private partnership opportunities; and stageability. The resulting projects are considered “early winners”- “projects that have the kinds of characteristics that would make them especially desirable.

Ms. Singleton indicated that BMC had done little in terms of evaluation either before or after deployment for both Howard County and the greater Baltimore Metropolitan area. However, with a renewed focus on ITS planning under the banner of Management & Operations, it is recommended that evaluations techniques be developed. She indicated that the State of Maryland evaluates the effectiveness of its CHART program on an annual basis.

ITS Deployment Statistics for Howard County

ITS deployment statistics were available for Howard County and the Howard Area Transit Service (HATS). As of 2004, 54 of 83 signalized intersection operated by the County were under closed loop or central system control. This represents an improvement from 40 in 2002. The County estimated that 62 signalized intersections would be under closed loop or central system control by 2005. In 2004, 33 signalized intersections allowed signal preemption for emergency vehicles with 60 estimated by 2005. However, no signalized intersections allowed signal priority for transit vehicles. A total of 76 signalized intersections had electronic data collection capabilities in 2004 with 80 estimated by 2005. Data collection technologies include loop detectors (72 intersections in 2004), video detection (18 intersections in 2004), and laser detection (4 intersections in 2004). Howard County participates in regional coordination of traffic signal timing plans.

Howard County had deployed 7 dynamic message signs (DMS) by 2004 (the same number as in 2002). The County has not installed any highway advisory radio (HAR) nor does it have any CCTV capabilities. In 2005, Howard County distributed a range of information, such as incident information, special events, and road closures, to the public via the internet. Howard County does not have a traffic operation center or traffic management center (TOC/TMC). The County does have electronic devices to collect pedestrian data, specifically, a video imaging system. The County does have a traffic signal plan for inclement weather. Operational data collected from ITS elements is archived for 5 years as raw data in a computer database. Data collected in 2004 includes traffic volumes, traffic speeds, vehicle classification, turning movements, and incidents. Of that list, only traffic volume, turning movements, and incidents are archived. Data is used for traffic analysis, capital planning/analysis, traffic management, and safety analysis.

As of 2004, all of HATS' 24 fixed route buses and all 22 demand responsive vehicles used in revenue service were equipped with automated vehicle location (AVL) technology. HATS does not have an advanced traveler information system (ATIS). In 2004, HATS disseminated transit routes, schedules, and fare information to the public via a website, email or other direct PC communication, monitors/DMS (not in vehicles), and live agents. HATS disseminated real-time transit schedule adherence or arrival and departure times to the public via the internet, email or other direct PC communication, and monitors/DMS (not in vehicle). Although deployment of electronic display of automated and dynamic traveler information to the public was planned for 2005, there was no record of deployment in 2004. HATS vehicles do not have the ability to preempt traffic signals. HATS does not have vehicles equipped with magnetic stripe or smart card readers, although deploying smart card readers on all fixed route buses was anticipated in 2002. HATS' radio system is both digital and trunked. HATS is a partner in a joint interoperable system with local public safety agencies. As of 2004, HATS collects data on vehicle time and location (not electronically) for use in measurement of performance but does not archive the data.

Lessons Learned

There are few lessons to be learned from Howard County. As compared to the other metropolitan areas surveyed, Howard County had done comparatively little to plan, design, and deploy ITS applications. The State seemed to be the main actor in regards ITS improvement with little interest exhibited by the County. This circumstance may derive from the fact that Howard has a smaller population than its more urban neighbors and is perceived as a 'through jurisdiction', thereby necessitating a greater role to play for the State. The BMC's ITS Early Deployment Plan withstanding, ITS deployment in Maryland seemed to be a top down exercise with little direct input or participation by the County. Those contacted spoke highly of other, larger jurisdictions (Montgomery County, Baltimore City) as examples of best practice of ITS deployment in Maryland. Despite this, Howard County reported a small but significant number of ITS deployments, at least in comparison to the other metropolitan areas examined. One best practice to take from this analysis is the effort by the BMC to integrate ITS planning with Management and Operations planning. This means that ITS is conceived of as part of a broader, system-based perspective.

Lake County, Illinois

Lake County, Illinois is a suburban area located north of Chicago and within a commuting distance south of Milwaukee. According to the 2000 Census, Lake County had roughly an 80% larger population but was 15% less dense than the South Western Region with a somewhat lower median household income ($66,973 vs. $76,554). Population growth was strong during the 1990s (+24.7%). Lake County commuters drive alone at a greater rate (76.4% vs. 69.1%) and use transit at a lower rate (4.6% vs. 12.9%) than do their counterparts in the South Western Region despite good commuter rail service connecting Lake County to Chicago. Lake County is overwhelmingly suburban with no major cities or central places. The densest portion of the county is found along a corridor of expressways, arterials, and commuter rail lines adjacent to the lakefront. Lake County is part of the Chicago Area Transportation Study (CATS), an MPO serving 8.2 million people in the Chicago area.

The initial contact in Lake County was made with the County's Division of Transportation. Mr. Anthony Khawaja, the County's Traffic Engineer, was very willing to share his expertise on ITS planning and deployment. He indicated that the County Board had defined congestion as its top transportation priority while also recognizing that simply widening roads was a difficult and costly solution. Instead, the County looked to ITS to address the congestion issue. As Mr. Khawaja put it, the County Board wanted "more green time at lights." Planning for ITS deployments took the form of feasibility study based on an inventory of existing facilities, an assessment of available technology given financial constraints, and input from relevant stakeholders. The key initiative to result from the feasibility study was deployment of a system to tie in all traffic signals in Lake County and creation of a central operations office to control the system. The deployments are branded as 'Lake County Passage' (http://www.lakecountypassage.com/index.jsp).

The Lake County Passage project includes an extensive list of ITS deployments. Among them are: traffic signal coordination and management, closed circuit television (CCTV), 24-7 traveler information systems, highway advisory radio, variable message signs, emergency and transit vehicle preemption at traffic signals, data sharing between the County Transportation office and Sheriff's office in support of computer-aided dispatching (CAD) of emergency vehicles, and data archiving and sharing within the greater metropolitan area. The goal of the system is to tie in all traffic signals in Lake County no matter the operator (municipal, county, state). With centralized control, Lake County will have the ability to monitor the system and modify signals in the event of an incident. Mr. Khawaja indicated that the new system had already improved the efficiency of the County engineers' operations; engineers can study intersections from CCTV instead of the field and visit more sites in a day than they did previously.

Lake County has been the project leader for this effort, working cooperatively with other key agencies and jurisdictions through memoranda of agreement. Lake County Passage went live several weeks before the interview, although deployment of ITS features has been an ongoing, incremental process over a long period of time. ITS deployment are integrated into Lake County's regular capital replacement program. As traffic infrastructure (such as traffic signals) reaches the end of its lifecycle, it is replaced with ITS compatible technologies. Data archiving, sharing, and broadcasting is administered by the Gary-Chicago-Milwaukee ITS Priority Corridor, a collaboration between the Indiana, Illinois, and Wisconsin DOTs.

Funding for the Lake County Passage program has come from a combination of local (50%) and Federal (50%) funds. A portion of local funds were obtained via a voter approved 0.25% sales tax hike. This funding made possible the two most important elements of Lake County Passage: a gigabit information network to tie in the traffic signals and other ITS elements and a new central traffic control facility. As was described above, many ITS elements were deployed as part of the County's routine replacement of its physical plant.

Mr. Khawaja indicated that Lake County had done a limited amount of evaluation in preparation for deployment of the system. A probe vehicle was used to record pre-deployment travel times to serve as a control. However, the County has yet to do any post-deployment travel time runs. Mr. Khawaja emphasized that many of the benefits from ITS deployments are difficult to evaluate and may not produce favorable results in a cost-benefit analysis. Improvements are difficult to put firm metrics on as they often result in only "split second improvements" that the individual motorists cannot perceive. Mr. Khawaja further asserted that one should not try to "oversell a project" because ITS improvements are "not magic bullets" that reduce congestion. He added that capacity problems are just that, and there's little that ITS can do to relieve those situations. The Lake County Passage project went live in February 2006 and was still in testing mode at the time of the interview, so no formal evaluations had been conducted. This being the case, Mr. Khawaja did seem satisfied with the new system in terms of the County's operations. He explained that the County's traffic engineers can now respond immediately to malfunctioning signals and that they can now visit more sites in a day than they did previously.

ITS Deployment Statistics for Lake County

ITS deployment statistics were available for Lake County. As of 2004, 90 of 123 signalized intersections operated by the County were under closed loop or central system control. This represents an improvement from 77 in 2002. The County estimated that 100 signalized intersections would be under closed loop or central system control by 2005. A total of 111 signalized intersections allowed signal preemption for emergency vehicles with 123 estimated by 2005. However, no signalized intersections allowed signal priority for transit vehicles. A total of 123 signalized intersections had electronic data collection capabilities in 2004 with 135 estimated by 2005. These figures imply that all signalized intersections in Lake County have or will have electronic data collection capabilities. Data collection technologies include loop detectors (93 intersections in 2004) and video detection (30 intersections in 2004). Lake County participates in regional coordination of traffic signal timing plans.

Lake County has deployed neither DMS nor HAR but anticipated deploying HAR along 500 centerline miles of highway by 2005. The County has CCTV coverage of 50 centerline miles with coverage of 80 centerline miles anticipated by 2005. Lake County reported distributing transportation and traffic information to the public via a website. By 2005, Lake County anticipates distributing a range of information to the public including: arterial travel times and speeds, incident information, work zone/construction events, road surface conditions, road closures, detours, road restrictions, congestion, CCTV images, travel and tourist information, and real-time construction information. In 2004, the County did not operate a TOC/TMC, although Mr. Khawaja indicated that a TOC/TMC was one of the more important elements of the recently completed Lake County Passage projects. Lake County reported employing a number of electronic technologies to improve the safety and mobility of pedestrians, including countdown pedestrian signals, automatic pedestrian detection, and in-roadway flashing lights. Lake County does not have a traffic signal plan for inclement weather. Operational data collected from ITS elements has been archived for the past fifteen years. Data collected and archived in 2004 includes traffic volumes, traffic speeds, lane occupancy, and vehicle classification. Data, which is stored as raw data in a computer database, is used for traffic analysis.

Lessons Learned

By all accounts, Lake County is an example of best practices in terms of ITS project development and deployment. The County's ITS deployments are thorough and comprehensive. Their broad scope demonstrates a high level of collaboration among stakeholders at many levels (municipal, county, and state transportation offices, emergency responders, transit agencies, elected officials, and the commuting public). Integrating ITS deployment with the County's regular replacement of existing infrastructure is a sound planning and financing strategy. Early notification of signal problem or traffic incidents means a faster response, which should decrease delays. Evidence of sophisticated ITS deployments is also seen in Lake County's ITS deployment statistics. It is clear from both the phone interview and the deployment statistics that Lake County has made significant progress towards comprehensive ITS deployment.

Unfortunately, Lake County had not done or could not provide much information regarding their project selection and evaluation process. However, the suggestions to not expect overwhelming benefits or oversell ITS projects to the public are well noted. Lake County Passage was recognized as the 2005 Public Sector Project of the Year by the ITS Midwest chapter.

Mercer County, New Jersey / Trenton PMSA

Mercer County in New Jersey is located between Philadelphia, Newark, and New York City. Mercer County is composed of a central city (New Jersey's capital), Trenton, and its surrounding suburbs. The boundaries of Mercer County are conterminous with those of the Trenton PMSA. According to the 2000 Census, Mercer County had similar population and density as does the South Western Region but a lower median household income ($56,613 vs. $76,554). Population growth in Mercer County during the 1990s was on par with growth in South Western Region (7.65% vs. 7.16%). Mercer County commuters drive alone at a greater rate (73.4% vs. 69.1%) and use transit at a lower rate (6.9% vs. 12.9%) than do their counterparts in the South Western Region despite the presence of a dense, older central city (Trenton) and commuter rail service to New York and Philadelphia. Mercer County is an example of an older, industrial northeastern city with a economically depressed, dense core surrounded by newer, wealthier, and less dense suburbs. Mercer County is part of the Delaware Valley Regional Planning Commission (DVRPC), an MPO serving 5.4 million people in and around Philadelphia.

The initial contact for Mercer County was made with Mr. Stan Platt, Manager of Transportation Operations at DVRPC, who expressed a willingness to participate. He indicated that the most pressing transportation issues identified in the greater region are incident management, construction and special event coordination, basic information sharing, and corridor management. Of specific importance within Mercer County is corridor management on parallel limited access facilities and traffic congestion on arterials. Sharing information, especially regarding construction, is a critical need because of the number of different localities and jurisdictions with responsibility for the transportation system. Coordination among the many and varied public entities is also an important impetus behind incident management.

In order to evaluate which ITS deployments were best for the overall region, an ITS technical advisory committee evaluated deployments hierarchically by service area and market package based on stated transportation needs. The committee first examined which service areas were most important or in greatest demand based on a set of criteria. Within each ranked service area, further ranking yielded a prioritized list of market packages that were most suitable for deployment. The service areas with highly ranked market packages included emergency management, incident management, and transit. On the other hand, deployments outside the purview of the interviewee’s agency, such as commercial vehicle and in-vehicle systems, were given low priority.

Mr. Platt indicated that there were limited ITS deployments in Mercer County. The New Jersey Department of Transportation, the implementing agency, had applied an ITS treatment to two major arterial corridors, consisting of closed circuit television, variable message signs, roadway weather information systems, and a fiber backbone along the routes to tie in all components. According to DVRPC planning documents, additional coverage on other routes is anticipated in the future. Mr. Platt also indicated that the City of Trenton maintained a closed loop traffic control system. An emergency service patrol is active in the Mercer County; however, the scope of the service is statewide. An evaluation of the impacts from ITS deployment was not part of the initial planning effort. Mr. Platt indicated that spotty deployment of ITS facilities both in Mercer County and in the larger metropolitan area makes any comparison to a control example more difficult. The marginal improvement derived from a deployment may be too subtle either to detect or to prove the worth of the deployment. A lack of data gathering devices also makes it difficult to analyze impacts derived from ITS deployments.

ITS elements have been implemented as part of larger projects in both Mercer County and the larger metropolitan area. ITS projects are often perceived as too expensive or of little interest to many policy makers. Therefore, there is little will to implement ITS elements as standalone projects. According to Mr. Platt, it is often the case that ITS elements are dropped from larger projects (along with bicycle and pedestrian elements) for cost savings. It was also noted that ITS deployments have significant maintenance costs in addition to capital costs, which make them more difficult for a jurisdiction to support and therefore less desirable. High cost maintenance items include high-speed communications networks and personnel required to man operations centers and service patrols. Mr. Platt added that to just state the capital cost of ITS deployments would be misleading.

ITS Deployment Statistics for Mercer County

ITS deployment statistics were available for the City of Trenton and Mercer County. As of 2004, 2 of 86 signalized intersections operated by the City of Trenton and none of the 123 signalized intersections operated by Mercer County were under closed loop or central system control. Only 6 signalized intersections in either the City of Trenton or Mercer County were estimated to be under closed loop or central system control by 2005. A total of 4 signals in the City of Trenton and 50 in Mercer County allowed signal preemption for emergency vehicles in 2004. No signalized intersections in either jurisdiction allow signal priority for transit vehicles. No signalized intersections in either jurisdiction had electronic data collection capabilities in 2004 although Mercer County estimated that 6 of its intersections would have this capability by 2005. The data collection technologies estimated to be employed were not specified. Neither jurisdiction reported participating in regional coordination of traffic signal timing plans.

Neither the City of Trenton nor Mercer County reported any HAR, DMS, or CCTV deployments. The City of Trenton did not distribute traffic information to the public while Mercer County employed email or other direct PC communication and anticipated using a website in 2005. In 2004, Mercer County distributed a range of information to the public including: work zones/construction events, road closures, detours, and alternate routes. In 2004, neither the City of Trenton nor Mercer County reported operating a TOC or TMC. Mercer County reported employing a number of electronic technologies to improve the safety and mobility of pedestrians, including countdown pedestrian signals, in-roadway flashing lights, and pedestrian-activated flashing beacons. Neither the City of Trenton nor Mercer County has a traffic signal plan for inclement weather. Neither the City of Trenton nor Mercer County collected operational data from ITS elements. However, Mercer County indicated it plans to begin archiving data within the next two years, including traffic volumes, vehicle classification, turning movements, and queues. It was anticipated that this data would be used for operation planning/analysis, traffic simulation modeling, and travel time prediction.

Lessons Learned

Despite the presence of several important transportation facilities and its prominent role as the state capital, Mercer County provided few examples of ITS planning or deployment. As in Howard County, the state seemed to be the main actor in ITS deployment with little notable effort from either the county or municipalities. Based on the reported deployment statistics, there appear to be few ITS deployments in Mercer County. No evaluation of impacts from ITS deployments had been performed by either DVRPC or other agencies. ITS did not appear to be a high priority for the larger metropolitan area as evidenced by Mr. Platt's observation that ITS elements are often dropped from projects to save on costs. The statement that spotty deployments are difficult to measure could also be understood to mean spotty deployments yield limited benefits. It might also be understood to mean focusing ITS deployments on a specific location can yield more substantial benefits. The use of a methodology to select market packages for deployment is one of the more positive lessons to be learned. Hierarchical ordering first by service area and then by market package based on a set of criteria seems to be a reasoned method for prioritizing deployment.

New Castle County, Delaware

New Castle County, Delaware, comprising the northern third of the state, is located within commuting distance of Philadelphia. The northern portion of New Castle County is heavily developed with two large central cities, Wilmington and Newark, and their surrounding suburbs. The southern portions of the county can be characterized as more exurban and rural. According to the 2000 Census, New Castle County had a roughly 40% greater population and was 30% less dense than the South Western Region. Median household income was lower than in the South Western Region ($52,419 vs. $76,554) and lowest among all metropolitan areas examined. Population growth in New Castle County during the 1990s was greater than that experienced in the South Western Region (13.20% vs. 7.16%). New Castle commuters drive alone at a greater rate (79.0% vs. 69.1%) and use transit as a lower rate (3.9% vs. 12.9%) than do their counterparts in the South Western Region. Similar to Mercer County, New Castle County is an example of an older, industrial, region composed of older, denser central cities surrounded by newer, wealthier, and less dense suburbs. New Castle County is part of the Wilmington Area Planning Council (WILMAPCO), an MPO serving 600,000 people in and around Wilmington.

The initial contact for New Castle County was made with Mr. Dan Blevins, a senior planner at WILMAPCO, who expressed a willingness to participate in this effort. He indicated that the most pressing transportation needs in the region were congestion management, safety issues, and supporting economic development (freight movement). Through the lens of its congestion management systems (CMS) study, WILMAPCO has quantified congestion on key corridors. It is the hope of WILMAPCO that shifting trips to other modes will help alleviate congestion in these corridors. Among the solutions prescribed are improved transit service, park-and-ride facilities, ITS deployments, and better intersection design.

Delaware has a unique organizational structure in that the Delaware Department of Transportation (DelDOT) maintains nearly every road in the state as well as associated ITS elements in unincorporated areas. Incorporated places, such as the City of Wilmington, maintain their own local roads and associated ITS facilities, mostly signals and fiber optic networks. Examples of ITS elements currently deployed in New Castle County include fiber optic backbones, centralized traffic control, closed circuit television, highway advisory radio, and variable message signs. Mr. Blevins indicated that many ITS elements were deployed as standalone projects. He added that DelDOT emphasized integrating existing deployments with fiber optic backbones rather than retrofitting the entire transportation system. Support for ITS improvements has come from a combination of State and Federal matching funds. At this time, state and local agencies do not share ITS data nor do they anticipate doing so in the future.

In order to determine whether ITS deployments would benefit a congested corridor, WILMAPCO makes a thorough study of the corridor including intersections. Evaluation factors include roadway level of service, travel speed in comparison to design and posted speed, intersection level of service, and transit level of service. ITS treatments are then proposed based on results of the analysis. No post deployment evaluation has been conducted so far by either WILMAPCO or DelDOT but anecdotal evidence suggests that ITS treatments do improve corridor operations. Public opinion surveys regarding ITS improvements have yielded inconclusive results, with most respondents claiming not to have an interest in ITS. Stated another way, ITS deployments may have had an impact on travel in New Castle County but the traveling public does seem to notice or be aware of these impacts. Without public knowledge of and demand for ITS improvements, there is less political pressure to develop ITS projects.

ITS Deployment Statistics for New Castle County

ITS deployment statistics were available for the City of Wilmington. As of 2004, 6 of 268 signalized intersections operated by the City of Wilmington were under closed loop or central system control. It was estimated that 50 signalized intersections would be under closed loop or central system control by 2005. The City of Wilmington reported that none of its signalized intersections allow preemption for either emergency or signal priority for transit vehicles. It was estimated that 6 signals would allow signal preemption for emergency vehicles in 2005. A total of 243 signalized intersections had electronic data collection capability with full coverage of all 272 intersections estimated by 2005. The electronic data collection technologies in use were not specified. The City of Wilmington does not participate in regional coordination of traffic signal timing plans.

The City of Wilmington reported that neither HAR nor DMS nor CCTV had been deployed. The City of Wilmington did not report distributing transportation and traffic information to the public nor did it report operating a TOC or TMC. The City of Wilmington does not have any electronic devices to collect pedestrian data nor does it have a traffic signal plan for inclement weather. The City of Wilmington does not archive any operational data from ITS elements not does it plan to begin to do so.

Lessons Learned

The approach towards ITS planning in New Castle County is notably different than in the other metropolitan areas examined. Instead of prioritizing projects for a large geographic area by service area or market package as the others areas have done, ITS deployments in New Castle County are ordered and prioritized by corridor. Identification of corridors in need of ITS deployments is based upon the region's congestion management system. The feasibility of ITS deployment is determined by the physical and operational characteristics of the corridor rather than a collaborative process among stakeholders. Some of the characteristics considered are roadway level of service, travel speed in comparison to posted or design speed, intersection level of service, and transit level of service. Another important point was the relative knowledge of and interest in ITS improvements among the general public as evidenced by public opinion surveys. As described in other metropolitan areas, officials in Wilmington noted that it was difficult for the traveling public to perceive of the marginal improvements from ITS deployments. This situation may be indicative of a need to better inform the traveling public of the role of and benefits to be derived from ITS.

San Mateo County, California

San Mateo County, California is located on the peninsula between San Francisco and San Jose. The most developed portions of San Mateo County are found along the road and rail corridor linking San Francisco and San Jose. The remainder of the county has a more exurban character or is protected open space. According to the 2000 Census, San Mateo County had double the population of but a similar density to the South Western Region. Median household income was only a bit lower than in the South Western Region ($70,819 vs. $76,554). Population growth in San Mateo County during the 1990s was on par with that experienced in the South Western Region (8.9% vs. 7.1%). San Mateo commuters drive alone at a greater rate (72.3% vs. 69.1%) and use transit at a lower rate (7.6% vs. 12.9%) than do their counterparts in the South Western Region, although these figures are the lowest and the highest, respectively, among all comparable metropolitan areas. San Mateo County lacks an established central city and might be best characterized as a modern, dispersed, suburban corridor with some strong activity centers. San Mateo County is part of the Metropolitan Transportation Council (MTC), an MPO serving 6.8 million people in and around San Francisco.

Initial contact was made with the MTC, who advised that further inquiry should be directed towards Ms. Sandy Wong at the San Mateo County Department of Public Works. Ms. Wong indicated that congestion relief, increasing transit's mode share, coordination between motorized and non-motorized traffic, and resolving conflicts on major arterials were identified as the most important transportation needs in San Mateo County according to the Countywide Transportation Plan completed several years ago. Recommendations from this plan are being implemented thanks to a voted-approved 0.5% sales tax increase that goes to fund transportation improvements. The County recently completed an ITS strategic plan with the recognition that "ITS offers the opportunity to make more efficient use of existing transportation facilities and services."

San Mateo County's ITS Strategic Plan began by defining a countywide ITS vision. This vision was divided into ITS system areas, including freeway management, arterial management, transit management, traveler info, incident management, and supporting elements. Within each system area, San Mateo engaged stakeholders to further develop this vision and identify specific ITS deployments and key locations. For instance, outreach for the freeway management program was directed at Caltrans and the MTC while outreach for transit management program was directed at the various transit agencies serving San Mateo County. Stakeholders began evaluating the list of market packages by dismissing those that were either not applicable to the County or not in the purview of the stakeholders. The remaining market packages were prioritized from high to medium to low based on a ranked set of needs. The stakeholders performed the ordering of needs and ITS deployment opportunities collaboratively.

Among the more important ITS deployments implemented as a result of the ITS Strategic Plan was ramp metering along US 101 and I-280, the principal routes both within the County and between San Francisco and San Jose, as well as associated improvements on connecting roads. Ramp meters are being deployed along sections of expressway rather than one ramp at a time. It was anticipated that the first phase of ramp meters would begin operating by the end of 2006. Ms. Wong indicated that it took a long time to sell the concept of ramp metering to local communities, who were concerned about spillback from the expressway onto local roads. The County diffused these concerns by deploying spillback detectors on each ramp and by promising to monitor and evaluate conditions before and after implementation.

In addition to ramp meters, a variety of ITS elements are currently being deployed in San Mateo County. The County is working with Caltrans to coordinate all signals in the US 101 corridor and tie them into municipal control centers. While no countywide control center is anticipated, all local centers will tie into Caltrans master traffic center. It is anticipated that these traffic control centers will improve incident management response. The San Mateo County Transit District (Samtrans) has deployed automatic vehicle location systems on some bus routes and is working on deploying on-board electronic information systems. Samtrans has also benefited from transit vehicle priority that was deployed along with the upgraded traffic control systems in the US 101 corridor. Electronic displays have been deployed on platforms at the Millbrae station, one of the county's principal multimodal facilities.

In addition to programmed federal dollars, ITS deployments (as well as other transportation improvements) in San Mateo County are funded from a voter approved 0.5% sales tax hike. In fact, voters have recently approved a forty-year extension of the sales tax hike to continue paying for transportation improvements. This funding stream also includes a small pot that can be used for future ITS studies. ITS elements are implemented as components of all highway improvement projects rather than as standalone projects. Little evaluation was done before or since deployment of ITS elements. As indicated above, some monitoring is proposed in order to assuage local community concern about spillback on local arterials from ramp metering. However, Ms. Wong indicated that results from ramp metering have been positive so far. Some evaluation may be performed in the future based on efforts in nearby jurisdictions. However, because individual ITS deployments result in only marginal benefits, it would be difficult to evaluate what has been recently deployed, which represents only small parts of a larger system.

ITS Deployment Statistics for San Mateo County

Unfortunately, no ITS deployment statistics were available for San Mateo County roadways. However, ITS deployment statistics were available for the San Mateo County Transit District (Samtrans). As of 2004, Samtrans reported that all 317 fixed route vehicles used in revenue service were equipped with automated vehicle location (AVL) technology, mobile data terminals, and automated dispatching or control software available. In addition, 80 fixed route vehicles used in revenue service were equipped with automatic passenger counters.

Samtrans has an advanced traveler information system (ATIS) deployed on all its fixed route revenue service vehicles. Samtrans reported disseminating transit routes, schedules, and fare information to the public via the internet, kiosks, DMS (in vehicle), monitors/DMS (not in vehicle), and audible enunciators. Samtrans disseminated real-time transit schedule adherence or arrival and departure times to the public via kiosks, in-vehicle navigation systems, DMS (in vehicle), and audible enunciators. Of Samtran's 2,500 bus stops, 15 electronically display or will in the future display automated and dynamic traveler information to the public.

Although no fixed route buses had traffic signal priority capability in 2004, it was estimated that 5 buses would have such capability in 2005. Samtrans reported that other transit agencies in the metropolitan area use the same electronic fare payment system. Samtrans' radio system is both analog and regular. Samtrans does not have a direct means of communicating with public safety agencies via its mobile communication system and is not considering adding the capability of interoperability with public safety agencies. As of 2004, Samtrans reported collecting data on vehicle time and location, passenger count, passenger information, vehicle monitoring status, and incidents in real time. Only vehicle time and location, passenger count, and incidents are archived. No information is collected or archived electronically. Collected data is used for operation planning/analysis, capital planning/analysis, and measurement of performance.

Lessons Learned

San Mateo County is notable for the variety of ITS elements deployed and its track record of implementation. Freeways, arterials, and transit all benefit from elements currently deployed or in development including ramp meters and coordinated traffic control systems as well as transit vehicle priority and on-board traveler information systems. The ability to implement such a broad range of elements, as is evidenced by Samtrans' reporting of ITS deployment statistics, is in no small part due to a dedicated funding source beyond what is available from federal and state formula grants. What is less notable about San Mateo County is its use of pre- or post- deployment evaluation. Quantitative evaluation of ITS elements seemed to be missing from their otherwise comprehensive planning process. Instead, planning identified overarching strategies leaving specifics to future efforts.

5.4 LEARNING FROM CENTRAL CITIES

While a direct comparison of the selected metropolitan areas is not feasible given the limits of the ITS deployment statistics data, it is possible to make a comparison of some of the central cities within the selected metropolitan areas. Data was available on at least one city in all of the selected metropolitan areas except Howard County. Data was available for Trenton (Mercer County), Wilmington (New Castle County), Waukegan, (Lake County), and Redwood City (San Mateo County) as well as for Norwalk and Stamford (South Western Region). A quick examination of several of the Census tables used in the *Parameters* section revealed that these cities were roughly comparable in terms of demographics and travel statistics.

Despite these demographic similarities, an examination of the ITS deployment statistics for each city reveals some marked differences. For instance, even though all the cities have roughly similar population size density (with the exception of Trenton), the number of signalized intersections varies significantly. For example, Waukegan reported that the city has 26 signalized intersections while Wilmington, which has a smaller population, reported 268 signalized intersections. These differences may in part be attributed to issues of jurisdiction in each city. A higher level of government may operate some of the signalized intersection or other ITS elements, which therefore would not be reported by the city. With that caveat in mind, it is possible to draw some conclusions. For one, only Redwood City reported as high a percentage of signalized intersections under closed loop control as did either Norwalk or Stamford. Norwalk and Stamford reported a greater percentage of signals that allow preemption for emergency vehicles than did other cities. Norwalk is the only city to indicate that it has signals that allow priority for transit vehicles. Both Wilmington and San Mateo reported a much greater percentage of signalized intersections with electronic data capability than did either Norwalk or Stamford.

Interesting, none of the cities reported that they had deployed any DMS or HAR and Stamford was the only city to report CCTV capabilities. Redwood City was the only city besides either Norwalk or Stamford to indicate that it disseminated information to the public about traffic conditions. Redwood City was also the only city besides Norwalk and Stamford that reported it operated a traffic operations center/traffic management center (TOC/TMC). Only Redwood City reported they it employed any electronic devices to improve the safety and mobility of pedestrians. None of the cities reported the presence of a traffic signal plan for inclement weather or slick pavement. Only Norwalk and Stamford indicated that they collect operational data for ITS elements. Both communities reported collecting an assortment of data, including traffic volume and emergency vehicle signal preemption.

Based on this data alone, it would seem that Norwalk and Stamford have more advanced ITS programs that do the cities in comparable metropolitan areas. However, as was noted previously in this section and in the individual examinations of metropolitan areas, there are many actors who play a role in ITS operations. For instance, in Lake County, the County has taken the lead and has been responsible for much of the implementation of the Lake County Passage project. Therefore, it should not be a surprise that the City of Waukegan reported only a limited amount of ITS deployment. Nevertheless, the conclusion to draw from this data may be that municipalities must play a significant role in any ITS deployment strategies in the South Western Region.

Assessment

Based on experiences with ITS planning and deployment in comparable metropolitan areas, the following recommendations should be given due consideration:

- *Engage stakeholders and seek high-level collaboration.* All metropolitan areas examined had a variety of important stakeholders involved, from units of local government to state department of transportations to transit agencies to emergency service providers. The most successful efforts engaged a full range of stakeholders who collaborated in the project through formal agreements.
- *Project selection derives from predetermined criteria and is ordered on multiple levels.* The most sophisticated project selection methods ranked ITS elements by identified needs, which were themselves ranked. Ranking is done on several levels, beginning with transportation needs, followed by service area, and finally by market packages.
- *Project selection should include location as a consideration.* One of the more intuitive project selection methods was that in use by WILMAPCO in New Castle County. They begin by examining the deficiencies along a corridor and then choosing the market package(s) that best address the identified issue(s). Examining corridors individually obviates the need to engage in the intensive process of developing and sorting through a laundry list of ITS deployments that are applicable region-wide. This method was also notable because it directly ties into WILMAPCO's Congestion Management System.
- *Benefits from ITS deployments are marginal and often imperceptible to the traveling public.* Given the incremental approach to ITS deployments in many areas, the benefits derived from ITS deployments may not result in any immediate improvements. As one of the respondents put it, ITS is not a magic bullet and will not solve all of an area's transportation needs. ITS proponents are well advised not to oversell projects to the general public or to expect much public demand for these sorts of improvements. Many of the respondents cited spotty, incremental deployment and marginal benefits as disincentives/detriments to sophisticated evaluation of ITS deployments.
- *Plan for pre- and post-deployment data collection to enhance understanding of the effects of ITS deployments.* All respondents noted that there had been little pre- or post-deployment data collection associated with either their strategic planning or their deployment efforts. As a result, there was little evidence

available for use in evaluating their strategies. Therefore, respondents could only speak of the impacts of ITS deployments in qualitative terms. Despite the notion that ITS deployment may not result in dramatic impacts on the transportation system, data collection for the purpose of evaluation is a worthwhile exercise.

- *ITS plays a critical role in transportation systems management and operations.* The objective of transportation systems management and operations is to optimize the performance of and address concerns regarding the transportation system given financial and physical constraints on the system. ITS is an important component of transportation system management and operations strategies and help make better use of exciting facilities.
- *ITS elements should be incorporated into all projects rather than deployed as stand-alone projects.* Those metropolitan areas with the most advanced ITS capabilities also had regular capital replacement programs that included ITS. Deploying ITS elements as part of a regular capital replacement program obviates the need for capital-intensive retrofitting of existing facilities. Deploying ITS elements as part of regular capital replacement cycles or as portions of larger projects helps also to decrease the marginal costs associated with deployment. Stand alone ITS projects often have higher costs and little public or political support.
- *ITS projects take on a greater important when there is a champion within the metropolitan area.* Areas with limited ITS developments did not appear to have dedicated staff resources to guide planning or implementation. Instead, these areas relied on higher levels of government, mostly state departments of transportation, who have a much broader focus and who may not assign priority to improvements in specific metropolitan areas. In contrast, those areas with well developed ITS programs had an identifiable local champion to promote the concept and move projects towards implementation. Presence of a champion appears to help create a culture of support for ITS in a metropolitan area.

5.5 Environmental Screen Conclusion

The environmental screen yielded a number of important lessons that will help inform strategic ITS planning in the South Western Region. These lessons are based upon the information provided by respondents in metropolitan areas comparable to the South Western Region as well as a literature review of planning documents developed by the respondents and their agencies and ITS deployment statistics available on the FHWA's website.

Many of the recommendations presented in the *Assessment* can help inform SWRPA's efforts to develop an ITS Strategic Plan and deployment strategy for the South Western Region. To begin with, SWRPA should continue to **engage stakeholders** and should **seek out high-level collaboration**. This means continued dialogue with municipalities and transit agencies in the region as well as important actors at other levels (Connecticut state agencies, neighboring jurisdictions). SWRPA should continue to refine the list of market packages for further analysis following its current, well-reasoned method. This method will yield a good, generalized list of market packages that can be thought of as a toolbox for deployment.

Adding **location as a consideration to project selection** will help to further refine a deployment strategy for the South Western Region by applying the correct tools from the toolbox to the corridor or location where a deficiency has been identified. Data collection, analysis, and evaluation should also be an integral part of SWRPA's ITS deployment strategy. Though none of the metropolitan regions examined had developed much of a data collection or evaluation program, several of them indicated that they planned on doing so as part of their future ITS program. **Pre- and post-deployment data collection** would serve as the basis for future evaluations of the deployment strategies, which will help SWRPA make the case for ITS deployments to policy makers and the public. At the same time, SWRPA must make reasoned arguments and recommendations for its deployment strategies and **make sure to not oversell benefits of ITS or conceive of it as a magic bullet**.

ITS deployments can play **a critical role in transportation system management and operation**. Given the fiscal and physical constrains to any major expansion of the transportation system in the South Western Region, strategic deployment of ITS elements represents one of the best strategies to optimize system performance and enhance traveler satisfaction. SWRPA should encourage the deployment of **ITS elements as integral components projects rather as stand alone projects** through its regular transportation planning activities. To the South Western Region's advantage, it appears that Norwalk and Stamford are already developing comprehensive ITS programs, especially in comparison to the other central cities examined.

SWRPA can help serve as a **champion for ITS deployment** in the region and help create a culture of ITS. Although not an implementing agency, SWRPA can serve an important role recommending ITS strategies to the Region's chief elected officials and working with its stakeholders to promote best practices in ITS deployment and support transportation improvement projects for funding. The final recommendations that emerge from the *South Western Region ITS Strategic Plan* should serve as an excellent foundation to a more developed ITS program in the South Western Region.

6.0 Project Development and Preliminary Budget Estimates

This section of the document will provide a brief background on existing ITS equipment and infrastructure in the South Western Region. Based on a list of ITS strategies developed by SWRPA in consultation with the South Western Region ITS Technical Advisory Committee (TAC), this section of the document develops preliminary project descriptions for implementation of these strategies. Furthermore, it will develop preliminary, order of magnitude, planning cost estimates for these proposed ITS strategies. These cost estimates will be based on a review of cost data for other ITS deployments in the region, national ITS cost data, as well as vendor information and past experience. Preliminary estimates of both capital costs and operating and maintenance costs will be provided.

6.1 EXISTING REGIONAL ITS INFRASTRUCTURE

The South Western Region has existing ITS deployments along several of its key corridors. For example, CT DOT operates the following equipment in the region:

- Thirty-eight (38) traffic surveillance cameras located primarily along I-95. See Exhibit 2-1 below for camera location information.
- Twelve (12) changeable message signs (CMS) located along I-95, CT 15, and CT 7. See Exhibit 2-2 below for CMS location information.
- One (1) highway advisory radio site in Stamford, with associated flashing advisory signs located in Stamford and Greenwich. There is also a HAR beacon located at the CT DOT maintenance facility in Darien adjacent to the rest area on I-95 south.

Additionally, CT DOT has deployed a fiber-optic communications backbone along I-95, which may be used to communicate with future ITS field devices.

Table 6.1 CT DOT Cameras in South Western Region

CMS #	Town	Route	Direction	Location
1	Greenwich	I-95	NB	South of Exit 2 – James St.
2	Greenwich	I-95	SB	Ritch St.
3	Greenwich	I-95	SB	Weigh Station
4	Greenwich	I-95	NB	Steamboat Road
5	Greenwich	I-95	SB	Kingsman Avenue
6	Greenwich	I-95	NB	Indian Field Road
7	Greenwich	I-95	SB	West of Strickland Avenue
8	Greenwich	I-95	SB	South of Exit 5 – Riverside Avenue
9	Greenwich	I-95	NB	Route 1 Connector
10	Greenwich	I-95	SB	Laddins Rock Road
11	Stamford	I-95	NB	Wilson St.
12	Stamford	I-95	NB	Atlantic Avenue
13	Stamford	I-95	SB	Clark Hill
14	Stamford	I-95	NB	Lockwood Avenue
15	Stamford	I-95	NB	Boston Post Road
16	Darien	I-95	SB	Darien Rest Area
17	Darien	I-95	SB	Hollow Tree Ridge
18	Darien	I-95	NB	Norton Avenue
19	Darien	I-95	SB	South of Exit 10
20	Darien	I-95	NB	North of Bridge 44
21	Darien	I-95	NB	Darien Rest Area
22	Darien	I-95	SB	Kings Highway North
23	Norwalk	I-95	NB	Richards Avenue
24	Norwalk	I-95	SB	Rampart Avenue
25	Norwalk	I-95	SB	North of Exit 14 – Taylor Road
26	Norwalk	I-95	SB	Stuart Avenue
27	Norwalk	7	SB	At the I-95 Merge
28	Norwalk	I-95	NB	NY/NH Railroad
29	Norwalk	I-95	SB	East Avenue
30	Norwalk	I-95	NB	Karen Dr.

Table 6.1 CT DOT Cameras in South Western Region (continued)

CMS #	Town	Route	Direction	Location
31	Westport	I-95	SB	Saugatuck Avenue
32	Westport	I-95	NB	Elaine Road
33	Westport	I-95	SB	Hales St.
34	Westport	I-95	SB	Compo Hills Pond
35	Westport	I-95	NB	Beachside Road
36	Westport	I-95	SB	New Creek Road
37	Westport	I-95	NB	Maple Avenue
38	Westport	I-95	NB	Sasco Creek Road

Source: Information provided by Bridgeport HOC, March 2008.

Table 6.2 CT DOT CMS in South Western Region

CMS #	Town	Route	Direction	Location
51	Greenwich	I-95	NB	South of Exit 3
52	Stamford	I-95	NB	South of Exit 9
53	Norwalk	I-95	NB	South of Exit 14
54	Westport	I-95	NB	South of Exit 19
79	Norwalk	I-95	SB	North of Exit 16
80	Darien	I-95	SB	South of Exit 13
81	Greenwich	I-95	SB	South of Exit 6
97	Norwalk	7	SB	At Route 1
108	Harrison, NY	15	NB	South of Exit 26
109	Norwalk	15	NB	South of Exit 38
119	Westport	15	SB	North of Exit 41

* Information provided by Bridgeport HOC, March 2008.

In addition to the ITS equipment operated by CT DOT, the City of Stamford operates its own Computerized Central Traffic Control Center which monitors the City's traffic surveillance cameras and controls its computerized traffic signals. The City of Norwalk and the Town of Greenwich also operate ITS traffic signal equipment.

Figure 6.1 Stamford Central Traffic Control Room

Source: Image courtesy of City of Stamford Office of Operations Engineering Bureau Major Accomplishments 1998-2006, July 2006.

6.2 DRAFT ITS STRATEGIES

SWRPA, in consultation with the ITS TAC, has developed a draft list of ITS strategies. SWRPA and the ITS TAC believe these projects to be the most pressing long-term ITS needs for the South Western Region. This chapter presents these draft ITS strategies, as presented in the SWRPA memorandum dated June 7, 2007:

Integrated Corridor Management

The South Western Region features four important, parallel transportation routes: I-95, CT 15, US 1, and the New Haven line railroad. An incident on one route can have a ripple effect on the other three. This strategy would evaluate the cost and benefits of an ITS approach to better integrate the four corridors and improve redundancy of the transportation network. Elements of this strategy may include:

- Instrumentation of CT 15, US 1
- Additional DMS (Dynamic Message Signs) at decision points and other important locations
- Signal coordination
- Incident management systems
- Other elements

Automated Vehicle Location System for Transit

Automated Vehicle Location (AVL) systems can help a transit agency improve efficiency and attract riders. This strategy would evaluate the impact of a full-scale AVL deployment for each bus transit agency operating in the South Western Region. The two transit agencies are:

- Norwalk Transit District
- Connecticut Transit – Stamford Division

Transit Signal Priority

SWRPA and the City of Stamford are both studying the potential for bus rapid transit service in the South Western Region[4]. This strategy would evaluate the impact of deploying transit signal priority treatments at signalized intersections. The geographic focus would include:

- US 1, Greenwich – Norwalk
- City of Stamford – All bus routes

[4] Greenwich/Norwalk Bus Rapid Transit Study

Arterial Management – Real-time Traveler Information

The City of Stamford is considering a system to monitor and broadcast real-time traveler information to travelers on major arterials. This strategy would evaluate the impact of deploying such a system. The geographic focus would include:

- City of Stamford – Major arterials

Incident Management System

This project will provide the City of Norwalk with the ability to implement the diversionary plans prepared by CT DOT and the City of Norwalk. The project will consist of installing approximately 50 electronic blankout signs at various locations though the City, all of which can be activated by the City's central traffic control software and camera monitoring equipment. In addition, the City's ITS systems will be fully integrated with the City's PSAP computer-aided dispatch (CAD) system, GIS, and AVL systems. Information will be made available to the public over the internet and through the 511 traveler information system. The geographic focus would include:

- City of Norwalk – various locations

6.3 REGIONAL ITS PROJECTS

This chapter presents conceptual descriptions for each project based on the draft ITS strategies identified by SWRPA and the ITS TAC. Exhibit 4-1 presents eight specific project-based ITS deployments in each of the ITS strategic emphasis areas. Planning-level budget estimates were developed for each of these projects based upon the descriptions, assumptions, and unit quantities presented in this document.

The budget estimates are intended to complement the benefit calculations used by the IDAS (ITS Deployment Analysis System) described in the following chapter. Based on a comparative evaluation of costs and benefits using these estimates, projects can be prioritized, programmed into the regional TIP, funded, and implemented strategically over time.

Table 6.3 Summary of Regional ITS Projects

Reference Number	Project Title	Project Description	Project Location(s)	Planning Budget Estimates[a] (Capital/O&M)	Expected Benefits
ICM-1	CT 15 ITS Instrumentation	Deployment of additional DMS, cameras, and communications equipment on CT 15.	CT 15	$2.47 million/$500,0000	Improved incident detection and response.
ICM-2 Ref. #	US 1 ITS Instrumentation Project	Deployment of additional DMS, cameras, and communications equipment on US 1. Project Description	US 1 Project Location(s)	$2.12 million/$590,000 Planning Budget Estimates[a] (Capital/O&M)	Improved incident detection and response. Expected Benefits
AVL-1	Norwalk Transit District AVL	Deployment of AVL for Norwalk Transit District.	Norwalk Transit Vehicles	$1.37 million/$130,000	Improved transit operational efficiency and real-time traveler information.
AVL-2	CT Transit – Stamford AVL	Deployment of AVL for CT Transit – Stamford.	CT Transit Vehicles	$1.21 million/$110,000	Improved transit operational efficiency and real-time traveler information.
TSP-1	US 1Transit Signal Priority	Deployment of transit signal priority equipment at signals along US 1.	US 1	$4.33 million/$355,000	Improved transit travel times and reliability.
TSP-2	City of Stamford Transit Signal Priority	Deployment of transit signal priority equipment in Stamford.	Stamford	$660,000/ $95,000	Improved transit travel times and reliability.
AM-1	Stamford Real-time Traveler Information System	Deployment of real-time travel time data collection system in Stamford.	Stamford	$945,000/$200,000	Improved provision of traveler information on arterials.
IM-1	Norwalk Incident Management System	Deployment of blankout signs and integration of Norwalk ITS systems.	Norwalk	$2.31 million/$245,000	Improved incident and emergency management.

[a]Planning budget estimates are preliminary and intended for planning analysis only. Refer to Section 4.3.

6.4 PROJECT DESCRIPTIONS

Full descriptions of each project are included in Chapter 5. Each description contains the following information:

- **Project Title and Overview:** A general overview is given for each project, primarily focusing on the operational capabilities and functional scope of the project.
- **Project Location(s):** The approximate geographic extent of the project is described.

- **Planning Budget Estimates:** High-level, preliminary planning budget estimates are included for each project. Refer to Section 4.3 for further details.
- **Lead Agency:** The public agency or agencies judged to be the most appropriate lead agency for each deployment are identified.
- **Project Participants:** Principal stakeholders and agencies whose cooperation and support is critical to the implementation and success of the project are identified.
- **Expected Benefits:** The high-level expected benefits of the project are identified.
- **Integration with Other Projects:** Identification of other projects that should be coordinated/integrated in order to maximize the benefits of the project investment.

6.5 Planning Budget Estimates

Planning-level budget estimates have been provided for each of the projects identified in this technical memorandum to facilitate decision-making related to project programming, prioritization, and funding. These planning budget estimates are high-level and preliminary.

Actual costing for individual projects is dependent on a wide variety of factors, including: detailed project functional requirements; final quantities and specifications of equipment to be installed; existing field conditions; available communications infrastructure; coordination with other infrastructure construction or rehabilitation projects; and a host of other determinants that shall be investigated in the preliminary engineering phase of each project to produce refined engineering cost estimates.

The planning budget estimates have been prepared based on approximated equipment quantities and installed unit costs for field and headend equipment. These costs were estimated using the USDOT's ITS Cost Database, recent vendor price quotes, past ITS deployment and operations experience in Connecticut and the region and input from the SWRPA ITS TAC. Preliminary cost estimate details on a project-by-project basis, including unit quantities and operating cost assumptions, are included in Appendix H.

NOTE: The budget estimates presented in this document are intended for planning analysis only; development of detailed engineering estimates will require additional verification of assumptions, existing conditions, communications availability, and other factors during the systems engineering process for each project.

6.6 LIFECYCLE ESTIMATES

Estimating the replacement lifecycles for ITS deployments is inherently difficult for several reasons:

- **The rapidly changing pace of technological advancement.** With technology changing and improving so quickly, it makes it difficult to assess the lifecycle risks of any technological investment. Operationally, many of these ITS devices and technologies may continue to remain functional for an extended period of time. However, as technology improves, the need/desire to replace this equipment may shorten its effective lifecycle.
- **Functional vs. Operational Obsolescence.** Many ITS technologies and devices can continue to function at reduced effectiveness for an extended period of time. However, as the device becomes older, it may be necessary to replace the device for operational purposes before it becomes functionally obsolete. For example, an LED sign may continue to function at decreased brightness for several years. However, for safety operations reasons, LED signs should be replaced prior to its failing to function.
- **Supporting infrastructure.** Most ITS deployments involve the deployment of not just ITS devices, but also supporting infrastructure, such as towers, poles, foundations, cabinets, conduit, power, communications, etc. When an ITS device becomes operationally obsolete and needs to be replaced, to what extent, if any, does this supporting infrastructure also need to be replaced? Likewise, upgrading infrastructure may also require the replacement of ITS devices. For example, if a roadway is widened, ITS infrastructure may need to be removed, relocated, and/or replaced.
- **Changing technology standards and legislation.** It may also be desirable to replace/upgrade ITS technologies in response to changes in ITS standards, public policies, regulations, legislation, etc. These continually evolving conditions add another layer of uncertainty and risk when estimating a replacement lifecycle.
- **Installation variations.** The replacement lifecycle of a piece of ITS equipment can vary significantly depending on how well it is installed. Improper installation can result in a much reduced effective lifecycle.

In addition, developing replacement lifecycle estimates for the conceptual project descriptions developed as part of this document is further complicated by the high-level nature of these project concepts. At this preliminary planning stage, specific technologies have not been determined. Replacement lifecycles can vary dramatically depending on the technology selected. Furthermore, the manufacturers' warranties, software and hardware technical support, and preventive and routine maintenance procedures all play a part in the effective lifecycle of an ITS component.

In developing equipment lifecycle estimates to accompany the preliminary budget estimates, it was decided to provide an estimate of "productive" lifecycle. In other words, how long an ITS component would likely continue without a strong agency incentive to replace/upgrade. It was also assumed that supporting infrastructure's lifecycle would be considered separate from the ITS devices it is intended to support.

These replacement lifecycles were estimated using recent manufacturer equipment product sheets and past ITS deployment and operations experience in Connecticut and the region. In most cases, an appropriate range of values were provided. Preliminary replacement lifecycles for ITS components are included in Appendix E.

NOTE: The lifecycle estimates presented in this document are preliminary and intended for planning analysis only; development of more detailed lifecycle estimates will require additional verification of assumptions, existing conditions, an examination of detailed project equipment and supporting infrastructure, and other factors to be determined during the systems engineering process for each project.

6.7 ADDITIONAL PROJECT NOTES

In addition to the project concepts developed as part of this technical memorandum, it is also recommended that the region take into account the following considerations:

- **Regional Telecommunications Planning:** The effectiveness of many ITS deployments is highly dependent upon a robust and reliable communications system. Based on the project concepts developed herein, it appears that the region would benefit from the development of a regional telecommunications plan to identify existing infrastructure and additional infrastructure needs to support the proposed ITS projects (and other public agency needs). Such a plan would be very useful in making determinations of the costs and tradeoffs of fiber, wireless, and commercial communications solutions for various projects, and could support sharing of telecommunications capacity among agencies for both transportation and non-transportation public sector applications. Furthermore, a coordinated regional telecommunications strategy can lead to future cost savings and increased interagency coordination.

- **Regional ITS Architecture:** In order to be eligible for federal funding, ITS projects need to be consistent with relevant regional ITS architectures. The South Western Region was included in the Connecticut Statewide ITS Architecture, completed in April 2005. It is recommended that the region conduct a review to ensure that these projects are consistent with the Statewide ITS Architecture and request modifications to the architecture as necessary.
- **Video Sharing Policy:** There has been significant discussion in the region and statewide regarding the need for increased video sharing among different agencies and disciplines. Since several of the projects identified herein include a camera surveillance component, it is recommended that the region work with other transportation stakeholders throughout the state to develop a standard policy and the accompanying interagency agreements necessary to facilitate interagency video sharing.

6.8 PROJECT DESCRIPTIONS

This chapter provides more detailed descriptions of the projects proposed as part of this document. Information on project components, locations, and underlying assumptions are described.

<table>
<tr><th colspan="2">ICM-1: CT 15 (Merritt Parkway) ITS Instrumentation</th></tr>
<tr><td>Project Description</td><td>CT 15 (also known as the Merritt Parkway) is one of the four parallel transportation routes through the South Western Region identified in the draft ITS strategies. This project would deploy additional ITS instrumentation along CT 15 as part of the effort to improve and integrate corridor management efforts in the region.

CT 15 has two existing Dynamic Message Signs (DMS) in the northbound direction (south of Exit 26 on the Hutchison River Parkway in Harrison, NY and south of Exit 38 in Norwalk), and one in the southbound direction (north of Exit 41 in Westport). These DMS would be supplemented with five (5) additional DMS placed strategically along the corridor at locations that enable drivers to make alternative route or travel mode decisions. Other factors to consider when evaluating the placement of DMS and/or cameras include: availability of communications and right-of-way, the ease of maintenance, and the camera field of vision.

Proposed locations for the additional DMS along the northbound corridor include: south of Exit 34 and south of Exit 36. Proposed locations for the additional DMS along the southbound direction include: north of Exit 40B, north of Exit 37, and north of Exit 35, respectively.

There are currently no surveillance cameras located along CT 15, complicating traffic management on this corridor as well as parallel corridors such as I-95 and Route 1. It is proposed that eight (8) cameras would be deployed to monitor traffic flow at strategic locations, especially locations experiencing significant traffic congestion or a high number of incidents. The following are possible locations for consideration: the Connecticut/New York border, the CT 104 interchange (exit 34), the CT 137 interchange (exit 35), the CT 106 interchange (exit 36), the CT 124 interchange (exit 37), the CT 123 interchange (exit 38), the US 7 interchange (exit 39B) and the CT 33 interchange (exit 41).Traffic flow detection equipment is also proposed along the corridor. Potential technologies to be evaluated for the corridor may include: loop detection, microwave sensors, infrared, video detection, etc. Regardless of the technology used, it is proposed that one detection station be deployed approximately every 2 miles along the corridor in both directions. In particular, it is proposed that continuous count stations be installed at the CT/NY border and at the CT 15 and CT 7 interchange.

In addition, it is proposed that overweight/overheight (OW/OH) vehicle detection technology be deployed on Hutchinson River Parkway northbound before King Street (i.e., prior to the NY/CT border). Since this equipment is technically not located within the region, necessary agreements will need to be reached with New York agencies. This OW/OH vehicle detection technology will be used primarily as a remote automated enforcement station. When anOW/OH vehicle is detected, a camera will capture an image of the vehicle and alert CT State Police and the CT DOT's Highway Operations Center (HOC) . For estimating purposes, it was assumed that this OW/OH vehicle detection will consist of mainline Weigh-In-Motion (WIM) scales, Automatic Vehicle Classification (AVC) sensors, infrared overheight detectors, a vehicle image capture camera, and ancillary hardware and communications equipment. It was assumed that this information will interface with an existing central enforcement planning database.</td></tr>
</table>

	Video surveillance monitoring, traffic flow monitoring, and DMS control would be handled through CT DOT's HOC in Bridgeport. Communications between the central system and the field devices would likely require leased communication lines because of the lack of fiber-optics in the corridor. As an alternative to leasing communications, the region could explore deployment of its own communications system (e.g., fiber-optic communications or a wireless communications solution). This alternative would result in a greater initial capital cost, but reduced operating costs, and may have applications and benefits outside of traffic management.	
		Notes
Planning Budget Estimates	Capital Cost: $2.47 million O&M Cost: $500,000	Refer to Appendix A for detailed cost breakdowns.
Project Location(s)	Strategic locations along CT 15 (the Merritt Parkway).	
Lead Agency	CT DOT	
Project Participants	FHWA, Connecticut Department of Public Safety, NYSDOT, Greenwich, Stamford, New Canaan, Norwalk, Westport, SWRPA	
Expected Benefits	• Improved integrated corridor management of CT 15, US 1, and I-95 • Improved surveillance capabilities • More rapid detection of incidents and reduced response times • Improved traveler information to assist in incident management and informed traveler decision-making	
Integration with Other Projects	This project would leverage CT DOT's existing ITS investments in the region including headend systems and instrumentation of parallel corridors. Incident management strategies along CT 15 would be coordinated with I-95 traffic management and the proposed US 1 project to allow for integrated corridor management of the principal travel corridors in southwestern Connecticut.	

ICM-2: US Route 1 ITS Instrumentation

Project Description	US Route 1 is also one of the four parallel principal transportation routes through the South Western Region identified in the draft ITS strategies. This project would deploy ITS instrumentation along US 1, complementing existing and proposed traffic management instrumentation along these other routes and supporting integrated corridor management in the region. There are currently no Dynamic Message Signs (DMS) or CT DOT-operated surveillance cameras located along US 1. It is proposed that five (5) DMS be deployed along US 1 NB at strategic locations. Possible locations for CMS on US 1 NB include: south of Exit 5, south of Exit 9, south of Exit 11, south of the US 7 interchange, and south of the Fairfield-Westport border. It is proposed that five (5) DMS be deployed along US 1 SB at strategic locations. Possible locations for DMS on US 1 SB include: north of the Fairfield-Westport border, north of the Newtown Ave intersection, north of Ledge Rd intersection, north of Seaside Ave intersection, and north of the Havemayer Lane intersection. The project includes eight (8) CT DOT-operated cameras to monitor traffic flow at strategic locations, especially locations experiencing significant traffic congestion or a high number of incidents. Possible camera locations for consideration include: two locations in Greenwich to monitor the Edgewood Ave and the Field Point Rd intersections, two locations in Stamford to monitor the Laddin Rock Rd and the Greenwich Ave intersections, in Darien at the Norton Ave and the Mansfield Ave intersections, in Norwalk at the CT 7 interchange, and in Westport at the bridge over the Saugatuck River. In evaluating the location and placement of DMS, the primary determinant should be the ability for DMS to provide sufficient advance notice to drivers to allow them to make alternative route or travel mode decisions. Other factors to consider when evaluating the placement of DMS and/or cameras include: availability of communications and right-of-way, the ease of maintenance, and the camera field of vision. Traffic flow detection equipment is also proposed along the corridor. Potential technologies to be evaluated for the corridor may include: loop detection, microwave sensors, infrared, video detection, etc. Regardless of the technology used, it is proposed that one detection station be deployed approximately every 2 miles along the corridor in both directions. Video surveillance monitoring, traffic flow monitoring, and DMS control would be handled through CT DOT's Highway Operations Center (HOC) in Bridgeport. Communications between the central system and the field devices would likely need to be accomplished via leased communication lines. As an alternative to leasing communications, the region could explore deployment of its own communications system (e.g., fiber-optic communications or a wireless communications solution). This alternative would result in a greater initial capital cost, but reduced operating costs.

		Notes
Planning Budget Estimates	Capital Cost: $2.12 million O&M Cost: $590,000	Refer to Appendix E for detailed cost breakdowns.
Project Location(s)	Strategic locations along US 1.	

Lead Agency	Greenwich, Norwalk, and Stamford within their respective communities and CT DOT within Darien and Westport	
Project Participants	FHWA, Connecticut Department of Public Safety, NYSDOT, Darien, Westport, SWRPA	
Expected Benefits	• Improved integrated corridor management of CT 15, US 1, and I-95 • Improved surveillance capabilities • More rapid detection of incidents and reduced response times • Improved traveler information to assist in incident management and informed traveler decision-making	
Integration with Other Projects	This project would leverage CT DOT's existing ITS investments in the region. Incident management strategies along US 1 would be coordinated with I-95 traffic management to allow for an integrated corridor management system.	

AVL-1: Norwalk Transit District AVL

Project Description	Norwalk Transit District offers fixed route and demand response transit services in the South Western Region. It currently operates approximately 45 fixed route buses and 20 demand response vehicles. Norwalk Transit District is interested in implementing an AVL system in order to improve its operating efficiency and increase its attractiveness to riders. Norwalk Transit District recently upgraded its on-board and dispatching technology. A new two-way digital radio communication system became operational in 2007. New dispatching and scheduling software was installed in 2005 for its door-to-door services. It is anticipated that the new AVL system would be integrated with its existing digital radio system and dispatching software. Therefore, no CAD functionality or communications equipment is included as part of this project description. However, it is likely that the digital radio system will need to be upgraded/configured to accommodate the additional data communications. The AVL system would likely consist of a transit GPS (or DGPS) unit that would allow dispatchers to monitor the location of transit vehicles in order to improve the efficiency of their existing dispatch efforts. In addition to improving operational efficiency, the AVL system would support other future transit ITS applications such as: emergency alarms, automatic passenger counters, real-time passenger information, in-vehicle signs and annunciators, and traffic signal priority based on schedule adherence. In addition, it is proposed that Norwalk Transit District would install displays at five (5) locations to provide passengers with next bus arrival/departure time information. One of these locations would be Norwalk's main transfer point or "pulse point".	
		Notes
Planning Budget Estimates	Capital Cost: $1.37 million O&M Cost: $130,000	Refer to Appendix E for detailed cost breakdowns.
Project Location(s)	Norwalk Transit District Vehicles	
Lead Agency	Norwalk Transit District	
Project Participants	FTA, Norwalk, SWRPA, CT Transit, CT DOT	
Expected Benefits	• Improved operational efficiency by providing dispatchers with real-time location of transit vehicles. • Improved data accuracy and data collection for planning, operations research, and reporting requirements.	
Integration with Other Projects	This project should be coordinated with Norwalk Transit District's other transit ITS procurements to ensure interoperability. Norwalk Transit District should also coordinate with CT Transit – Stamford's AVL system procurement to take advantage of any economies of scale or system interoperability opportunities.	

AVL-2: CT Transit-Stamford AVL*

Project Description	CT Transit - Stamford operates 15 local bus routes 7 days a week. CT Transit - Stamford buses connect with other state-subsidized services in Norwalk, with the New Haven Line in several locations, and with Bee-Line buses in Westchester County New York. CT Transit - Stamford also operates the I-BUS, an express service between downtown Stamford and White Plains, New York. CT Transit – Stamford currently operates approximately 40 fixed route vehicles. CT Transit – Stamford is also interested in implementing an AVL system in order to improve its operating efficiency and increase its attractiveness to riders. It is assumed that CT Transit – Stamford will utilize its existing scheduling and dispatching software. Therefore, no CAD functionality or software is included as part of this project description. However, it is likely that the AVL system will require additional RF communications to transmit data from the vehicles back to a central location. As an alternative, CT Transit – Stamford may also pursue commercial communications services. The AVL system would likely consist of a transit GPS (or DGPS) unit that would allow dispatchers to monitor the location of transit vehicles in order to improve the efficiency of their existing dispatch efforts. In addition to improving operational efficiency, the AVL system would support other future transit ITS applications such as: emergency alarms, automatic passenger counters, real-time passenger information, in-vehicle signs and annunciators, and traffic signal priority based on schedule adherence. ***NOTE:** Following development of this project concept and preliminary budget estimates, it was brought to the attention of IBI Group that the City of Stamford is in the midst of procuring CAD/AVL as part of its Stamford Urban Transitway project. The ITS components for this project include not just CAD/AVL, but also automatic passenger counters, on-board cameras, vehicle diagnostics, stop callers, DMS, parking guidance, outdoor digital signage, wireless LAN networks, fiber-optic communications, etc. It is also intended that this procurement will include a Central Traffic Control System Interface to provide transit signal priority functionality, which was estimated separately as part of this effort. The City estimates that the overall cost for the ITS elements will be between $3.5 million and $6.5 million. The preliminary budget estimate developed here is only in regards to the AVL portion of this larger procurement. Given that these technologies are well on their way to deployment, SWRPA may want to reconsider including this project as one of their future strategies.	
		Notes
Planning Budget Estimates	Capital Cost: $1.21 million O&M Cost: $110,000	Refer to Appendix E for detailed cost breakdowns.
Project Location(s)	CT Transit Vehicles	
Lead Agency	CT Transit	
Project Participants	FTA, Stamford, SWRPA, Norwalk Transit District, CT DOT	
Expected Benefits	• Improved operational efficiency by providing dispatchers with real-time location of transit vehicles. • Improved data accuracy and data collection for planning, operations research, and reporting requirements.	

<table>
<tr><th colspan="3">TSP-1: US 1 Transit Signal Priority</th></tr>
<tr><td>Project Description</td><td colspan="2">The Region is considering implementing Bus Rapid Transit (BRT) along the US 1 corridor. In order to reduce the transit travel times and improve the schedule adherence of the BRT vehicles, the Region is interested in implementing transit signal priority (TSP) systems along the corridor from Greenwich to Norwalk. TSP systems modify the typical operation of a traffic control signal to provide priority to transit vehicles.

TSP can either be achieved in several different ways:
• Traffic signal change can be implemented locally by the signal controller or centrally by a signal monitoring and control system.
• Vehicle detection can be interfaced to the signal controller or can be managed by a separate transit vehicle monitoring system and passed on to the traffic signal system and subsequently the traffic signal controllers
• Granting of signal priority can be unconditional (granted every time a transit vehicle approaches a signalized intersection) or conditional (granted only when the approaching transit vehicle meets certain specified conditions)

TSP systems can also implement a variety of priority strategies including extending green times, providing early green signals, or inserting a short green phase into the signal cycle to allow a transit vehicle to proceed. It should be noted that the level of sophistication possible in the implementation of a TSP system is directly constrained by the level of sophistication of the traffic signal controller/system; a detailed field inventory of traffic control hardware is necessary to make a final determination about necessary hardware upgrades to achieve a desired level of TSP functionality.

For US 1, it is assumed that the buses will communicate locally with the US 1 traffic signal intersections, since there is currently no centralized remote signal control along this corridor. For the purposes of this project, it is estimated that 80 intersections between Greenwich and Norwalk will be upgraded and equipped with TSP receivers (two per intersection). Additionally, it was assumed that TSP processors/emitters will be installed on 40 transit vehicles with 10 spares.</td></tr>
<tr><td></td><td></td><td>Notes</td></tr>
<tr><td>Planning Budget Estimates</td><td>Capital Cost: $4.33 million O&M Cost: $355,000</td><td>Refer to Appendix E for detailed cost breakdowns.</td></tr>
<tr><td>Project Location(s)</td><td>US 1, Greenwich to Norwalk</td><td></td></tr>
<tr><td>Lead Agency</td><td>Greenwich, Norwalk, and Stamford within their respective communities and CT DOT within Darien and Westport</td><td></td></tr>
<tr><td>Project Participants</td><td>FHWA, SWRPA, Norwalk Transit District, CT Transit, Darien, Westport</td><td></td></tr>
<tr><td>Expected Benefits</td><td>• Improved bus schedule adherence.
• Reduced transit travel times.
• Improved transit travel time reliability.</td><td></td></tr>
<tr><td>Integration with Other Projects</td><td>This effort should be coordinated with traffic signal improvements along the corridor, as well as any ITS instrumentation along the corridor (ICM-2).</td><td></td></tr>
</table>

TSP-2: Stamford Transit Signal Priority*	
Project Description	The Region is considering implementing Bus Rapid Transit (BRT) services in the City of Stamford. In order to reduce the transit travel times and improve the schedule adherence of the BRT vehicles, the Region is interested in implementing transit signal priority (TSP) systems throughout the City. TSP systems modify the typical operation of a traffic control signal to provide priority to transit vehicles. TSP can either be achieved in several different ways: • Traffic signal change can be implemented locally by the signal controller or centrally by a signal monitoring and control system. • Vehicle detection can be interfaced to the signal controller or can be managed by a separate transit vehicle monitoring system and passed on to the traffic signal system and subsequently the traffic signal controllers • Granting of signal priority can be unconditional (granted every time a transit vehicle approaches a signalized intersection) or conditional (granted only when the approaching transit vehicle meets certain specified conditions) TSP systems can also implement a variety of priority strategies including extending green times, providing early green signals, or inserting a short green phase into the signal cycle to allow a transit vehicle to proceed. It should be noted that the level of sophistication possible in the implementation of a TSP system is directly constrained by the level of sophistication of the traffic signal controller/system. The City of Stamford has invested in a Computerized Central Traffic Control System. This central system allows the City's traffic engineers to monitor and control traffic signals throughout the city. Emergency vehicle signal preemption has been implemented on a majority of these traffic signals. It is therefore assumed that these intersections' traffic signal controllers will not need to be significantly upgraded to accommodate the TSP systems. The City of Stamford also has plans to implement TSP on its Stamford Urban Transitway. This system would consist of a specialized equipment and software that would transmit bus location and schedule information simultaneously to the transit and traffic management centers. Conditional signal priority would be granted by the central traffic control system depending on the bus' schedule adherence. For the purposes of this project, it was assumed that TSP processors/emitters will be installed on an additional 40 transit vehicles with 6 spares. The central traffic control system would be expanded/upgraded to accommodate the additional transit signal priority requests. ***NOTE:** Following development of this project concept and preliminary budget estimates, it was brought to the attention of IBI Group that the City of Stamford is in the midst of procuring TSP as one of the ITS components of its Stamford Urban Transitway project. The ITS components for this project include CAD/AVL, automatic passenger counters, on-board cameras, vehicle diagnostics, stop callers, DMS, parking guidance, outdoor digital signage, wireless LAN networks, fiber-optic communications, etc. The City estimates that the overall cost for the ITS elements will be between $3.5 million and $6.5 million. The preliminary budget estimate developed here is only in regards to the TSP portion of this larger procurement. Given that these technologies are well on their way to deployment, SWRPA may want to reconsider including this project as one of their future strategies.

		Notes
Planning Budget Estimates	Capital Cost: $660,000 O&M Cost: $95,000	Refer to Appendix E for detailed cost breakdowns.
Project Location(s)	City of Stamford	
Lead Agency	City of Stamford	
Project Participants	FHWA, CT DOT, SWRPA, CT Transit, Norwalk Transit District	
Expected Benefits	• Improved bus schedule adherence. • Reduced transit travel times. • Improved transit travel time reliability.	
Integration with Other Projects	This effort should be coordinated with traffic signal improvements by the City, as well as the Stamford Urban Transitway project.	

AM-1: Stamford Real-Time Traveler Information System

<table>
<tr><td>Project Description</td><td colspan="2">
To assist in its arterial management efforts, the City of Stamford is considering deployment of a system to detect and broadcast real-time traveler information to travelers on its major arterials. There are several challenges with collecting and broadcasting real-time traveler information on arterial roads. Traveler information services must find a balance between information that can be easily and reliably detected and information that is useful to the traveling public. Real-time traveler information must also be disseminated in a manner that makes it easy for the traveling public to understand.
For the purpose of this project, it was assumed that real-time traveler information would be disseminated via a public website, as opposed to radio, telephone, kiosks, or other dissemination options. As an example, a web-based arterial traffic flow map has been deployed by the city of Bellevue, Washington (http://trafficmap.cityofbellevue.net). Private television or radio service providers could also be provided with a direct interface to the real-time traveler data, or Internet access to the website at little additional cost. It was also assumed that the following types of information will be considered of greatest interest to the general public: 1) incident and construction locations, 2) a description of traffic congestion levels, and 3) camera snapshots of roadway conditions. Travel time data would also be of interest, but is not included as part of this project due to the challenges associated with real-time travel time data collection on arterials.
Real-Time Data Collection:

In order to collect real-time incident and construction information, the City will need to coordinate public safety incident reports and construction activity reports with the operators of the City’s traveler information website. Some incidents and construction activities may also be detected using the City’s traffic surveillance cameras.
In order to collect traffic congestion data, the City will need to deploy additional traffic flow sensors or take advantage of their existing traffic detectors. For this project, it was assumed that the City will use its existing detector data. This traffic flow data would then need to be smoothed, calibrated, and displayed in a manner that is easily understood by a nontechnical public.
Still images will need to be collected and regularly updated from the City’s existing traffic surveillance cameras.

Traveler Information Display:
In order to display the real-time traveler information, the website will need to feature a GIS map-based display that will:

Allow City operators to input the location of incidents and construction activities as they are reported.
Show calibrated congestion levels on specific City-defined roadway links. It is recommended that the City use a color-coded real-time traffic map.
Show the location and icon of the City’s traffic surveillance cameras. Website users should be able to click on a camera icon and see the latest camera still image.

</td></tr>
<tr><td></td><td></td><td>Notes</td></tr>
<tr><td>Planning Budget Estimates</td><td>Capital Cost: $945,000 O&M Cost: $200,000</td><td>Refer to Appendix E for detailed cost breakdowns.</td></tr>
</table>

Project Location(s)	City of Stamford	
Lead Agency	Stamford	
Project Participants	CT DOT, SWRPA	
Expected Benefits	• Improved arterial management within Stamford. • Improved communication with the general public.	
Integration with Other Projects	This project should be coordinated with other Stamford ITS deployment efforts, as well as Statewide ATIS efforts, such as CT DOT's future 511 website.	

IM-1: Norwalk Incident Management System

Project Description	The City of Norwalk features several key corridors and interchanges, including: I-95, US 1, CT 15, and US 7. The presence of these corridors and interchanges make it a key part of diversionary plans in the South Western Region. Norwalk is therefore interested in improving its incident/emergency management capabilities on arterial streets within the city when incidents on the limited-access network cause large volumes of vehicles to divert onto local arterials. This will improve traffic flow and also improve the City's ability to provide timely emergency services during such diversions. The purpose of this project would be to provide the City of Norwalk with the ability to implement the diversionary plans prepared by CT DOT. The project would consist of installing approximately 50 electronic blankout signs at strategic locations throughout the City. These signs could be activated and controlled by the City's central traffic control software. In addition, the City's ITS systems (the blankout signs, central traffic signal control, and traffic surveillance cameras) would be integrated with the City's PSAP computer-aided dispatch (CAD) system, GIS, and AVL systems. Incident and emergency information would also be provided to the public via the City's existing website and potentially through a subscriber email service. This project would also establish an interface with Connecticut's future 511 system.

		Notes
Planning Budget Estimates	Capital Cost: $2.31 million O&M Cost: $245,000	Refer to Appendix E for detailed cost breakdowns.
Project Location(s)	City of Norwalk	
Lead Agency	Norwalk	
Project Participants	CT DOT, Connecticut Department of Public Safety, SWRPA	
Expected Benefits	• Improved incident and emergency management. • Improved communication of incident and emergency management information to the general public.	
Integration with Other Projects	This project should be coordinated with the City's other ITS investments, the State's incident/emergency management efforts, and the State's 511 efforts.	

7.0 Benefit/Cost Analysis

This section of the Plan will focus on the benefit-cost analysis conducted for the alternatives. It will include a brief summary of the project and costs listed above, a description of the methodology used to estimate benefits and a summary of the benefit-cost analysis results.

7.1 PROJECT DESCRIPTION

The ITS Strategic Plan builds on the extensive ITS infrastructure already in place in the region. This infrastructure, installed and operated by CT DOT, is concentrated on I-95, which is the major expressway facility in the corridor. The current system provides surveillance, detection, and traveler information services along I-95. The goals of the current system are to provide for more rapid clearance of incidents and provide travelers with advance information on delays, incidents, and construction activity along the corridor. Information is communicated to the traveling public through Dynamic Message Signs (DMS) and Highway Advisory Radio located on I-95 and a variety of media outlets. There is currently no 511 traveler information system available in Connecticut.

One of the goals of the proposed ITS strategies is to expand the system by providing better balance between different facilities and different modes of transportation. In addition to I-95, the region has two other regional expressway facilities, the Merritt Parkway (CT-15), which parallels I-95; and US 7, the primary north-south highway in the region. While there has been some ITS deployment on CT 15 (Merritt Parkway), deployments on this facility are limited compared to those on I-95.

Two other key elements of the transportation system that are addressed in this plan are the arterial system and the extensive public transportation system that serves the region. ITS deployment packages have been proposed to improve the day-to-day efficiency of the arterial system, as well as to improve performance when it must be used to divert traffic during major freeway incidents. Improved efficiency and traveler information services are key goals of the region's two local transit systems, the Norwalk Transit District (NTD) and Connecticut Transit – Stamford Division (CTTransit). Table 7.1 summarizes the proposed alternatives for this analysis.

Table 7.1 Summary of South Western Region ITS Strategies

Ref. #	Project Title	Project Description	Project Location(s)	Planning Budget Estimates (Capital/O&M)	Expected Benefits
ICM-1	CT 15 ITS Instrumentation	Deployment of additional DMS, cameras, and communications equipment on CT 15.	CT 15	$2.47 million/ $500,0000	Improved incident detection and response.
ICM-2	US 1 ITS Instrumentation	Deployment of additional DMS, cameras, and communications equipment on US 1.	US 1	$2.12 million/ $590,000	Improved incident detection and response.
AVL-1	Norwalk Transit District AVL	Deployment of AVL for Norwalk Transit District.	Norwalk Transit Vehicles	$1.37 million/ $130,000	Improved transit operational efficiency and real-time traveler information.
AVL-2	CT Transit – Stamford AVL	Deployment of AVL for CT Transit – Stamford.	CT Transit Vehicles	$1.21 million/ $110,000	Improved transit operational efficiency and real-time traveler information.
TSP-1	US 1 Transit Signal Priority	Deployment of transit signal priority equipment at signals along US 1.	US 1	$4.33 million/ $355,000	Improved transit travel times and reliability.
TSP-2	City of Stamford Transit Signal Priority	Deployment of transit signal priority equipment in Stamford.	Stamford	$660,000/$95,000	Improved transit travel times and reliability.
AM-1	Stamford Real-Time Traveler Information System	Deployment of real-time travel-time data collection system in Stamford.	Stamford	$945,000/ $200,000	Improved provision of traveler information on arterials.
IM-1	Norwalk Incident Management System	Deployment of blankout signs and integration of Norwalk ITS systems.	Norwalk	$2.31 million/ $245,000	Improved incident and emergency management.

The proposed packages represent a balance between different facilities and modes. The Integrated Corridor Management (ICM)-1 package is proposed to provide a higher level of surveillance, detection, and traveler information on the Merritt Parkway. This deployment will improve incident response and improve overall system performance, particularly when the Merritt Parkway is forced to serve traffic diverted from I-95. The operation of this system would be integrated into CT DOT's Bridgeport Traffic Operations Center.

The ICM-2 package is designed to improve incident response and traveler information along US 1. Through much of the region, this arterial route is characterized by numerous signalized intersections and high levels of commercial development. US 1 serves as an alternate route for I-95 for short stretches during incidents or periods of very heavy congestion. Deployment of ITS along this corridor would help to support diversion when necessary.

Two Automated Vehicle Location (AVL) packages are proposed for the region's bus systems; one for NTD and one for the CTTransit. The purpose of these deployments is twofold; to improve on-time performance and to provide information to the public on bus stop arrival times. AVL would be deployed on all revenue vehicles, although this may be accomplished in phases due to cost. While another important goal is to improve traveler information services for Metro-North Railroad in the region, this is a major initiative that must involve multiple regions and States to be successful.

Two additional projects are proposed that are oriented toward improving transit service. Transit Signal Priority (TSP)-1 would deploy signal priority equipment at intersections along portions of the US 1 corridor that have transit service. TSP-2 would provide Transit Signal Priority at major intersections on bus routes throughout the City of Stamford. Both deployments would be designed to improve bus travel times and reliability.

Project Arterial Management (AM)-1 also would be concentrated in Stamford and would use surveillance and detection equipment to provide a real-time traveler information system within the City. This system would be focused on the downtown area of Stamford, which is the largest employment center in the South Western Region and also contains Connecticut's busiest rail station serving both Amtrak and Metro-North passengers.

Project Incident Management (IM)-1 is focused on the arterial system of Norwalk and would provide a series of blank-out signs designed for use during major incidents, construction, or other events that cause excessive delay in the system. Signs would be integrated with other ITS deployments and preplanned scenarios developed to help optimize use of the system.

7.2 METHODOLOGY

IDAS overview

This section presents a brief overview of the ITS Deployment Analysis System (IDAS) software used to conduct the benefit-cost analysis for this project. More detail on IDAS can be found at http://idas.camsys.com/. IDAS is a sketch-planning software and analysis methodology developed by Cambridge Systematics for the Federal Highway Administration (FHWA).

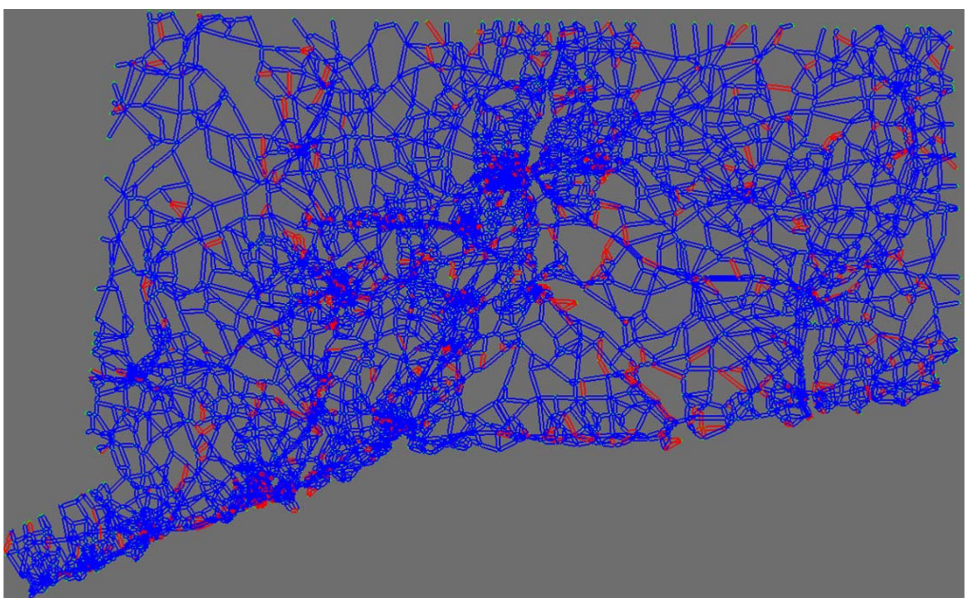
IDAS was developed to assist state, regional, and local agencies in integrating ITS into the transportation planning process. Planners and others can use IDAS to calculate relative costs and benefits of ITS investments. Currently, IDAS can predict costs, benefits, and impacts for more than 60 types of ITS investments in combination or isolation.

In order to be consistent with current transportation planning processes, IDAS operates as a postprocessor to travel demand models used by Metropolitan Planning Organizations (MPO) and by state Departments of Transportation (DOT). The Connecticut DOT Statewide model, shown schematically in

Figure 7.1, was used for this analysis. The model included all of the major roadways in the South Western Region, but was calibrated on a statewide basis. Vehicle trips were the basis of this analysis, with an assumed occupancy of 1.25 persons per vehicle. Both auto and truck trip tables were obtained from CT DOT and incorporated into the model.

Once the model was incorporated into IDAS, the model volumes were checked against actual counts. On major regional roads, the model replicated actual volumes within a reasonable level of accuracy. For example, comparison of model volumes with permanent count stations in Norwalk (I-95 both directions) and New Canaan (Route 124) showed discrepancies of less than 10 percent. However, some significant errors were found on portions of Route 1 in the study area. Rather than attempting to adjust the model, actual volumes were used in the benefit-cost analysis on those portions of US 1 where model volumes were not reliable. The analysis was conducted for year 2010 and reflects 24-hour traffic volumes. Because a daily model is used the impacts of peak-hour congestion are not fully captured in the analysis. As a result this analysis reflects a conservative estimate of the benefits gained from the proposed deployments.

Figure 7.1 CT DOT Statewide Travel Demand Model



There are a wide range of ITS improvements that can be assessed in IDAS, including Freeway Management Systems, Advanced Public Transit Systems, Incident Management, Emergency Management, Advanced Traveler Information Systems, and many others. IDAS, although a sketch-planning tool, can implement the modal split and/or traffic assignment steps associated with a traditional planning model. These steps permit estimation of the changes in modal, route, and temporal decisions of travelers resulting from ITS technologies. While IDAS does have the capability to handle transit analysis within the model, it does not use a specific transit network. For this reason, transit analysis is usually done in a spreadsheet format, and alternatives are evaluated based on either route-or system-level ridership and vehicle hours of service.

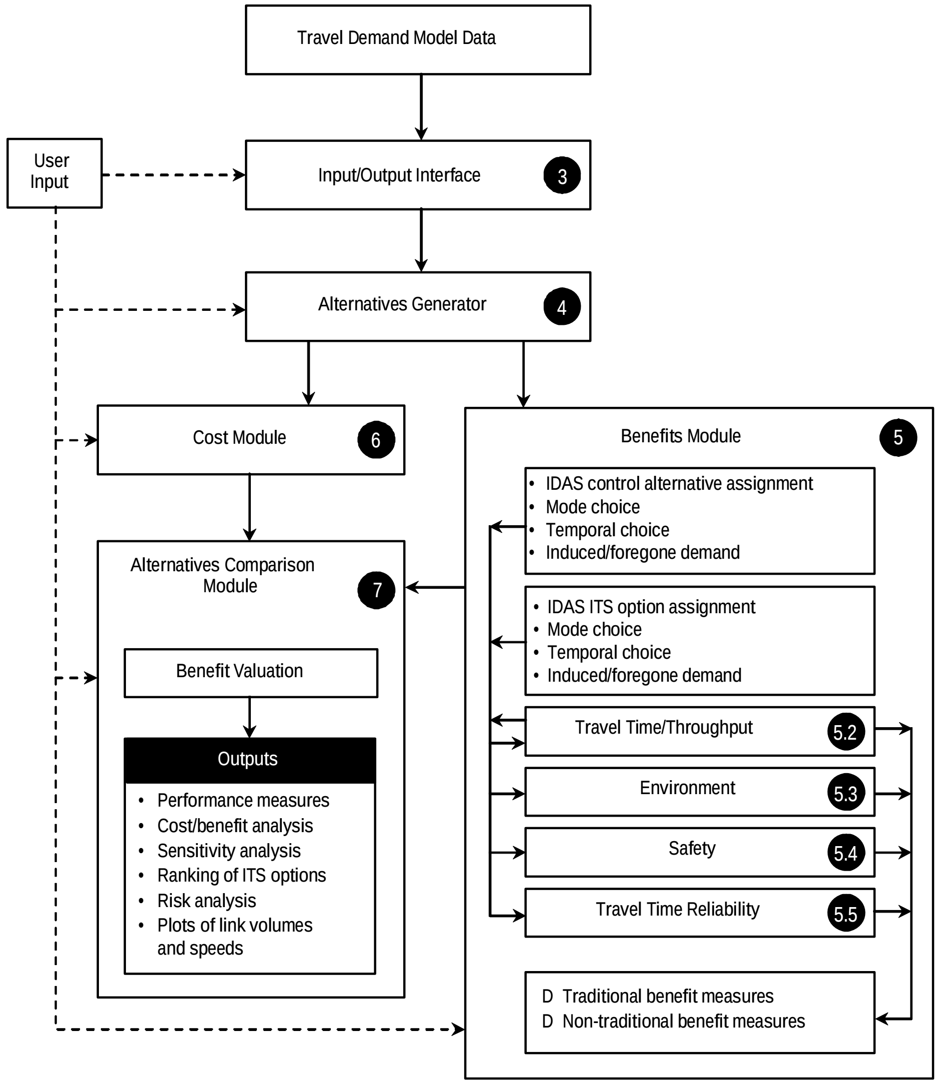
The set of impacts evaluated by IDAS included changes in user mobility, travel time/speed, travel-time reliability, fuel costs, operating costs, accident costs, emissions, and noise. The performance of selected ITS options can be viewed by market sector, facility type, and district. IDAS is comprised of the following five different analysis modules:

- Input-Output Interface Module (IOM);
- Alternatives Generator Module (AGM);
- Benefits Module;
- Cost Module; and
- Alternatives Comparison Module (ACM).

The input-output interface is used to specify and translate the data files provided by the regional travel demand models, and convert the data into a format that can be used internally by the IDAS model. The alternatives generator module allows an analyst to use a graphical user interface (GUI) to define and code ITS improvements into IDAS. The IDAS model structure is shown in Figure 7.2.

The cost module allows the user to define the incremental costs of the various ITS deployments being studied, including capital costs, and operating and maintenance costs. The user can modify IDAS-supplied default values for the proportion of the costs borne by the public and private sectors. Finally, the alternative comparison module provides the analyst with information regarding the value of user benefits from ITS deployments, the associated costs of the deployments, and a comparison of the benefits and costs for different ITS deployment options.

Figure 7.2 IDAS Model Structure and Process



The specific performance measures generated by IDAS include the following:

- Vehicle miles of travel (VMT);
- Vehicle hours of travel (VHT);
- Average speed;
- Person hours of travel (PHT);
- Number of person trips;
- Number of accidents:
  - Fatality;

- Injury; and
- Property damage only.

- Travel-time reliability (hours of unexpected delay);
- Fuel consumption (gallons); and
- Emissions:
  - Hydrocarbon and reactive organic gases;
  - Carbon monoxide;
  - Nitrous oxides; and
  - PM_{10}.

IDAS Benefit-Cost Summary details the results of the benefits valuation (value of time saved, value of accident reductions, etc.), cost analysis of the ITS option, net annual benefit, and benefit-cost ratio. These include the following:

- Annual Benefits:
  - Change in user mobility;
  - Change in user travel time (in-vehicle, out-of-vehicle, and travel-time reliability);
  - Change in costs paid by users (fuel costs, nonfuel operating costs, and accident costs – internal only);
  - Change in external costs (accident costs – external only, HC/ROG, NO_x, CO, PM_{10}, CO_2, global warming, noise, other mileage-based external costs, and other trip-based external costs);
  - Change in public agencies costs (efficiency included);
  - Other calculated benefits; and
  - User-defined additional benefits.
- Annual costs:
  - Average annual private sector costs;
  - Average annual public sector costs; and
  - Net benefit (annual benefit minus annual cost).

IDAS model parameters

The benefits module of IDAS operates on a series of parameters that are applied within the model to estimate the benefits of various improvements. The parameters used in this study are based on several sources listed below and are summarized for each deployment in Table 7.2. In order to compare alternatives directly, all benefits are monetized. The monetary values applied to the different type of benefits are shown in Table 7.3. A variety of sources were utilized to obtain the values included in Tables 7.2 and 7.3, including:

- IDAS default parameters based on benefits estimated by FHWA from various evaluation studies: http://www.benefitcost.its.dot.gov/its/benecost.nsf/BenefitsHome
- Surveys of commuters in Southeast Michigan and the greater Cincinnati region in which commuters were asked how often they change their travel behavior in response to DMS messages. Parameters were reduced from these values in the SWRPA region to reflect the high level of congestion in the system and the limited number of viable alternative routes.
- Cambridge Systematics' experience in running IDAS for various projects. Parameters for incident management and traveler information have been adjusted downward from the defaults in order to achieve more reasonable results.
- Economic factors shown in Table 7.3 are primarily IDAS defaults inflated at four percent per year to 2010. Adjustments were made for rapid increase in fuel costs at the time of the analysis, with a value applied of $3.80 per gallon.

Cost parameters were summarized and presented in chapter 6.0: *Project Development and Preliminary Budget Estimates*. In addition to descriptions of project elements, this chapter provides cost breakdowns for capital, operating, and maintenance expenses.

Table 7.2 IDAS Benefit Parameters

Deployment	Benefit	Parameter
ICM-1 CT 15 ITS Instrumentation (Areas with DMS, CCTV and Detection)	Percent responding to information	28%
	Percent of time with relevant information	5%
	Estimated time saved	5 minutes
	Reduction in incident duration	5%
	Reduction in fuel consumption	1%
	Reduction in fatality rate	1%
ICM-1 CT 15 ITS Instrumentation (Areas with CCTV and detection only)	Reduction in incident duration	5%
	Reduction in fuel consumption	1%
	Reduction in fatality rate	1%
ICM-2 US 1 ITS Instrumentation (Areas with DMS, CCTV and Detection)	Percent responding to information	20%
	Percent of time with relevant information	2.5%
	Estimated time saved	2.5 minutes
	Reduction in incident duration	5%
	Reduction in fuel consumption	1%
	Reduction in fatality rate	1%
ICM-2 US 1 ITS Instrumentation (Areas with CCTV and Detection only)	Reduction in incident duration	5%
	Reduction in fuel consumption	1%
	Reduction in fatality rate	1%
TSP-1 US 1 Transit Signal Priority	Transit travel-time reduction	5%
TSP-2 City of Stamford Transit Signal Priority	Transit travel-time reduction	5%
AVL-1 Norwalk Transit District AVL	Operating cost savings	5%
	Transit travel-time reduction (fixed route passengers only)	5%
AVL-2 CT Transit Stamford AVL	Operating cost savings	5%
	Transit travel-time reduction (fixed route passengers only)	5%
AM-1 Stamford Real-Time Traveler Information System	Travel-time savings	2%
IM-1 Norwalk Incident Management System	Reduction in incident duration	5%
	Reduction in fuel consumption	1%
	Reduction in fatality rate	1%

Table 7.3 Monetary Values of IDAS Default Parameters

Benefit Parameters	Parameter Values
Number of travel days in a year	247
Year of dollar values	2010
Inflation Rate	3%
Value of in-vehicle time	$15.00
Value of in-vehicle time (commercial)	$26.42
Value of out-of-vehicle time (commercial)	$26.49
Value of time multiplier for Emergency Vehicle	30.0
Value of out-of-vehicle time	$26.49
Value of reduced delay time	$15.00
Fuel costs (gallon)	$3.80
Emissions Costs (dollars per ton)	
HC/ROG	$2,763.83
NO_X	$5,812.78
CO	$6,058.94
PM_{10}	$17,240.47
CO_2	$5.55
SO_2	$5.55
GW	$0.00
Accident Costs	
Internal	
Fatality	$3,610,430.58
Injury	$79,082.43
Property damage	$4,399.70
External	
Fatality	$637,133.89
Injury	$13,956.27
Property damage	$775.87
Nonfuel operating costs (dollars per mile)	$0.10
Noise Damage Costs (dollars per mile)	$0.0011

7.3 Benefit-Cost Analysis Results

Results of the benefit-cost analysis are shown in this section. Annualized benefits are presented in current year dollars (2008) for the analysis year of 2010. The benefits are monetized as explained in Section 2.0. Capital costs are annualized based on the original cost of the equipment and the number of years of anticipated life. This essentially represents and "annual payment," including interest, based on the life of the capital equipment. Estimated annual operating costs are added to this to estimate total annualized cost. The types of benefits gained from the different packages vary slightly. The categories of benefits found include:

- **Change in user mobility.** This includes travel-time savings obtained from improved traveler information service. Information is obtained through surveillance and detection and transmitted to motorists through DMS or other services.
- **Travel-time reliability.** This includes travel-time savings from improved incident management services and includes change in unexpected delay from faster removal of incidents.
- **Fuel costs.** This includes the cost of fuel saved as a result of reduced delay.
- **Nonfuel operating costs –** This includes automobile operating costs other than fuel, such as tires and regular maintenance**.**
- **Accidents (internal).** This includes the cost of accidents to the user of the system, including vehicle damage, medical costs or loss of income in the case of severe injury or fatality.
- **Accidents (external).** This includes the cost to society of accidents, including incident removal, law enforcement, and in the case of more severe accidents, court costs.
- **Environmental.** These include various categories of emissions, including hydrocarbons, CO, NO, and particulate matter. Noise impacts also result form some alternatives.

The remainder of this chapter summarizes the results.

Integrated Corridor Management-1

The ICM-1 project expands the Freeway Management System on CT 15 (Merritt Parkway). Key elements of the system include 5 DMS, 8 Closed Circuit Television Camera (CCTV) installations, and 20 traffic flow detection stations. Capital costs are estimated at $2.47 million, with annual operations and maintenance costs of $500,000. Roughly one-half the operations and maintenance cost is for leased communication lines. This benefit-cost ratio estimated for this option is highly positive, particularly given the fact that costs are relatively high and the daily model does not fully account for the high level of peak-period congestion found on the Merritt Parkway. Over 80 percent of the monetary value of benefits received is in travel time.

Table 7.4 ICM-1 Benefit-Cost Results

Change in User Mobility	$2,149,000
Travel-Time Reliability	$1,218,000
Fuel Costs	$382,000
Accident Costs (Internal)	$59,000
Accident Costs (External)	$10,000
Total Annual Benefits	$3,818,000
Total Annualized Costs	$833,000
Benefit-Cost Ratio	4.58
Net Benefits	$2,985,000

Integrated Corridor Management-2

The ICM-2 project includes deployment of ITS equipment on US 1, which is the most important arterial corridor in the South Western Region. Major elements of the system include 4 DMS, 8 CCTV installations, and 20 detection stations. Capital costs are estimated at just at $2.12 million and annual operations and maintenance costs are estimated at $590,000. Over one-half of the operations and maintenance costs are for leased communication lines. The results of the benefit-cost analysis indicate a benefit/cost ratio lower than one, showing that this investment does not have positive returns. US 1 has much lower traffic volumes than the regional expressways and limited capacity to accommodate additional traffic during incidents. Nearly all of the benefits from this option are in travel time.

Table 7.5 ICM-2 Benefit-Cost Results

Change in User Mobility	$236,000
Fuel Costs	$68,000
Accident Costs (Internal)	$22,000
Accident Costs (External)	$10,000
Total Annual Benefits	$369,000
Total Annualized Costs	$842,000
Benefit-Cost Ratio	0.44
Net Benefits	($473,000)

Arterial Management-1

Package AM-1 includes an arterial management system for the City of Stamford. Downtown Stamford is a major regional employment center and growing residential center with a number of alternative arterial routes. Improved signal coordination and an improved information system can help guide motorists more quickly to their destination in Stamford or provide an efficient through route in case of an incident on I-95. The major costs elements for this system are software and modifications to detection equipment and controllers at downtown intersections. Operations costs include a full-time operating employee and software and web site-related expenses. Capital costs are estimated at $945,000 while annual operations and maintenance costs are estimated at $200,000. This alternative provides a good return on investment, due in part to its reasonable cost. Benefits from travel-time reductions and fuel savings are somewhat offset by increases in accident-related costs. This is caused by a shifting of traffic from expressways to the arterial system. Arterials have higher accident rates per VMT than do expressways.

Table 7.6 AM-1 Benefit-Cost Results

In-Vehicle Travel Time	$2,160,000
Travel-Time Reliability	$1,258,000
Fuel Costs	$174,000
Nonfuel Operating Costs	($289,000)
Accident Costs (Internal)	($234,000)
Accident Costs (External)	($39,000)
Emissions	$13,000
Noise	($3,000)
Total Annual Benefits	$3,040,000
Total Annualized Costs	$308,000
Benefit-Cost Ratio	9.87
Net Benefits	$2,732,000

Incident Management-1

This package is focused on the City of Norwalk and is designed to maximize the efficiency of the arterial system during incidents or periods of heavy congestion. The major cost elements of this package are 50 electronic blank-out signs and integration of communications and software equipment. Total capital costs are estimated at $2.31 million and annual operating costs at $245,000. This alternative also provides a good return on investment, primarily based on improvement in travel-time reliability and reduced fuel costs.

Table 7.7 IM-1 Benefit-Cost Results

Travel-Time Reliability	$2,574,000
Fuel Costs	$279,000
Accident Costs (Internal)	$48,000
Accident Costs (External)	$8,000
Total Annual Benefits	$2,909,000
Total Annual Costs	$460,000
Benefit-Cost Ratio	6.32
Net Benefits	$2,449,000

Automated Vehicle Location-1 (Norwalk)

Package AVL-1 involves installation of AVL equipment on all Norwalk Transit District vehicles. This will allow real-time tracking of vehicles and provide benefits in both travel time saved for passengers and reduced operating costs for NTD. Travel-time savings were calculated for fixed route passengers only due to the difficulty of estimating travel times for demand responsive passengers. The NTD serves 1.83 million passengers annually and has a total operating budget of $9.44 million. The capital cost of the AVL system is estimated at $1.37 million and annual operations and maintenance costs are estimated at $130,000. Forty-five fixed route buses and twenty demand responsive vehicles would be outfitted. The benefit-cost ratio for this option is highly positive, with the majority of benefits accrued from travel-time savings.

Table 7.8 AVL-1 (Norwalk) Benefit-Cost Results

Travel-Time Savings	$705,000
Operating Cost Savings	$472,000
Total Annual Benefits	$1,177,000
Annualized Cost	$295,000
Benefit-Cost Ratio	3.99
Net Benefits	$882,000

Automated Vehicle Location-2 (Stamford)

Package AVL-2 involves installation of AVL equipment on all Connecticut Transit – Stamford Division vehicles. This will allow real-time tracking of vehicles and provide benefits in both travel time saved for passengers and reduced operating costs for CTTransit. Travel-time savings were calculated for fixed route passengers only, as CTTransit does not provide demand responsive transit. Connecticut Transit – Stamford Division serves 3.7 million passengers annually and has a total operating budget of $7.83 million. The estimated capital cost of the AVL system is $1.21 million and the estimated annual operations and maintenance cost is $110,000. Forty fixed route buses would be outfitted. The benefit-cost ratio for this option is positive, with the majority of benefits accrued from travel-time savings. The overall benefit-cost ratio and net benefits are similar to those estimated for NTD.

Table 7.9 AVL-2 (Stamford) Benefit-Cost Results

Travel-Time Savings	$770,000
Operating Cost Savings	$392,000
Total Benefits	$1,162,000
Annualized Cost	$263,000
Benefit-Cost Ratio	4.42
Net Benefits	$899,000

Transit Signal Priority-1 (US 1)

This deployment package includes implementation of transit signal priority capability at intersections along US 1 that are served by either CTTransit or NTD. The major capital cost component is for signal controller upgrades, with the remainder of costs going to on-board bus units. Capital costs are estimated at $4.3 million with annual operating costs of $355,000. Benefits gained are improved travel time for transit passengers. The benefit-cost analysis indicates that this option does not provide a positive return on investment. Due to the large number of signalized intersections along US 1, costs are high and not compensated for by the amount of travel time saved. An alternative approach to increase cost effectiveness could be to concentrate TSP deployment in a more limited segment(s) of US 1 that has the highest ridership.

Table 7.10 TSP-1 (US 1) Benefit-Cost Results

Travel-Time Savings	$705,000
Annualized Cost	$850,000
Benefit-Cost Ratio	0.83
Net Benefits	($145,000)

Transit Signal priority-2 (Stamford)

This deployment package includes implementation of transit signal priority capability at intersections along bus route served by the CTTransit. Since many of the intersections in Stamford already have upgraded signal controllers costs are significantly lower than for TSP-1. Capital costs are estimated at $660,000, which includes software upgrades and on-board units. Annual operations and maintenance cost is estimated at $95,000. Due to low costs and a reasonable level of annual benefits, this package shows a positive benefit-cost ratio.

Table 7.11 TSP-2 (Stamford) Benefit-Cost Results

Travel-Time Savings	$618,000
Annualized Cost	$179,000
Benefit-Cost Ratio	3.45
Net Benefits	$439,000

7.4 Conclusions of Analysis

Table 4.1 summarizes the results of the benefit-cost analysis. Six of the eight proposed projects have positive benefit-cost ratios ranging from approximately 3.4 to 9.9. The net benefits gained vary significantly, however, as do the level of initial investments required. It is important to note that in some cases the benefits are highly sensitive to the parameter assumptions documented in Section 2.0 of this report. Additional sensitivity analysis should be conducted before proceeding into detailed planning and design for any of these projects. Based on this analysis, it does appear that two projects, ICM-2 and TSP-1, will not provide benefits adequate to justify the significant expenditures required. More limited deployment in targeted areas may be a more effective strategy.

Table 7.12 Summary of Benefit-Cost Analysis for South West Region ITS Plan

	Total Benefits	Annualized Cost	Benefit-Cost Ratio	Net Benefits	Capital Cost	Annual O&M
ICM-1 Merritt ITS	$3,818,000	$833,000	4.58	$2,985,000	$2,470,000	$500,000
ICM-2 US 1 ITS	$369,000	$842,000	0.44	($473,000)	$2,120,000	$590,000
AM-1 Stamford Information	$3,040,000	$308,000	9.87	$2,732,000	$945,000	$200,000
IM-1 Norwalk IM	$2,909,000	$460,000	6.32	$2,449,000	$2,310,000	$245,000
AVL-1 Norwalk	$1,177,000	$295,000	3.99	$882,000	$1,370,000	$130,000
AVL-2 Stamford	$1,162,000	$263,000	4.42	$899,000	$1,210,000	$110,000
TSP-1 US 1	$705,000	$850,000	0.83	($145,000)	$4,355,000	$355,000
TSP-2 Stamford	$618,000	$179,000	3.45	$439,000	$660,000	$95,000
Total Program	$13,798,000	$4,030,000	3.42	$9,768,000	$15,440,000	$2,225,000

8.0 Implementation

8.1 ITS Program Management

The complex nature of ITS deployments requires cooperation and integrated management between lead and participating agencies. In the South Western Region, the South Western Region ITS Technical Advisory Committee (TAC) is positioned to serve in a coordinating role between municipalities and partner agencies including Connecticut Department of Transportation (CT DOT), Federal Highway Administration (FHWA) and Federal Transit Administration (FTA).

8.2 Freeway and Arterial Management Strategies

The following strategies target freeway and arterial management. The strengths of these projects lie in their high benefit-to-cost ratio and in their ability to potentially impact the largest number of travelers.

Integrated Corridor Management-1 (ICM-1): CT-15 (Merritt Parkway) ITS Instrumentation

CT DOT currently operates three dynamic message signs (DMS) along CT-15. There are currently no surveillance cameras on CT 15. However, CT DOT does operate numerous cameras and DMSs on the parallel I-95 corridor.

This strategy would leverage CT DOT's existing ITS investments in the parallel I-95 corridor and would deliver a high degree of net benefits. Those benefits would include improved surveillance capabilities, more rapid detection of incidents and reduced response times, and improved traveler information to assist in incident management and informed traveler decision-making. Most importantly, this strategy would help integrate the management of the parallel CT 15 and I-95 corridors.

The key elements of this package include five DMSs, eight CCTV cameras and twenty detection stations. The greatest benefit realized from this strategy is the monetary value of travel time savings.

In the near-term, this strategy will require the following action items:

- Develop a scope of work to identify actions required to deploy a regional communications system

- Identify available sources of funding and amounts available for deployment
- Since the ICM-1 deployment will be most effective as a regional system, SWRPA should work cooperatively with CT DOT as well as Greater Bridgeport Region (GBRPA) and South Central Region (SCRCOG) to develop detailed plans for deployment
- SWRPA and CT DOT should coordinate with New York State agencies regarding deployment on Hutchinson River Parkway

Arterial Management -1 (AM-1): Stamford Real-Time Traveler Information System

This strategy includes an arterial management system for the City of Stamford. The package includes the creation of a public website that would collect and transmit real-time traveler information from public safety incident reports, construction activity reports, and the City's traffic surveillance cameras and detectors.

With $945,000 in estimated capital costs and annual operations and maintenance costs around $200,000, the costs of this project are low and the benefit to cost ratio is high (9.87). Operations for this project will require a full-time employee.

In the near term, this project will require the following action items:

- The City of Stamford should lead an effort to identify the specific data elements required to populate this system, and the sources of the data;
- SWRPA and CT DOT should identify opportunities to coordinate deployment with other projects in Stamford, including:
  - Arterial and intersection improvement projects should provide data feeds on traffic volume and delay that can be incorporated traveler information systems including future 511 system;
  - The SWRPA ITS TAC should work with law enforcement and construction managers to make sure that incident and construction information is kept up-to-date and reported into the information system.
- Identify available sources of funding and amounts available for deployment

Incident Management – 1 (IM-1): Norwalk Incident Management System

The City of Norwalk is the locus of several key corridors including I-95, CT 15 US 1, and US 7. The interchanges between these corridors make Norwalk a key node in diversionary plans prepared by CT DOT for in the event of a major incident. The benefits to cost ratio for this strategy is high (6.32) but so are capital costs. The system would likely only be used during major incidents. The benefits are primarily based on improvement in travel-time reliability and reduced fuel costs.

In the near-term, this project would require the following action items:

- Identify opportunities to implement this project in coordination with other Norwalk ITS and capital investments, such as arterial and intersection improvements. The cost of this option can be reduced by implementing the IM-1 deployments as part of other capital improvements.
- The City of Norwalk along with SWRPA, CT DOT and law enforcement agencies should develop an operations plan for the system as it is put in place. The operations plan would include actions required to coordinate the system with CT DOT's Traffic Management center and specific operational protocols.

Integrated Corridor Management-2 (ICM-2): US Route 1 ITS Instrumentation

This strategy would leverage CT DOT's existing ITS investments on the parallel I-95 corridor. The key elements of this package include four DMSs, eight CCTV cameras and twenty detection stations. Although this package would confer benefits, primarily in the form of travel time savings, the annualized cost of this strategy exceeds the monetary value of the benefits.

Further study of this strategy is required before any implementation is pursued.

8.3 Transit Management Strategies

The following ITS projects aim to improve transit services in the South Western Region. These strategies taken as a whole are relatively inexpensive, have strong net benefits and help to meet the growing transit needs of the Region and its transit operators.

Automated Vehicle Location-1 (AVL-1): Norwalk Transit District AVL

This project involves installation of automatic vehicle location (AVL) equipment on all Norwalk Transit District (NTD) buses. AVL systems enable real-time tracking of transit vehicles resulting in time savings for passengers and reduced operating costs for the operator.

NTD operates approximately forty-five fixed-route buses and twenty-five demand responsive vehicles, which would all be outfitted with an AVL system through the addition of GPS (or DGPS) units and an upgrade to the existing digital radio communication system.

The benefits to this project are largely accrued from travel-time savings and result in a relatively high benefit to cost ratio (3.99). Additionally, this project will meet one of the NTD's urgent needs.

In the near-term, the following action items should be pursued in furtherance of this project:

- Develop a work plan to evaluate existing digital radio system for AVL compatibility
- Coordinate with other NTD capital procurements
- Coordinate with CTTransit and CT DOT to realize economies of scale and system interoperability opportunities
- Identify available sources of funding and amounts available for deployment

Transit Signal Prioritization – 2 (TSP-2): Stamford Transit Signal Priority

In order to reduce transit travel times and to reinforce the schedule adherence of planned bus rapid transit (BRT) service, this project aims to provide transit vehicle signal prioritization throughout the City of Stamford. Many of the intersections in Stamford already have upgraded signal controllers and the costs for this project are therefore significantly lower than they would be otherwise.

In the near-term, the following action items should be pursued in furtherance of this project:

- SWRPA and the City of Stamford should initiate a study to identify priority corridors for implementation of this system. One option is to develop a test corridor so that the estimate of costs and benefits can be refined.
- Identify available sources of funding and amounts available for deployment

Automated Vehicle Location – 2: CTTransit – Stamford AVL

This project aims to add AVL equipment to all Connecticut Transit – Stamford Division (CTTransit) buses. This strategy is intended to improve the operating efficiency of CTTransit and increase transit's attractiveness to riders. The overall benefit-cost ratio and the net benefits are similar to those estimated for strategy

AVL-1. The City of Stamford is currently procuring a CAD/AVL system as part of its Stamford Urban Transitway project.

In the near-term, the following action items should be pursued in furtherance of this project:

- Identify available sources of funding and amounts available for deployment
- Develop phasing plan for implementation

Transit Signal Prioritization – 1 (TSP-1): US 1 Transit Signal Priority

In order to reduce transit travel times and to improve the schedule adherence of planned bus rapid transit (BRT) service, this project aims to provide transit vehicle signal prioritization along US 1 between Greenwich and Norwalk. Although this package would confer benefits, primarily in the form of travel time savings, the annualized cost of this strategy exceeds the monetary value of the benefits.

Further study of this strategy is required before any implementation is pursued.

Table 8.1 Near-Term Action Items

Lead Agency	Participating Agencies	Near-Term Action Items
ICM-1: CT-15 (Merritt Parkway) ITS Instrumentation		
CT DOT	FHWA Connecticut Dept. of Public Safety NYSDOT *Municipalities:* Greenwich Stamford Darien Norwalk Westport SWRPA	Develop a scope of work to identify actions required to deploy a regional communications System Identify available sources of funding and amounts available for deployment Since the CT-15 deployment will be most effective as a regional system, SWRPA should coordinate with CT DOT as well as GBRPA and SCRCOG to develop detailed plans for deployment SWRPA and CT DOT should coordinate with NYS agencies regarding deployment on Hutchinson River Parkway
AM-1: Stamford Real-Time Traveler Information System		
City of Stamford	CT DOT SWRPA	City of Stamford should lead an effort to identify the specific data elements required to populate this system, and the

			sources of the data; SWRPA and CT DOT should identify opportunities to coordinate deployment with other projects in Stamford; Arterial and intersection improvement projects should provide data feeds on traffic volume and delay that can be incorporated into traveler information systems including a planned statewide 511 system; The SWRPA ITS TAC should work with law enforcement and construction managers to make sure that incident and construction information is kept up-to-date and reported; Identify available sources of funding and amounts available for deployment.
IM-1: Norwalk Incident Management System			
	City of Norwalk	CT DOT Connecticut Dept. of Public Safety SWRPA	Identify opportunities to implement this project in coordination with other Norwalk ITS and capital investments, such as arterial and intersection improvements. The cost of this option can be reduced by implementing the IM system as part of other capital projects. SWRPA and the City of Norwalk along with CT DOT and law enforcement agencies should initiate an effort to develop operations plan for the system as it is put in place. The operations plan would include actions required to coordinate the system with CT DOT's Traffic Management center and specific operational protocols.
ICM-2: US-1 ITS Instrumentation			
	CT DOT	FHWA Connecticut Department of Public Safety SWRPA NYSDOT *Municipalities:* Greenwich Stamford Darien Norwalk	The cost of this strategy exceeds the benefits. Further study is required before any implementation is pursued.

AVL-1: Norwalk Transit District AVL		
Norwalk Transit District	Federal Transit Administration Norwalk SWRPA CTTransit CT DOT	Develop a work plan to evaluate existing digital radio system for AVL compatibility Coordinate with other NTD capital procurements Coordinate with planned CTTransit ITS deployments to achieve economies of scale and system interoperability opportunities Identify available sources of funding and amounts available for deployment
TSP-2: Stamford Transit Signal Priority		
City of Stamford	FHWA CT DOT SWRPA CTTransit Norwalk Transit District	SWRPA and the City of Stamford should initiate a study to identify priority corridors for implementation of this strategy. One option is to develop a test corridor so that the estimate of costs and benefits can be refined. Identify available sources of funding and amounts available for deployment
AVL-2: CTTransit-Stamford AVL		
CTTransit	FTA City of Stamford SWRPA Norwalk Transit District CT DOT	Identify available sources of funding and amounts available for deployment. Develop phasing plan for implementation.
TSP-1: US-1 Transit Signal Priority		
CT DOT	FHWA SWRPA Norwalk Transit District CTTransit *Municipalities:* Greenwich Stamford Darien Norwalk	The cost of this strategy exceeds the benefits. Further study is required before any implementation is pursued.

9.0 Financial Plan

This Financial Plan is conceptual and assumes current prices in year 2010 dollars for all costs. For each of the priority ITS projects, this plan will outline the costs associated with initial design, acquisition and deployment; operations and maintenance; and projected upgrade and replacement. Replacement schedules and costs reflect planning-level estimates and are conceptual. Replacement schedules are illustrated for one lifecycle of each piece of equipment. All costs are presented in 2010 dollars.

Each replacement and upgrade graph is followed by a bulleted list of the most significant replacement or upgrade items, in terms of dollars. Lifetime years are generally offered as a range. For the purposes of the accompanying graphs, the midpoint of that range has been utilized for expected lifetime.

It must be noted that replacement lifecycle estimates for ITS deployments are inherently difficult and should be regarded as a high-level guide. This difficulty arises from several factors including the rapidly changing pace of technological advancement; changing technology standards and legislation; required upgrades to supporting infrastructure; and the difference between functional and operational obsolescence.

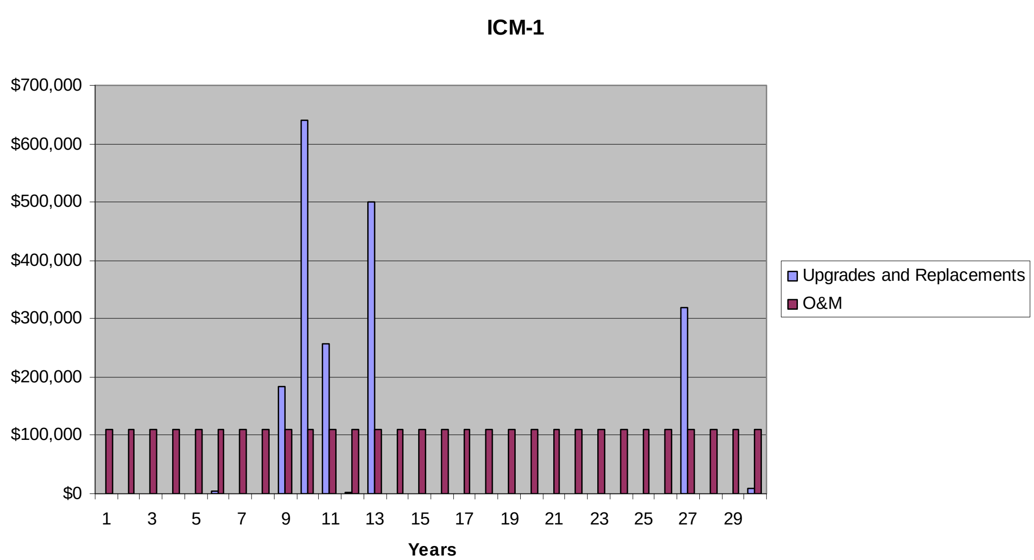
Unless otherwise noted, these costs are in 2010 dollars and represent a single lifecycle for each piece of equipment.

9.1 FREEWAY AND ARTERIAL MANAGEMENT STRATEGIES

Integrated Corridor Management-1 (ICM-1): CT-15 (Merritt Parkway) ITS Instrumentation

- Initial design, acquisition, and deployment: $2.47 Million
- Annual operations and maintenance: $500,000
- Project upgrade and replacement timing and costs:
  - (5) Dynamic message signs at 12 – 15 years ($500,000)
  - (8) Camera poles with cabinet and foundation at 25 – 30 years ($320,000)
  - (32) Detection stations with cabinets and overweight detection cabinets at 5 – 15 years ($640,000)

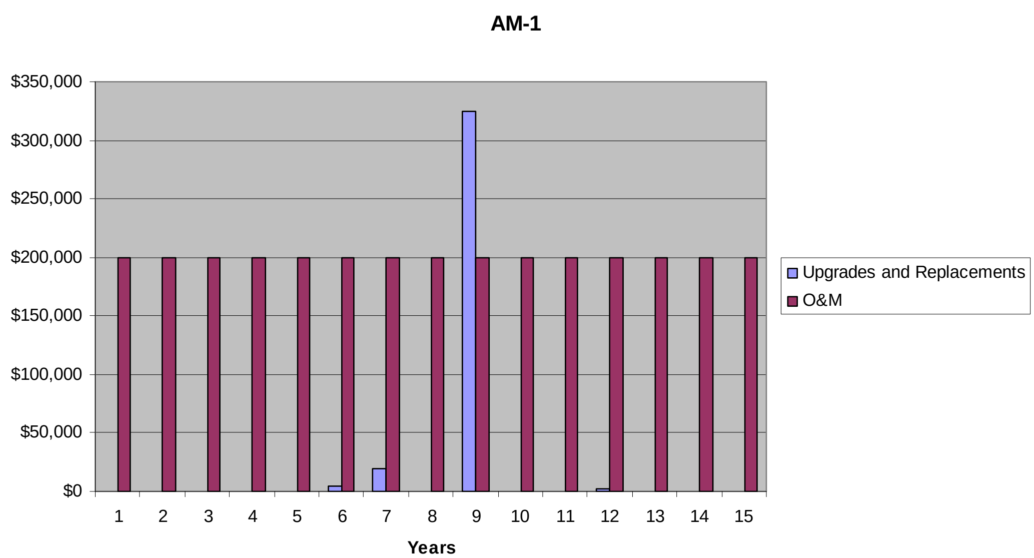
Figure 9.1 ICM-1 Upgrade and Replacement Costs



Arterial Management -1 (AM-1): Stamford Real-Time Traveler Information System

- Initial design, acquisition, and deployment: $945,000
- Annual operations and maintenance: $200,000
- Project upgrade and replacement timing and costs:
  - Customized traffic congestion data collection software at 8 – 10 years ($200,000)
  - Communications equipment upgrades at 8 - 10 years ($100,000)

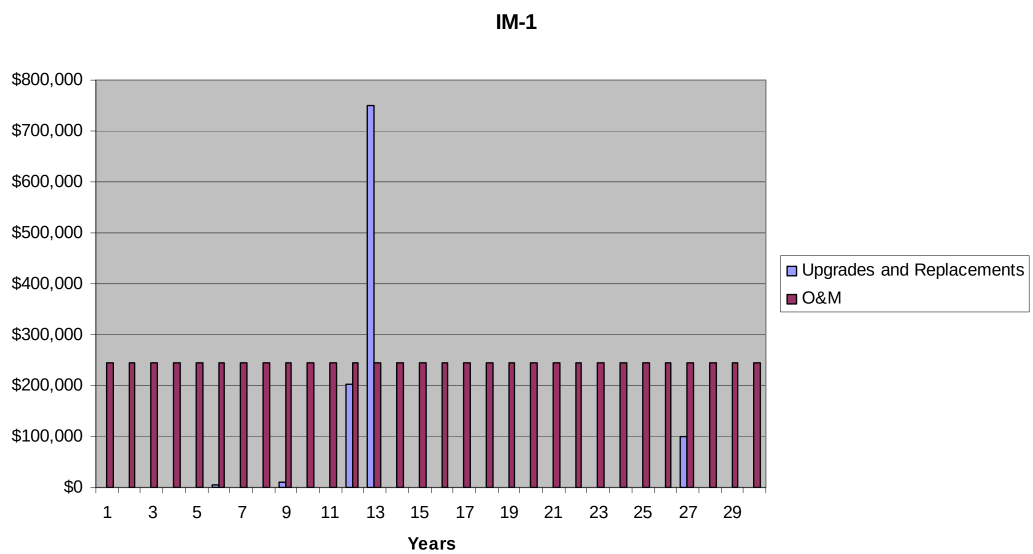
Figure 9.2 AM-1 Upgrade and Replacement Costs



Incident Management – 1 (IM-1): Norwalk Incident Management System

- Initial design, acquisition, and deployment: $2.31 million
- Annual operations and maintenance: $245,000
- Project upgrade and replacement timing and costs:
  - (50) Electronic blankout signs at 12 – 15 years ($750,000)
  - Communications equipment upgrades at 10 – 15 years ($100,000)
  - Electronic sign control software at 10 – 15 years ($100,000)

Figure 9.3 IM-1 Upgrade and Replacement Costs

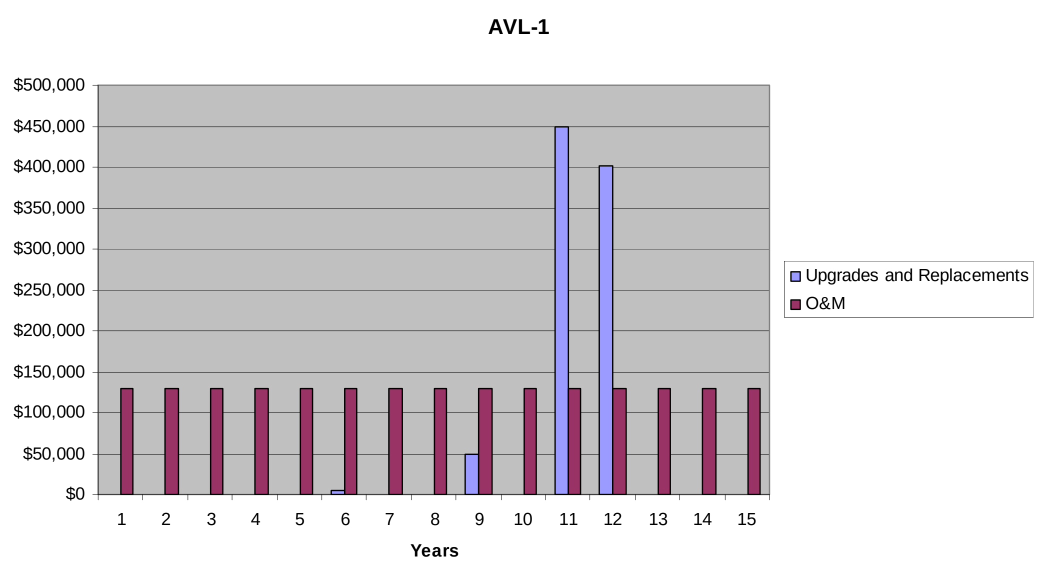


9.2 TRANSIT MANAGEMENT STRATEGIES

Automated Vehicle Location-1 (AVL-1): Norwalk Transit District AVL

- Initial design, acquisition, and deployment: $1.37 million
- Annual operations and maintenance: $130,000
- Project upgrade and replacement timing and costs:
  - (75) On-board fixed route and demand responsive GPS units at 10 – 12 years ($450,000)
  - Radio system upgrade for mobile data communications at 10 – 15 year ($200,000)
  - AVL software at 10 – 15 years ($150,000)
  - (5) Information displays at 12 – 15 years ($150,000)

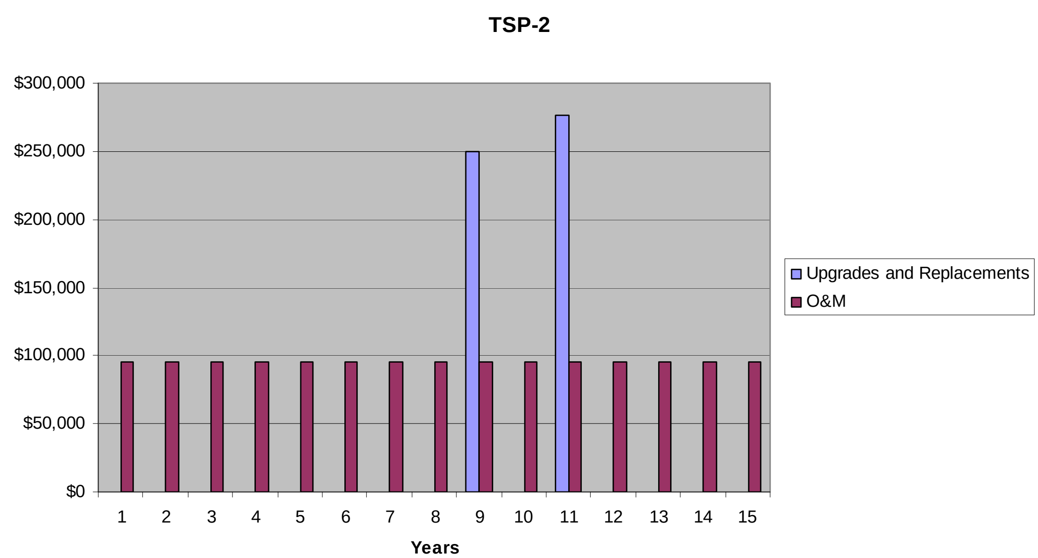
Figure 9.4 AVL-1 Upgrade and Replacement Costs



Transit Signal Prioritization – 2 (TSP-2): Stamford Transit Signal Priority

- Initial design, acquisition, and deployment: $660,000
- Annual operations and maintenance: $95,000
- Project upgrade and replacement timing and costs:
  - (46) On-board TSP emitter/processor units at 10 -12 Years ($276,000)
  - Computerized central traffic control system software expansion at 8 – 10 years ($150,000)
  - Central traffic control system hardware at 8 – 10 years ($100,000)

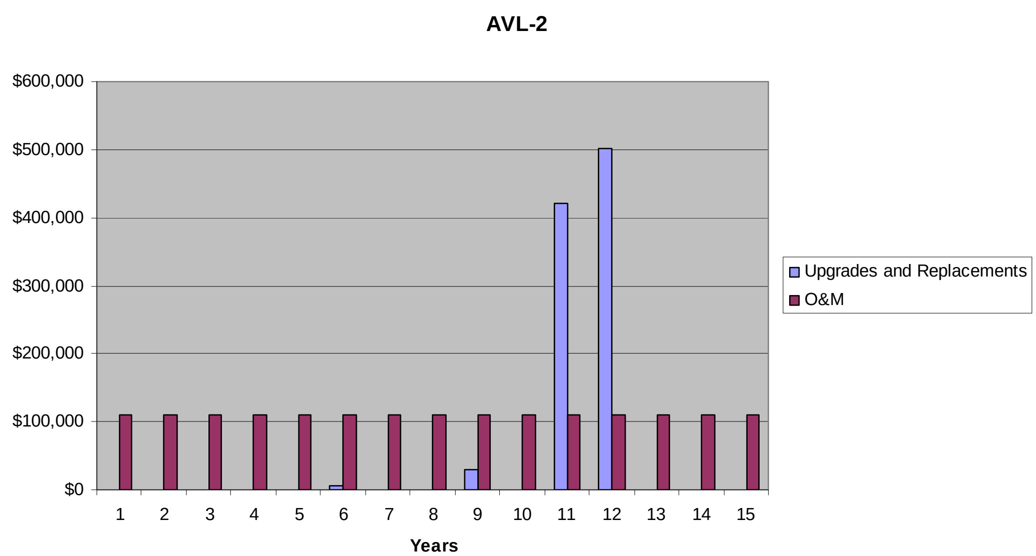
Figure 9.5 TSP-2 Upgrade and Replacement Costs



Automated Vehicle Location – 2: CT Transit – Stamford AVL

- Initial design, acquisition, and deployment: $1.21 million
- Annual operations and maintenance: $110,000
- Project upgrade and replacement timing and costs:
  - (46) On-board fixed route bus GPS units at 10 – 12 years ($414,000)
  - Radio system hardware and upgrade at 10 – 15 years ($350,000)
  - CAD/AVL software at 10 – 15 years ($150,000)

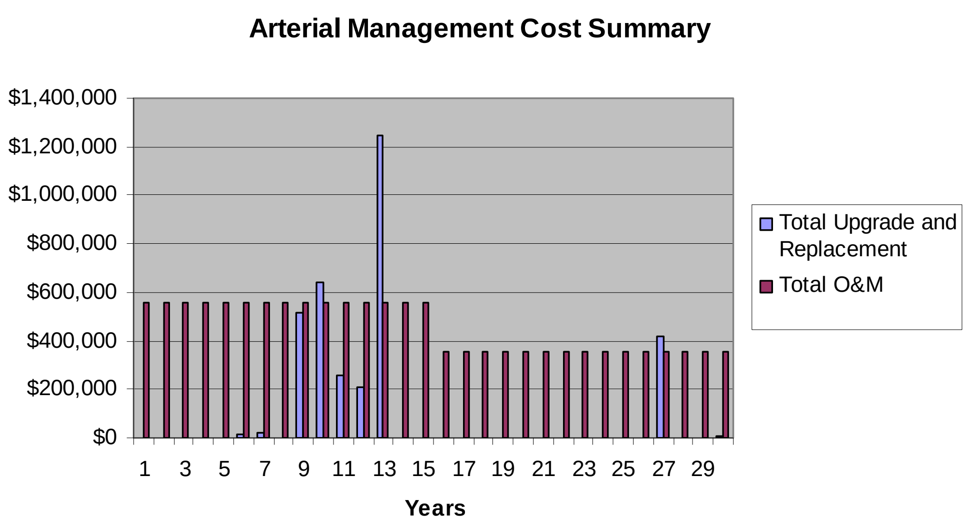
Figure 9.6 AVL-2 Upgrade and Replacement Costs



Summary of all Arterial Management Package Costs

- Initial design, acquisition, and deployment: $5.725 million
- Annual operations and maintenance: $945,000
- Project upgrade and replacement timing and costs

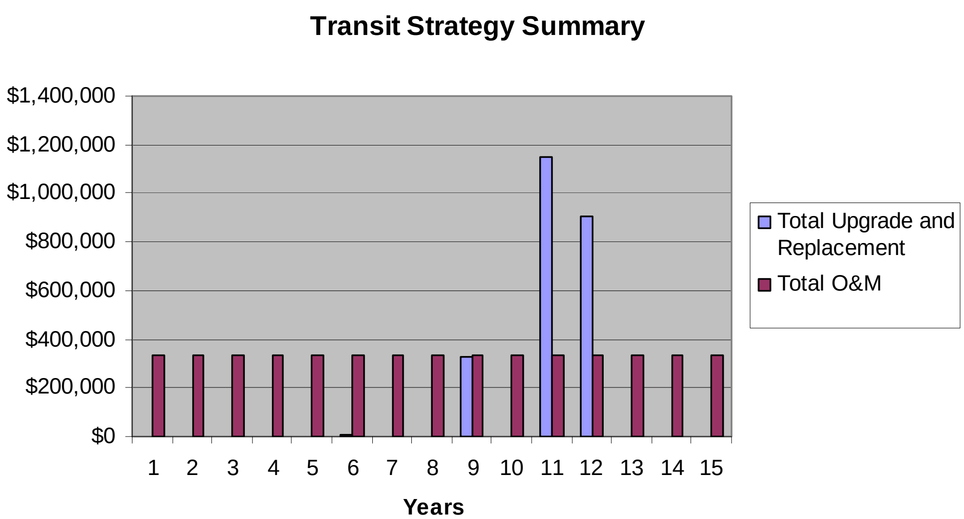
Figure 9.7 Arterial Management Cost Summary



Summary of all Transit Management Package Costs

- Initial design, acquisition, and deployment: $3.24 million
- Annual operations and maintenance: $335,000
- Project upgrade and replacement timing and costs

Figure 9.8 Transit Strategy Summary



9.3 FEDERAL FUNDING SOURCES

The following section presents potential funding sources on both the federal and state level. Examples of funding sources that have been used in Connecticut are identified.

National Highway System Funds

These (80/20) funds are more flexible than Interstate Highway Funds can be used for any type of highway project including transit or other transportation projects in the corridor, maintenance and capital improvements. CT 15 is eligible for these funds as it is designated part of the National Highway System.

Surface Transportation Program (STP)

This program provides flexible funding to be used by states and localities for projects on any Federal-aid highway, including the National Highway System, bridge projects on any public road, transit capital projects and intracity and intercity bus terminals and facilities. STP funds are divided amongst several subprograms, some of which could be tapped for ITS projects in the SWRPA region including:

STP-Urban; STP-Bridgeport/Stamford.

These funds are designated for specified urban areas. In the South Western Region, Stamford is the only specified urban area. These funds are flexible and can be used for a wide variety of projects. 50% of all STP funds are designated for STP – Urban projects.

STP – Anywhere

These STP funds are available for projects anywhere in the State. They represent 30% of all STP funds and are 80% federal with 20% State matching funds. They are generally allocated by CT DOT in Connecticut.

STP-Enhancement

These 80% funds are available for projects that go beyond traditional transportation activities. These enhancement projects must relate to the intermodal transportation system by function or by impact. The State generally does not provide matching funds, those are typically produced locally. This program encompasses 10% of total STP funding.

Highway Safety Improvement Program

This program provides Federal-aid funding to achieve a significant reduction in traffic fatalities and serious injuries on all public roads. As the State of Connecticut has in place a Strategic Highways Safety Plan, the State is eligible to receive 90% funding for safety improvement projects including those that improve emergency medical services.

Congestion Mitigation and Air Quality (CMAQ) Improvement Program

This program, jointly administered by the Federal Highway Administration (FHWA) and the Federal Transit Administration (FTA), provides funding to projects that reduce criteria air pollutants regulated from transportation-related sources. The funds can be allocated to CT DOT, SWRPA and transit agencies. **CMAQ funds are being used by the City of Stamford to fund ITS elements of the Stamford Urban Transitway.**

FTA Section 5309/07/10/11 Capital Funding Programs

These programs, administered by the FTA, provide capital funding for various improvements and operating programs to defray the costs of transit services and improvements.

Homeland Security

The Department of Homelands Security administers several grant programs that support the protection of critical infrastructure including mass transit and highways that are vital to the nation's economy. These funds are available to states at the request of the Governor appointed State Administrative Agency, which will distribute funds to Transit Agencies. ITS projects may qualify for some funding through these programs:

- Transit Security Grant Program (TSGP)
- Intercity Bus Security Grant Program (IBSGP)
- Trucking Security Program (TSP)
- Buffer Zone Protection Program (BZPP)

9.4 State and Local Funding Sources

Special Transportation Fund

The state Special Transportation Fund pays the operating expenses of the Department of Transportation; State funded (100%) infrastructure improvement projects; and the interest and principal due from the sale of bonds. The fund is fed primarily by motor fuel tax and motor vehicle receipts.

Local Capital Improvement Program

This program distributes funds to municipalities to reimburse the costs of eligible capital improvement projects including road and bridge projects. These funds can be applied for using a simple application to the Office of Policy and Management.

Local Bonds

The City of New Haven issued bonds to pay for GPS units for its Public Works fleet and accompanying software as well as and camera security for facilities.

The City of Hartford issued bonds to pay for traffic cameras on arterial streets. The funds provided new cameras and replaced existing cameras.

10.0 Policy Statement

The goals of this policy statement are as follows:

- To encourage standardization of data structures, communications protocols, and interfaces;
- To enable simplified data exchange between agencies and regional stakeholders;
- To prioritize data sharing goals and initiatives.

10.1 Federal Requirements for ITS

The Federal Highway Administration (FHWA) and Federal Transit Administration (FTA) outline standards which must be met in order for a regional ITS system to receive federal funding.

Regional ITS Architecture

A region must develop an ITS architecture to guide the development of ITS projects and programs. This must be accomplished within four years of the first ITS project in order for that region to advance a project to final design. Further, the agencies and stakeholders must develop and implement procedures as well as assign responsibility for maintaining the regional ITS architecture as needs evolve.

Developing a regional ITS architecture requires participation from the following agencies, as appropriate:

- Highway agencies
- Public safety agencies (police, fire, medical)
- Transit operators
- Federal lands agencies
- State motor carrier agencies
- Other operation agencies as necessary

FHWA/FTA Regional ITS Architecture Minimum Requirements

1. A description of the region;
2. Identification of participating agencies and other stakeholders;
3. An operational concept that identifies the roles and responsibilities of participating agencies and stakeholders in the operation and implementation of the systems included in the regional ITS architecture;
4. Any agreements (existing or new) required for operations, including at a minimum those affecting integration of ITS projects; interoperability of different ITS technologies, utilization of ITS-related standards, and the operation of the projects identified in the regional ITS architecture;
5. System functional requirements;
6. Interface requirements and information exchanges with planned and existing systems and subsystems (for example, subsystems and architecture flows as defined in the National ITS Architecture);
7. Identification of ITS standards supporting regional and national interoperability;
8. The sequence of projects required for implementation of the regional ITS architecture.

10.2 Systems Engineering Process

All funded ITS projects must be based on a systems engineering analysis on a scale commensurate with the project scope.

FTA/FHWA Systems Engineering Analysis Minimum Requirements

1. Identification of portions of the regional ITS architecture being implemented (or if a regional ITS architecture does not exist, the applicable portions of the National ITS Architecture);
2. Identification of participating agencies roles and responsibilities;
3. Requirements definitions;
4. Analysis of alternative system configurations and technology options to meet requirements;
5. Procurement options;
6. Identification of applicable ITS standards and testing procedures; and
7. Procedures and resources necessary for operations and management of the system.

The final design must incorporate the interface requirements and information exchanges as specified in the regional architecture. All projects funded with highway trust funds must use DOT approved ITS standards and interoperability tests.

10.3 DATA SHARING

The Benefits of Sharing Data

Sharing ITS data between agencies is a long-term goal that has multiple benefits. These benefits include allowing safety agencies to more appropriately respond to an accident, enhancing the development of traffic management and operations, and better reporting of conditions between municipalities and the State.

Benefits to the Agency

To enable data sharing, data and interface standards must first be established and applied. With standardization, the agency not only benefits from being able to receive and work with exterior data sources, but also protects its own interests. Standards avoid the costly dangers of early obsolescence, provide a choice of manufacturers and contractors during procurement, ensures future proofing, and allows existing and future sources of data to be used together in new ways. By avoiding lock-in with a certain manufacturer, the agency ensures competition and reasonable costs for future ITS procurement. The agency can easily, and without great cost, share and receive data with other agencies, planning organizations, and the public.

Benefits to the Public

Allowing a broader range of players access to relevant data will result in more insightful planning practices. Planning organizations and other agencies will not need to collect their own data, saving the organizations time and the taxpayers' money. Integrated data exchange between agencies and players will result in a more integrated, informative regional network where travelers can access relevant information from a centralized location rather than from various sources. Sharing information with first responders will enable faster, more accurate responses to emergency situations, enhance safety and speed clearing of incidents.

10.4 Challenges to Sharing Data

Several challenges exist which limit the ability of data to be shared between agencies.

Format Standardization

The most significant challenge facing the drive to enhance data sharing is the lack of a standard format in which the data is stored and managed.

Contractors and vendors supply equipment and software that manages the data in a proprietary, nonstandard format. Different municipalities choose different vendors during the bidding process, which results in a fragmented network of equipment that cannot communicate with any single network.

The use of proprietary standards faces other problems:

- Expansion and maintenance of the system requires the use of the same vendors which undermines the bidding process
- Vendors that go out of business may require the entire system to be replaced rather than expanded or maintained in the future
- Copyright or encryption of the original format restricts vendor selection

Resources

Establishing channels for data sharing requires money and staff resources.

Security and Privacy

There are concerns that transmitting data between agencies could lead to security leaks, either by exposing ports to attack or by interception by a malicious third party. Video feeds, in particular, may wish to be cut off during a serious accident.

Internal Disparity

There may be a lack of understanding within agencies what the standards for formatting, interfaces, and data sharing are.

10.5 SOLUTIONS FOR SHARING DATA

Develop and Apply a Standard

The Federal Systems Engineering process requires that agencies comply with the regional architecture when deploying new systems or technology and adopt DOT standards (as described in FHWA's "Regional ITS Architecture Guidance Document.")

NTCIP (National Transportation Communications for ITS Protocol)[5] is a family of established standards that provides protocols and data formats that allow for equipment from different manufacturers to interoperate and store data in an open format. NTCIP standards "reduce the need for reliance on specific equipment vendors and customized one-of-a-kind software."

The Connecticut Statewide ITS Architecture (April 2005) identifies several relevant ITS standards that regional stakeholders should consider when planning, designing, procuring, and implementing ITS systems. These standards should be as widely applied as possible. When necessary standards do not exist, for example when sharing video data, they should be developed and implemented as part of the development process.

Require vendor standards compliance

As part of the bidding process, vendors may be required to provide solutions that comply with defined standards and allow interoperability with other systems.

Data Ownership

The agency which initially acquires the data necessarily "owns" the data. As such, they are at liberty to restrict its usage. However, a regional architecture should define who can access what data.

Identify Priorities – Establish a forum for communication between agencies and regional stakeholders

[5] www.ntcip.org

Discussion with regional stakeholders that wish to exchange data will reveal what the regional priorities for sharing data are. For instance, coordination with public safety officials could identify the most urgent priorities for video sharing.

Face-to-face meetings are especially helpful for sharing ideas, discussing implementation, and exchanging information. Regularly scheduled meetings with stakeholders, including planners, engineers, agencies, and related organizations can be a productive and effective way to incite regional progress.

10.6 Conclusion

Exchanging data between agencies and regional stakeholders benefits everyone. With a well-considered architecture, establishment and following of standardization, and communication between stakeholders, data sharing is cost-effective and has long term benefits. The side effect of standardization benefits the agency by reducing costs, ensuring competition for contracts, and future-proofing equipment and software. The public benefits from enhanced emergency response, streamlined information resources, and a better-informed regional planning process.