5

SYSTEM PRESERVATION, MODERNIZATION, AND EFFICIENCY

The Boston Region MPO's Vision for System Preservation, Modernization, and Efficiency

Preserving the existing transportation network and replacing systems once their life span has been realized are tasks critical to the promotion and effective management of regional mobility. The vision of the Boston Region MPO is to maintain and manage existing transportation facilities so that they function at their highest possible level of safety, service, and efficiency. In this manner, people using elements of the system will experience the highest possible service level. Application of transportation systems management and intelligent transportation systems (ITS) technologies will be the main tool used to provide information, reduce congestion, and expedite transit service, thereby providing for system reliability, safety, and efficiency. Upgrading to keep in step with evolving standards will help meet the region's changing needs.

To implement this vision, the MPO has developed a set of policy statements to guide its decision-making:

- Put priority on projects that maintain, repair, and modernize existing infrastructure.
- Set funding goals for maintaining the system.
- Make investments that maximize the efficiency, effectiveness, reliability, and flexibility of the existing transportation system.
- Encourage and support, through planning and programming, projects and programs that improve the operation of the existing transportation system through the use of ITS, new technologies, and transportation systems management.

Introduction

Due to its size, use, and age, the Boston regional transportation network must be constantly maintained and modernized to handle the millions of trips that are made every day. An extensive transportation network ties the region together. Private vehicles, freight, and transit share much of the over 23,000 lane-miles and 1,447 bridges in the region. With over 2,500 vehicles, 275 stations, 885 miles of track, over 46,000 parking spaces, 20 miles of tunnels, and 19 maintenance shops, the MBTA's infrastructure is extensive and has major capital needs. Thousands of miles of sidewalks, bike lanes, and multi-use paths connect people's homes with transit, work, and shopping, as well as providing recreation opportunities for the region's residents.

Boston has the oldest subway system in North America, with the first underground streetcar service dating back to 1897. Original sections of this subway still exist along the Green Line under Boston Common. The first station along what is now the Blue Line opened in 1906, the first stations along the Orange Line in 1908, and the first stations along the Red Line in 1912. In 1973, the MBTA bought various commuter rail lines from private owners. The MBTA's commuter rail system now runs from as far away as Worcester and Providence, Rhode Island, into Boston.

The long-term plan must succeed at preserving, modernizing, and improving the operational efficiency of the transportation system. In almost all cases, the most effective use of limited transportation resources is to preserve and modernize existing facilities by maintaining a state of good repair, relieving choke points, addressing high-incident crash locations, and improving mobility. To continue to meet the challenge of keeping the transportation network in good condition, significant state resources must be directed toward system preservation. These resources will be used to reduce the number of structurally deficient and weight-restricted bridges, invest in newer and cleaner transit vehicles, and ensure that all modes are safe, secure, and meet customer expectations.

Programs That Emphasize the Preservation, Modernization, and Efficiency of the Existing Transportation System

More efficient spending can be achieved through optimizing performance and maintaining the current transportation system investments. The programs described below have been identified under two categories—physical maintenance and management programs (programs to maintain the physical infrastructure) and operational efficiency management programs (programs designed to preserve capacity and improve mobility and safety throughout the region).

Physical Maintenance and Management Programs

Preservation of the Existing Transportation System

The Boston Region MPO emphasizes reinvesting in the region's transportation infrastructure for

both highway and transit spending to ensure that current infrastructure is maintained and enhanced to best serve the public. This approach focuses on projects that preserve and rehabilitate transportation facilities. It ensures that assets are well managed, maintained, and operated to preserve their useful life, thereby reducing the need for more costly, capital-intensive replacements or solutions. The approach emphasizes keeping existing transportation assets in good condition. Allocating resources for existing infrastructure, can also enhance older communities with improved road, bridge, and public transit facilities, rather than encouraging new growth in open and undeveloped areas.

Various initiatives have been implemented to support these efforts. Some of these initiatives are described in the remainder of this chapter.

This approach does not preclude expansion projects. Some projects involving strategic capacity expansions can help address longstanding problems of safety and mobility, foster economic development and job creation, and improve air quality. Some of the projects in this Plan are included in an effort to advance these goals.

Roadway Maintenance

Chapter 90 Program

The Chapter 90 program (named for Chapter 90 of the Massachusetts General Laws), which is administered by MassHighway, contributes to the Commonwealth's strategy of preserving existing transportation facilities. This program supports the construction and maintenance of roadways classified as local; that work is performed by the cities and towns of the Commonwealth. The Chapter 90 program is funded by bond revenue.

Chapter 90 defines a specific formula for the apportionment of funds to municipalities. Under this formula, funds are distributed based on standardized measures of local roadway infrastructure and usage. The formula comprises three variables: local road mileage as certified by MassHighway, employment figures from the Department of Employment and Training, and population estimates from the U.S. Census Bureau.

Typically, the majority of Chapter 90 allocations (60 percent) are used for road resurfacing, with another 32 percent for reconstruction. The remaining funding goes toward engineering and equipment. These funds are reimbursed to communities based on certified expenditure reports submitted to MassHighway. This program helps communities maintain and preserve locally-owned roadways.

Interstate Highway Maintenance

MassHighway oversees the interstate maintenance program and ensures that the system of interstate highways within the region is maintained to an acceptable standard. Work under this category includes reconstruction, resurfacing, signing, striping, and other routine or periodic maintenance.

Pavement Management

Pavement management systems play a key role in the rehabilitation and maintenance of our highways. A pavement management system (PMS) stores, analyzes, and summarizes pavement

information for use in selecting and implementing pavement construction, rehabilitation, and maintenance programs. The system assists in the decision-making process required to maximize the funds employed for pavement preservation.

MassHighway uses PMS to constantly monitor the roadway network's roughness and deterioration using a variety of methods and measuring devices. Within the MPO region, they monitor all National Highway System (NHS) roadways and connector roads, which include all interstate roadways and some other major state roadways. They also monitor principal arterial roadways and non-NHS numbered state routes. The total amount of roadway monitored is approximately 1,300 miles. Based upon the results of this monitoring, MassHighway evaluates and prioritizes corrective actions for the improvement and maintenance of the roadways under its jurisdiction. Pavement maintenance may be accomplished through surface patching, roadway resurfacing, or full-depth reconstruction. The MPO encourages all municipalities in the region to use a PMS for their local roadways.

Bridge Maintenance and Rehabilitation

Over the next 20 years, the MPO will need to continue to fund the maintenance and rehabilitation of the region's bridges, which includes replacing bridge decks and reconstructing bridges. With the goal of optimizing allocation of limited resources, MassHighway and the MBTA implemented PONTIS, a bridge management software tool for recording, organizing, and analyzing bridge inventory and inspection data. PONTIS is used by departments of transportation in over 45 states and by numerous national and international agencies. PONTIS is used to guide the statewide bridge program, which dedicates significant resources to preservation, not just repair and replacement. PONTIS also assists in clearly articulating roles and responsibilities and coordinating between the various stakeholders in the process. PONTIS contains information on the year built/rebuilt, the inspection frequency for each bridge, and detailed structural information such as the bridge description, dimensions, and the conditions of the deck, superstructure, and substructural elements. The database also contains the inventory and operating values of each bridge, which indicate the load-carrying capacity of the structure.

Highway Bridges

A systematic approach to evaluating bridge conditions is critical to meeting the goal of infrastructure preservation. In Massachusetts (and many other states as well), bridge conditions are determined through a nationally adopted rating system. Using this system, bridges are typically inspected on a two-year cycle, although a particular bridge may be inspected as often as every six months, depending upon the identified concerns.

Since a majority of bridges in the region meet national standards for structural adequacy, safety, and public use, most preservation efforts are focused on bridges that are structurally deficient and weight-restricted. Currently, 12 percent of

the bridges in the Boston region (or 169 bridges) are within this classification. Structurally deficient bridges have experienced deterioration significant enough to potentially reduce their load-carrying capacities, although structurally deficient bridges are not necessarily weight-restricted or unsafe. Weight-restricted bridges can impede the flow of commercial trucks and public safety vehicles (such as fire engines) and school buses. When these bridges were built decades ago, they were not designed to support the increased weight of today's commercial vehicles. MassHighway rates the capacity of the bridges to safely carry the posted loads.

One important asset management initiative is the municipal bridge maintenance agreements between MassHighway and many local communities. Under these agreements, MassHighway reconstructs bridges under local jurisdiction. In return for bridge reconstruction, municipalities agree to the maintenance and repair of minor deficiencies of the new bridge. The preservation agreements specify the types of maintenance required and provide for routine inspections by MassHighway. Together with the bridge evaluation criteria, these preservation agreements are an important part of a unified system for prioritizing and addressing the needs of all bridges, regardless of ownership.

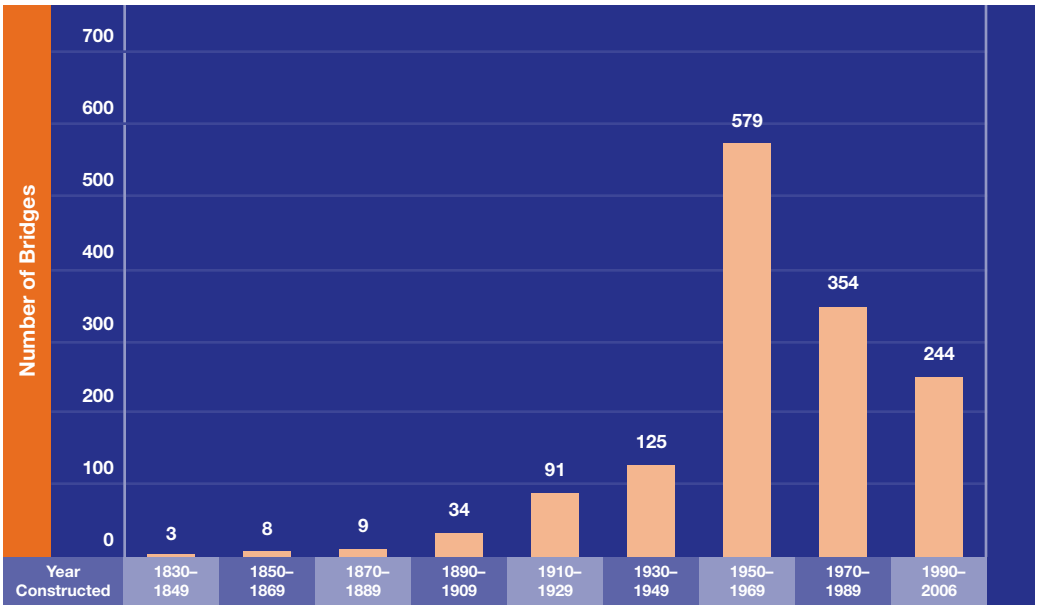
Another issue that has been acknowledged recently is the deteriorating condition of the bridges and roadways owned by the Department of Conservation and Recreation (DCR) in the Boston Region MPO area. The MPO recognizes this concern and believes that a resolution and sufficient additional funding must come from beyond the MPO, at the statewide level.

The age of the Commonwealth's bridges is a significant factor in preservation efforts (Figure 5-1), and a major reason for the region to place new emphasis on bridge preservation. Bridges have an average lifespan of approximately 50 years before significant rehabilitation work is needed. Many bridges will reach this milestone within the next decade; therefore, committing resources to bridge rehabilitation projects is a key priority during that time. As the bridge population ages, an increased focus on bridge rehabilitation and preservation will be needed.

In order to achieve a balanced statewide road and bridge program, MassHighway uses an

FIGURE 5-1

Number of Bridges in the Boston Region MPO Area by Year of Construction



asset management approach that emphasizes careful planning and preventive maintenance in the region. Additionally, MassHighway is committed to achieving and maintaining an adequate level of construction personnel. This includes engineering, inspection, and all other professions entrusted with the supervision, management, quality control, and overall safety of highway construction projects in the region.

Transit Bridges

The MBTA owns and maintains 473 bridges systemwide, comprising 285 railroad, 58 transit, 86 highway, and 44 pedestrian bridges. The MBTA also owns several bridges used for freight services. Railroad and transit bridges typically have a useful life span of 70 years, in comparison to highway bridges, which have a useful life span of 50 years.

Many of the MBTA-maintained bridges throughout eastern Massachusetts are close to reaching, or have already attained, their life expectancies. While many of these bridges are in good structural condition, others are anticipated to need repairs. Using structural integrity and deck ratings established under its bridge management program, the MBTA prioritizes bridge needs based not only on the useful life spans, but also on a variety of other factors, including safety implications, service impacts, and the potential to disrupt service.

In an effort to upgrade and maintain their bridges, the MBTA has customized the PONTIS program. The PONTIS program enables the MBTA to maintain an up-to-date database of all the MBTA-owned bridges and is used to evaluate the condition of each bridge based on the results of inspection and live load rating analysis. The results of the analyses are then used to establish a priority list for the rehabilitation or reconstruction of the bridges.

The bridge inspection program is tailored to ensure that all the bridges receive adequate attention. The frequency and type of inspection for each bridge depends on the structural condition of the bridge.

Both railroad and transit bridges have the same maintenance schedule. Renewal of bridge deck replacement occurs after 50 years of use. Bridge deck waterproofing is replaced after 40 years, and steel is repainted after 30 years. Highway bridges, however, have a different maintenance schedule. Bridge deck replacement occurs after 30 years of use and steel is repainted every 15 years.

Freight

In the Boston region, approximately 56 out of 350 bridges lack sufficient clearances over railroad rights-of-way to allow for double-stack trains. It is the state's policy to provide sufficient vertical clearance to permit double-stack freight movement when a bridge over a rail line is scheduled for rehabilitation. Also, weight-restricted bridges can require detours for commercial vehicles and direct them through residential neighborhoods or circuitously through remote areas. MassHighway also rates bridges to determine their safe load-carrying capacity using the weights of three standard trucks: a two-axle single unit, a three-axle single unit, and a five-axle

tractor-trailer. If the safe load-carrying capacity of a bridge falls below the statutory weight of any of these three trucks, then the bridge is posted for the rated load.

Transit System

State of Good Repair

A priority of the MBTA is the pursuit of a "State of Good Repair" for its systems. To measure the need for capital expenditures devoted to maintaining and replacing existing infrastructure, transit systems often use the State of Good Repair (SGR) standard, whereby all capital assets are functioning at their ideal capacity within their design life. While few transit systems are likely to achieve this ideal, the standard does identify a level of ongoing capital needs that must be addressed over the long term for the existing infrastructure to continue to provide reliable service. Based on an inventory of all existing MBTA capital assets, an SGR database allows the MBTA to track the capital investment needs for the MBTA's existing infrastructure, and to develop a capital investment program to maintain the system in a state of good repair. The State of Good Repair is a criterion that measures the degree to which a proposed project improves the condition of the MBTA's existing infrastructure.

Accessibility

In response to the Americans with Disabilities Act (ADA) of 1990, the MBTA developed an approved Key Station Plan as an initial step in making one of America's oldest public transit systems accessible to all. Title II of the ADA, which covers public services, prohibits public transportation systems from discriminating against persons with disabilities. The U.S. Department of Transportation has established specific requirements for developing systemwide program accessibility, including the need to work with the community of people who have disabilities to determine which stations should be designated as key stations.

Since 1990, the MBTA has been working toward achieving station accessibility. The MBTA has made 73 of its 80 key stations accessible, allocated the construction funds for the remaining 7, and has begun making dozens of non-key stations accessible as part of station modernization projects. In addition, in 2006 the MBTA entered an agreement with the Boston Center for Independent Living. The agreement called for increased funding for elevator improvements, accelerated purchases of low-floor buses and buses with lifts, management and training initiatives, and new public address systems.

The MBTA has programmed 4.1 percent of the total Capital Investment Program for accessibility. In addition to the improvements listed above, the majority of accessibility funding is devoted to the Light-Rail Accessibility Program for the Green Line to modernize stations, install elevators, and raise platforms, as well as the renovations and accessibility improvement project at the Charles/MGH Red Line station.

Vehicles

The revenue vehicle fleet is one of the most visible and important components of the MBTA

service network. These are the trains, buses, and other vehicles that passengers board every day. The MBTA's revenue fleet is composed of approximately 2,500 vehicles. The MBTA adheres to a general standard life cycle of 35 years for rapid-transit and light-rail vehicles, 25 years for commuter rail locomotives, and 25 to 30 years for commuter rail coaches. They recently adopted the policy that the average age of buses going forward will not exceed seven years. Scheduled major overhauls, maintenance, and planned retirements help these fleets reach their useful life, and prevent the unwarranted consumption of resources to maintain their reliability.

The revenue vehicle program represents 29 percent of the MBTA's total 2007–2012 Capital Investment Program, the largest share of any programmatic area, and is composed primarily of reinvestment in the subway system and the bus fleet. In keeping with the MBTA's commitment to upgrade its bus service, ongoing projects are bringing 360 new compressed-natural-gas (CNG) buses, 28 new electric trolley buses (also called trackless trolleys), 348 new emission-control-diesel buses, and 32 dual-mode buses to the MBTA system in the next few years. These fleets will permit the retirement of hundreds of aging diesel buses purchased in the 1980s. Other efforts in this program include major component replacements on the Green, Orange, and Red Lines. The MBTA has purchased of 85 new cars for the Green Line and is taking delivery of 94 new cars for the Blue Line. They are planning for the procurement of Orange Line vehicles in the next decade. This will modernize and expand those subway fleets. Activity within the commuter rail vehicle program includes major midlife overhauls for large portions of the locomotive and coach fleets. It is anticipated that the commuter rail fleet needs will represent a more significant portion of the Capital Investment Program in the future.

To respond to emergencies, perform maintenance work, keep the system safe for passengers, and engage in major construction work, the MBTA operates a large fleet of vehicles and work equipment that is not used to transport passengers. Non-revenue vehicles and equipment support the entire range of MBTA operations. In total, the MBTA owns and operates a fleet of 949 non-revenue vehicles.

Stations

MBTA stations are also one of the most visible components of the transit system. There are 266 rapid-transit, light-rail, commuter rail, and Silver Line stations in the MBTA transit system. There are also over 9000 bus transfer stations and bus stops. Stations are composed of the basic structure, roofs, platforms, lights, shelters, elevators and escalators. The majority of the funding for stations is devoted to the renovation of subway stations and systemwide replacement of escalators and elevators. The total investment in stations represents 11 percent of the 2007–2012 Capital Investment Program.

Extensive station renovation and modernization work is being completed on Red Line stations serving communities in Dorchester and Mattapan and on Blue Line stations serving East Boston

TABLE 5-1

MBTA Subway Track

NAME	LENGTH (MILES)	POWER
RED LINE	45	THIRD RAIL
GREEN LINE (LIGHT RAIL)	46	OVERHEAD CATENARY
ORANGE LINE	42	THIRD RAIL
BLUE LINE	12	THIRD RAIL/ OVERHEAD CATENARY
TOTAL	**125**	

and downtown to allow for six-car trains. Station improvement projects driven by accessibility concerns and the Key Station Plan, which may include other modernization work in addition to accessibility, are described in the Accessibility section of this chapter. Work also includes new stations on the Silver Line, Greenbush commuter rail line construction, and improvements to North Station and several other stations.

Track and Signals

The MBTA subway system operates on 185 miles of track with a wide variety of construction types, rail ties, and overhead catenary systems. The track network includes 125 miles of revenue track, and an additional 60 miles of non-revenue track within rail yards and other service areas. The right-of-way for heavy-rail subway track often includes a highly electrified third, rail running along the tracks, through which subway cars receive traction power to move.

Subway grade crossings have a useful life ranging from 12 to 15 years. There are 64 grade crossings along the Green Line, since portions of the Green Line are at street level and cross automobile traffic. There are additional grade crossings within MBTA Green Line maintenance facilities.

The commuter rail system operates on a vast network of 638 miles of track, 1.5 million timber ties, and 257 grade crossings, stretching across eastern Massachusetts. Rail on the commuter rail system can be expected to last approximately 40 years. Railroad crossties usually have a life span of 25 to 30, years depending on a variety of mechanical and environmental factors. Grade crossings have a life expectancy of 12 years.

The primary responsibility of the MBTA signal system is to control trains for efficient spacing and runtimes, making it an integral part of the transit system. The signal system's goal is maintaining train separation while attempting to minimize headways and runtimes. The signal system requires ongoing maintenance.

TABLE 5-2

MBTA Commuter Rail Track

NAME	LENGTH (MILES)
FITCHBURG LINE	90
LOWELL LINE	91
HAVERHILL LINE	55
NEWBURYPORT/ROCKPORT LINE	52
WORCESTER LINE	89
NEEDHAM LINE	13
FRANKLIN LINE	34
ATTLEBORO/STOUGHTON LINE	116
FAIRMOUNT LINE	19
MIDDLEBOROUGH/LAKEVILLE LINE	37
PLYMOUTH/KINGSTON LINE	42
TOTAL	**638**

Communications

The MBTA Communications Department's responsibilities include maintaining an inventory of equipment and overseeing contract services for the wide-area network, two-way radio systems, microwave links, emergency intercoms, public address systems, light-emitting-diode (LED) message signs, fire alarm systems, security systems, and the supervisory control and data acquisition system. The department manages the MBTA's Operations Control Center (OCC), which consists of technology that allows for real-time monitoring and supervisory control of the signal and communication systems for the rapid transit and bus systems.

Maintenance Facilities (Yards and Shops)

Maintenance facilities, or yards and shops, are the sites for regularly scheduled maintenance and emergency repairs on MBTA vehicles. The MBTA operates 4 rapid-transit yards and shops, 4 light-rail and 3 commuter rail maintenance facilities; and 9 bus maintenance facilities, including one bus repair shop. There are also 17 smaller general maintenance facilities throughout the system. A new facility was constructed to maintain Silver Line vehicles and CNG buses. Each facility generally includes a basic building structure with a mechanical plant and shop equipment. The expected life cycle of each of these facilities is 50 years.

The arrival of large fleets of vehicles equipped with new technologies will place additional demands on the personnel and facilities that maintain, repair, refuel, and service the vehicles. Additional fueling and engine equipment designed for CNG buses, along with maintenance and support equipment for additional 60-foot articulated buses, will be needed. Low-floor technologies on the new Green Line subway cars and incoming bus fleets will also have special maintenance needs.

Supporting Infrastructure

Supporting infrastructure includes facilities; tunnels, walls and culverts; and power. Facilities include administrative buildings, ferry terminals, vent buildings, storage buildings, noise walls, retaining walls, parking garages, parking lots, and bus shelters. Most facilities have a useful life of 50 years. Fencing, which prevents trespassers from gaining access to tracks and fast-moving trains, is also included in this category. Fencing has a considerable impact on maintenance costs, particularly on the commuter rail system.

Tunnels, walls, and culverts are located throughout the system. Tunnels are mainly on the core subway system and in several locations in the commuter rail network. The rapid-transit system operates within 14 miles of tunnels. The light-rail system operates within 5 miles of tunnels; the Transitway tunnel is approximately 1.1 miles long. Tunnels generally have a useful life of 100 years, but require periodic maintenance of interior surfaces. The MBTA also maintains an extensive network of culverts along the commuter rail and subway systems, and many retaining walls (all of which have a useful life of 50 years).

While power for the MBTA's network is supplied by an outside utility, the MBTA transforms and distributes electricity over its own system to power the entire network of subway, trackless trolley, and light-rail lines. The capital equipment

in this power program is essential to operations: it supplies electricity to subway trains and trolleys for the traction power they need to move; to the signal systems for the power needed to control the trains; and to stations for their operations.

Bicycle and Pedestrian Program

Pedestrian and bicycle facilities need to be preserved and enhanced to enable safe travel for the region's pedestrians and bicyclists. Almost everyone is a pedestrian at some point in the day; across the entire MBTA system, 84 percent of riders bicycle or walk to stations. The MPO will continue to fund trails, pedestrian amenities, and other bicycle and pedestrian projects. Improvements for bicyclists and pedestrians are a routine aspect of roadway reconstruction projects and are usually funded under roadway maintenance.

Transportation Enhancement Projects

There is a growing recognition that transportation programs must expand beyond their traditional definitions to foster a more sensitive relationship to the environments in which they are located. Transportation enhancement projects are designed to add community, environmental, scenic, or historic value to the transportation system.

As established by Federal legislation, there are twelve eligibility categories for transportation enhancement project funding. These include:

- Bicycle and pedestrian facilities
- Pedestrian and bicyclist safety education and activities
- Acquisition of scenic easements and scenic or historic sites
- Implementation of scenic or historic highway programs, including the provision of tourist and welcome-center facilities
- Landscaping and other scenic beautification
- Historic preservation
- Rehabilitation and operation of historic transportation buildings, structures, or facilities
- Preservation of abandoned railway corridors
- Control and removal of outdoor advertising
- Archeological documentation and research
- Environmental mitigation to address water pollution that is caused by highway runoff or to reduce vehicle-caused wildlife mortality
- Establishment of transportation museums

The MPO will continue to fund various types of transportation enhancement activities, including, but not limited to, bicycle and pedestrian projects, acquiring scenic easements, preserving historic transportation infrastructure, and providing landscaping, streetscaping, and other beautification projects.

Scenic Byways

The goals of scenic byway projects are to recognize, protect, and enhance the unique historic, scenic, cultural, and recreational resources along a designated byway. Two locations in the Boston

Region MPO area have been designated as scenic byways. They are Battle Road, which begins in Arlington and travels west to Concord, and the Essex Coastal Scenic Byway, which begins in Lynn and travels north to Gloucester. The next step after designation of a byway is the preparation of a corridor management plan (CMP) for the each of the locations. Each plan will provide comprehensive inventories and assessments of transportation infrastructure, identify concerns, determine needed improvements, and preserve the areas' intrinsic qualities.

The Battle Road Scenic Byway CMP will be carried out by a partnership with the Metropolitan Area Planning Council and the Working Group, which consists of the Minute Man National Historic Park and representatives from each community along the Routes 2A, 4, 225, and 3 byway corridor. The Essex Coastal Scenic Byway CMP will be prepared by the Essex National Heritage Commission with assistance from the Metropolitan Area Planning Council, several public agencies, and each community along the Routes 1A, 114, 127, and 129 byway corridor. The designated routes of each byway are both culturally and economically important transportation corridors in the Boston Region. Funding assistance may be available through the National Scenic Byway Program for subsequent scenic byway projects.

Operational Efficiency Management Programs

Intelligent Transportation Systems

The region's existing transportation system depends upon technological innovations such as intelligent transportation systems (ITS). ITS comprises advanced transportation applications that use computers, electronics, communications, and safety systems to improve the operation and efficiency of the transportation system. The goals of ITS are to improve interagency coordination; provide long-term cost savings; increase operational efficiency, capacity, and safety; reduce

environmental costs; and enhance personal mobility. Travel demand management and the use of ITS—including emergency response systems—play a significant role in maintaining the efficiency and safety of our roadway system, while helping to increase vehicle and person throughput.

According to the U.S. Department of Transportation, national benefits of ITS include:

- Advanced traffic surveillance and signal control systems have decreased travel times by 8 percent to 25 percent.
- Highway management systems have reduced crashes by 24 percent to 50 percent.
- Electronic fare-payment technologies for transit systems have resulted in revenue increases of 3 percent to 30 percent, due to fewer evasions.
- In some locales, incident-management programs have reduced delays associated with incident-related congestion by 10 percent to 45 percent.

- Electronic toll collection can increase throughput by 200 percent to 300 percent compared to attended lanes (those with toll collectors).

One of the most important uses of ITS in the region is to assist in detecting and responding to traffic incidents. MassHighway's incident-management program originates at the Traffic Operations Center (TOC) in South Boston. As part of the management of the highway system, incident calls are dispatched from the TOC to MassHighway's regional offices to mobilize field staff. Multiple tools are available to TOC operators, including variable-message signs across the region that can be activated with MassTERS software, which also generates lists of appropriate response plans. In addition to variable-message signs, TOC operators can take advantage of other ITS technologies deployed across the region, including cameras, loop detectors, and Remote Traffic Microwave Sensor (RTMS) radar units. Camera, RTMS, and loop-detector data are used to identify and verify incidents, monitor the responses, and to establish clearance of each incident.

Other agencies are integrating ITS into their operations in a variety of ways. The MBTA's Operations Control Center (OCC) was upgraded in the late 1990s to provide improved monitoring and location information for the rapid transit system. This control center allows operators to have real-time information on service and incidents and to plan service changes accordingly. The MBTA has also instituted an automated fare collection (AFC) system and has constructed a state-of-the-art bus control center. Massport has instituted an automated vehicle-identification system to improve revenue control at its parking facilities; has installed closed-circuit television to improve security, assist with incident detection, and provide enhanced curbside management; and has installed variable-message signs to improve landside traffic information.

The Central Artery/Tunnel project's Operations Control Center (OCC) in South Boston contains an advanced electronic traffic-monitoring and incident-response system. Using a wide array of ITS devices, the OCC monitors traffic in the I-93/I-90 (the Massachusetts Turnpike) system of tunnels, ramps, and surface highways in downtown Boston, as well as in the Sumner, Callahan, Prudential, and City Square tunnels and on I-90 from Route 128 to its easternmost end. This fail-safe "Smart Highways" computer system uses more than 45,000 data-collection points to manage traffic and incidents, fire detection and response, security, ventilation, lighting, and air quality. The OCC collects data on traffic speed, volume, and congestion, and distributes information to motorists through electronic message boards, lane control signals, Highway Advisory Radio, and - if necessary - an override of AM and FM radio broadcasts. The Massachusetts Turnpike Authority instituted FAST LANE, its electronic toll-collection system.

The Boston Transportation Department also operates a control center, the Traffic Management

Center (TMC), located in City Hall. The TMC monitors city traffic through the use of video cameras and embedded loop detectors and can adjust signals (in real time) that are owned by the City of Boston, as well as some detectors owned by Massport, the Department of Conservation and Recreation, and MassPike, to alleviate problems. It also allows for the real-time monitoring of traffic and incident management, and the integrated coordination of emergency-response providers across jurisdictions. The TMC is also capable of receiving and monitoring images from Central Artery Tunnel cameras through a shared video link with the Central Artery/Tunnel project's Operation Control Center. The MPO provides some funding for the operation of Boston's TMC.

ITS has been employed and will continue to be employed by Boston region transportation agencies. The use of ITS in improving mobility, safety, and security throughout the transportation network is discussed in the chapters on those topics.

MBTA Automated Fare Collection System

The MBTA's state-of-the-art fare collection equipment provides a convenient way for customers to pay fares and is an efficient way for the MBTA to collect fares. The MBTA's automated fare collection system (AFC) replaces tokens and turnstiles with modern fare gates and fare media throughout the rapid-transit and bus systems (AFC improvements for the commuter rail and commuter boat systems are anticipated to be in place in 2009-2010). Its use allows even more of a customer-service focus, a more flexible fare policy, greater equipment reliability, better fare compliance, and greater fare equity.

The new AFC fare media include the CharlieCard, a plastic "smart card," and the CharlieTicket, a magnetic ticket, both of which can "store" the value of a pass a single ride, or multiple rides. Customers can add value to CharlieCards and CharlieTickets with cash or a credit card using fare vending machines.

Intersection and Signal Improvements

At-grade intersections are, typically, the locations at which the greatest numbers of conflicts occur. Intersection and signal improvements include intersection channelization projects, signal upgrades, and realignments. It does not include intersections or segments of roadway that add additional roadway capacity. Capacity-adding projects are subject to air quality conformity analysis and have been identified in the recommended projects list in the Plan. Intersection and signal improvements not only preserve the system, but also improve the system's efficiency and contribute to improved mobility. Signal coordination, when the timing of consecutive traffic signals is synchronized, is also a strategy employed for moving platoons of vehicles efficiently along a roadway. The Boston Region MPO will continue to fund intersection and signal improvements in future Transportation Improvement Programs.

Interchange Improvements

An interchange is a grade-separated intersection that has ramps connecting major arterial roadways. Improvements can include constructing elevated slip and flyover ramps; constructing flyover bridges and underpasses; improving drainage systems; upgrading and installing guardrails and barriers; widening, relocating and realigning intersections; upgrading signals; and straightening lanes. Benefits of these projects include improved safety and traffic operations, higher levels of service, better site-distance lines, and reduced delays. The Boston Region MPO will continue to fund interchange improvement projects in future Transportation Improvement Programs.