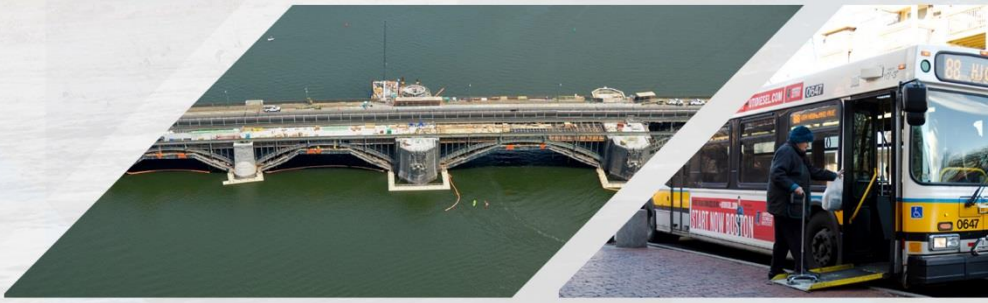
Annual Report of the Performance and Asset Management Advisory Council

presented by

Performance and Asset Management Advisory Council
Patricia Leavenworth, P.E., Chair



November 2017

massDOT
Massachusetts Department of Transportation

Executive Summary

MassDOT's progress in implementing asset management is keeping Massachusetts apace with Federal requirements. The Federal Highway Administration (FHWA) and Federal Transit Administration (FTA) have implemented final transportation asset management (TAM) rules in 2017 that impact how MassDOT measures and communicates the condition of its assets.

Transportation Asset Management Plans

FHWA and FTA rules require the Highway Division, the MBTA, the Rail and Transit Division, and each RTA to complete a transportation asset management plan (TAMP for Highway, TAM Plan for transit). The status on these plans is as follows:

- **Highway |** Will be submitted to FHWA in April, 2018.
- **MBTA |** Will be submitted to FTA by October, 2018.
- **Rail |** A consultant has been retained for delivery of an asset management plan for rail by February, 2018. This plan is not required by any Federal rule, but MassDOT is pursuing it to improve asset management at the agency.
- **Transit |** MassDOT is making progress toward submitting the TAM Plan for MassDOT's in-house transit assets and those of its Federal Aid sub-recipients to FTA by October, 2018.
- **RTAs |** Each RTA is at a different stage in the development of their asset management plans, due to the FTA by October, 2018. MassDOT is ready to assist if asked.

Performance and Condition

Key performance and asset management findings of this report are summarized below by asset type and division.

Highway Tunnels

MassDOT made its first formal inventory report (including age, length, and type) in December, 2015. FHWA requires that all tunnels must be inspected at the enhanced "element level" by the spring of 2018. MassDOT has begun inspecting all of its tunnels and is moving toward meeting this deadline. MassDOT maintains a stricter inspection protocol for overhead elements (annual) and lights (semi-annual).

For the 2018-2022 CIP, MassDOT has for the first time separated bridge and tunnel investments with the creation of a tunnel capital program. The 2018 triennial inspection has also been initiated and will provide an independent determination of the state of good repair of the MHS, including the tunnels, and also make recommendations for capital investments. The report will be filed in the fall of 2018, and MassDOT anticipates the findings will complement current efforts to develop a long-range strategy for the tunnel asset class.

Highway Pavement

MassDOT forecasts that it will exceed its performance targets for Interstate Pavement through 2020, but will miss its targets for Non-Interstate Pavement in both of those years.

In 2015, the Highway Division Pavement Management Section condition models anticipated that sustained levels of investment would result in a decline in Non-Interstate, State-owned pavement condition. This information resulted in an increase to the Non-Interstate program budget by approximately 80% in the 2017-2021 CIP. While substantial, the increased investment will not result in achievement of the current long term target of 62% good or excellent condition of the Non-Interstate system. Furthermore, the target itself is solely to prevent further decline of the system, which is not necessarily the desired outcome for MassDOT.

The Highway Division continues to evaluate its overall management of the pavement life cycle for changes that will improve long-term performance, and the current investment level will be reevaluated.

Highway Bridges

As of October 1st, 2017, 15% of the National Highway System bridge area in Massachusetts is currently structurally deficient, which exceeds the maximum threshold of 10% identified in Federal legislation. Though Massachusetts is subject to a penalty, the focused investment to bridges which began with the Accelerated Bridge Program in 2008 (and continues at historically elevated levels today) exceeds the level required by the penalty.

This report includes an analysis of historical and forecasted performance with respect to structurally deficient bridge deck area that demonstrates the recent progress made through bridge investments by the accelerated bridge program, and predicts performance in this metric through the current CIP.

The Highway Division is on pace to achieve its interim target of 14% in 2018, but will be challenged to reach its 2020 target of 13%, and therefore will remain in excess of the Federal threshold of 10% during through the current 5 year CIP. A plan to achieve this target will be provided in the TAMP.

The MBTA

The MBTA is implementing an Enterprise Asset Management System (EAMS) in two phases. Phase 1 is concerned with the Blue Line track only and scheduled to be populated and functional in January 2018 followed by Phase 2, which includes all remaining infrastructure to be fully populated and functional by December 2020. The tool includes complete life-cycle management, flexible preventative maintenance scheduling, requisitioning and purchase orders, inventory and warehousing capability, financial and human resource management, warranty management, mobile wireless handheld options and web based software interfaces. The project will also integrate with all key MBTA business systems including the State of Good Repair Database.

Rail and Transit

In FY2017 the Rail and Transit Division replaced or repaired approximately 26,000 rail ties (out of a total 800,000 statewide, or 3%). It also must typically inspect and maintain 163 bridges and over 600 culverts and meet national standards and industry demand for allowable weight (286,000 lb. cars).

RTA fixed-route buses are between 1.8 and 8.1 years old while demand-response buses are between 1.5 and 5.7 years old. Revenue vehicle condition on the TERM scale (on which 5 is new and 0 is non-functional) is between 2.8 and 4.8 for fixed-route vehicles, between 2.6 and 5.0 for demand-response vehicles, and between 3.0 and 5.0 for facilities.

Airport Pavement

A new statewide pavement assessment was completed by an outside contractor in June, 2017, with the next scheduled for 2020 and every three years thereafter. **The average PCI for runways at non-Massport facilities was 68, against a long-term target of 75.** In FY2018 and FY2019, MassDOT Aeronautics staff will accomplish annual in-house assessments to ensure annual tracking of pavement condition data.

Municipal Bridges

The Legislature has established the Municipal Small Bridge Program at $50 million over five years (up to a $500,000 maximum per sponsor). **In "Round 1" in FY2017, 36 projects were approved of 50 eligible projects submitted – 24 replacements and 12 rehabilitations.** For Round 2 (FY2018), 18 new applications are under review along with the 14 applications not approved in Round 1. MassDOT has distributed $16 million to cities and towns since November, 2016.

Municipal Pavement

Of the 351 cities and towns in Massachusetts, at least 142 currently operate a pavement management software application. An additional 82 do not, and 127 did not respond to the survey. The available municipal pavement data show that **Massachusetts' municipal pavement is currently at a condition of 70 ("fair-to-good"),** slightly better than the State-owned Non-Interstate asset group. Trends from the Pioneer Valley Planning Commission (PVPC) over the past five years, however, demonstrate a steady decline in pavement condition in its constituent cities and towns, though municipalities that invest in pavement beyond their Chapter 90 State reimbursement have maintained a more steady state.

November 16, 2017

The Honorable Karen E. Spilka
Chairwoman
Senate Committee on Ways and Means
State House, Room 212
Boston, MA 02133

The Honorable Jeffrey Sánchez
Chairman
House Committee on Ways and Means
State House, Room 243
Boston, MA, 02133

The Honorable Thomas M. McGee
Senate Chairman
Joint Committee on Transportation
State House, Room 109C
Boston, MA 02133

The Honorable William M. Straus
House Chairman
Joint Committee on Transportation
State House, Room 134
Boston, MA 02133

Members of the General Court:

On behalf of the Performance and Asset Management Advisory Council, I am pleased to submit this report in compliance with Chapter 46, Section 12 of the Acts of 2013 and as referenced in Chapter 6C, which requires the Council to report annually on progress by the Massachusetts Department of Transportation (MassDOT) to develop a mature asset management system.

Since 2013, this legislation has been a critical catalyst for MassDOT's ongoing effort to pursue a forward-looking investment policy across all of its functions. The efforts of the Department would not have been possible without the mandate. The ultimate legacy of the statute is more informed decision making for the Commonwealth's transportation future.

This report is intended to build on the previous year's filings and identify notable advances in asset management throughout MassDOT and the MBTA.

For the Highway Division, the report includes: a detailed description on inventory and condition assessment for tunnels; identifies challenges with non-interstate pavement condition and details strategies the Division is employing in response; and forecasts performance of National Highway System bridges with respect to structurally deficient deck area through the term of the current Capital Investment Plan.

The report provides status on the implementation of an enterprise-wide asset management system for the MBTA, identifies Federal Transit Administration reporting requirements, and describes performance for both Transit and the Commuter Rail.

Summaries of progress by MassDOT Rail and Transit and Aeronautics Divisions are also included and complete the overview of asset management activities at MassDOT.

For municipally owned assets, this year's report includes analysis of municipal pavement condition based on available data and updates progress on the inaugural round of small bridge inspections.

The Council can once again report significant progress by the operating divisions of MassDOT and the MBTA toward the employment of sound asset management practices. MassDOT is challenged to maintain existing infrastructure, adapt to extreme weather and begin to plan for the future demands on public transportation infrastructure. Accurate information on asset condition and performance are critical to make the right long-term investment decisions.

The Council looks forward to remaining a resource for MassDOT, local governments, and the Legislature in the upcoming year.

Respectfully Submitted,

Patricia Leavenworth, P.E., Chair

Performance and Asset Management Advisory Council

Ruth Bonsignore, MassDOT Board Member

Pat Ciaramella, Old Colony Planning Council

Dennis Dizoglio, Merrimack Valley Planning Commission

Christopher Hennessey, Cohen Kinne Valicenti & Cook LLP

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Patricia Leavenworth, Chief Engineer, MassDOT (Chair)

Robert Moylan, MassDOT Board Member

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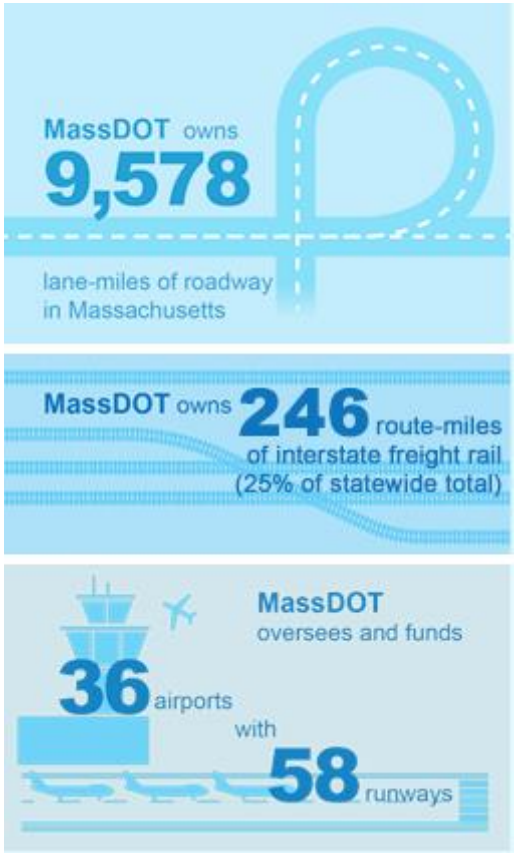
1. 0 Introduction

Figure 1.1: MassDOT Assets



The purpose of this document is to summarize progress toward implementing an integrated transportation asset management (TAM) system in MassDOT's Divisions: Highway, Rail and Transit, Aeronautics, and the MBTA. The report also addresses asset management for pavement and bridges owned by cities and towns (i.e., municipalities).

1.1 Legislation: A Mandate for Progress

The Performance and Asset Management Advisory Council (the Council) was created by Chapter 46 of the Massachusetts General Law Acts of 2013, which charges:

"On or before October 1 of each year, the council shall provide an annual progress report on the performance and asset management system to the House and Senate committees on Ways and Means and the Joint Committee on Transportation."

Since 2013, this legislation has been a critical catalyst for MassDOT's ongoing effort to pursue a forward-looking investment policy across all of its functions. The efforts of the Council would not have been possible without the mandate.

1.2 Context for This Report

MassDOT assets form the core of the Massachusetts transportation system, as summarized in Figure 1.1. The Department has made significant strides since its creation in 2009 to incorporate performance-based, data-driven planning principles and to keep pace with innovative methods in the maintenance and operation of transportation systems. Internal and external championing of asset management practices has underpinned this progress.

MassDOT's progress in implementing asset management is keeping Massachusetts apace with Federal requirements. Congress introduced the requirement for Transportation Performance Management (TPM) in 2012 with the Moving Ahead for Progress in the 21st Century Act (MAP-21). MAP-21 priorities have been carried forward in the Fixing America's Surface Transportation Act (FAST Act) of 2015. The Federal Highway Administration (FHWA) and Federal Transit Administration (FTA) have implemented final TAM rules in 2017 that are discussed in the related sections of this report. **These rules establish performance measures, and in some cases set minimum thresholds for statewide asset condition and require MassDOT to set performance targets.**

This report is designed to align with the *MassDOT Tracker FY2017*. That document summarizes additional performance metrics for each of MassDOT's divisions. While this document focuses on asset management and system condition,

the *Tracker* includes measures of customer experience, budget and capital performance, safety, and health and sustainable transportation.

1.3 Structure of This Report

This report summarizes the TAM practice of the MassDOT Highway Division, the MassDOT Rail and Transit Division, the MassDOT Aeronautics Division, MBTA, and Municipalities. For each of these groups, the report (Sections 2-5) presents a list of assets; investment levels; past and future performance; and progress since last year's report and next steps for the coming year(s).

1.4 What's New

This report is intended to build on the reports from prior years and call out notable advances in asset management throughout MassDOT and the MBTA. This year's report highlights the following:

For the Highway Division

- A summary of Tunnel asset management.
- An update on the Bridge Management Program, including projections for performance of NHS structures through the current 5-year Capital Investment Plan (CIP).
- An update on the Pavement Management Program, including an overview of a strategy being developed by the MassDOT Highway Division to improve Non-Interstate performance.

For the MBTA

- An update on implementation of enterprise-wide asset management.

For the Rail and Transit Division

- A summary of Rail asset management.

For the Aeronautics Division

- Updated airport pavement condition.

Related to Municipal Infrastructure

- A high-level assessment of statewide municipal pavement needs.

2. 0 The MassDOT Highway Division

2.1 Highway Division Assets

Per FHWA mandate, the Highway Division is required to conduct an inventory and condition assessment for pavements, bridges, and tunnels. However, the Highway Division TAM Steering Committee has completed a prioritization exercise for all assets owned by the Highway Division, and is steadily building the processes, inventories and data systems to support management of the full portfolio. This section provides an overview of the management of tunnels, to compliment previous years' reports on bridges and pavements (previous reports available here http://www.massdot.state.ma.us/highway/Departments/AssetManagement.aspx), and includes updates on work by the Highway Division on other assets.

2.1.1 Tunnel Asset Management

MassDOT tracks seven structures that it classifies as tunnels – the Sumner and Callahan Tunnels, the Prudential Tunnel, the CANA Tunnel (City Square in Charlestown), and on the Central Artery: the Ted Williams, I-90 Connector, and Tip O'Neill (I-93) Tunnels.

Tunnel assets are identified with "Tunnel Identification Numbers" (TINs). MassDOT tracks 44 TINs as of July, 2017. They are owned by several entities, including MassDOT, Massport, MBTA, Boston Properties, the Massachusetts Convention Center Authority (MCCA), and Simon/Copley. Two TINs are "highway transit" tunnels – Silver Line and Harvard Square – both owned and overseen by the MBTA. While the MBTA manages the maintenance and inspection of these tunnels, the inspection data is passed on to FHWA by MassDOT.

Figure 2.1: MassDOT Tunnels

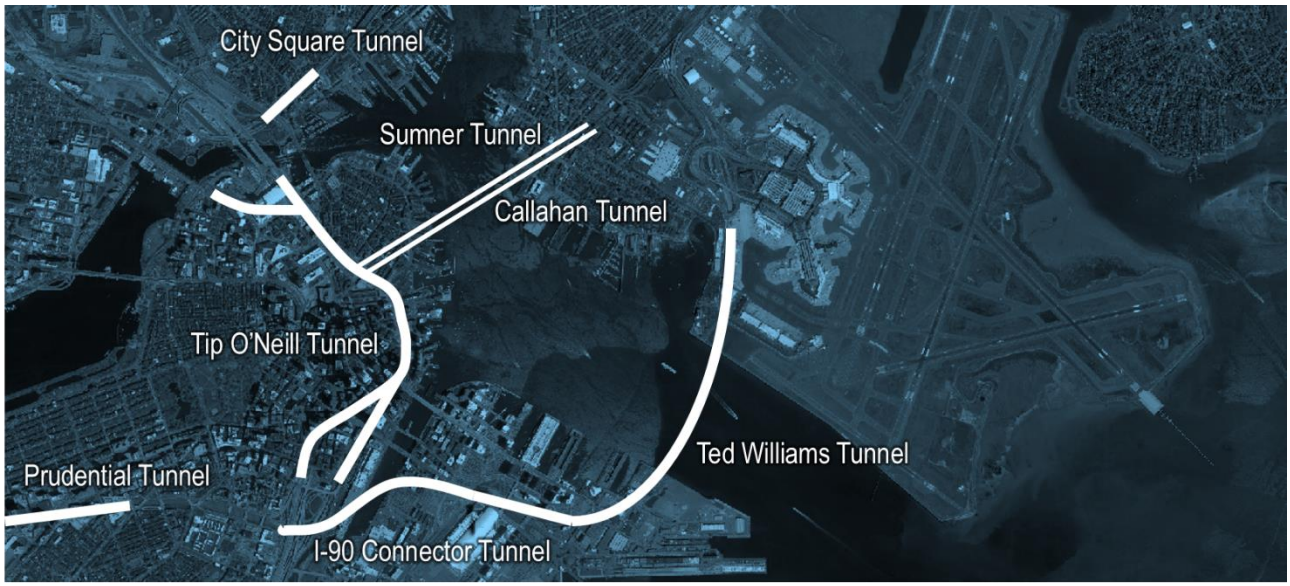
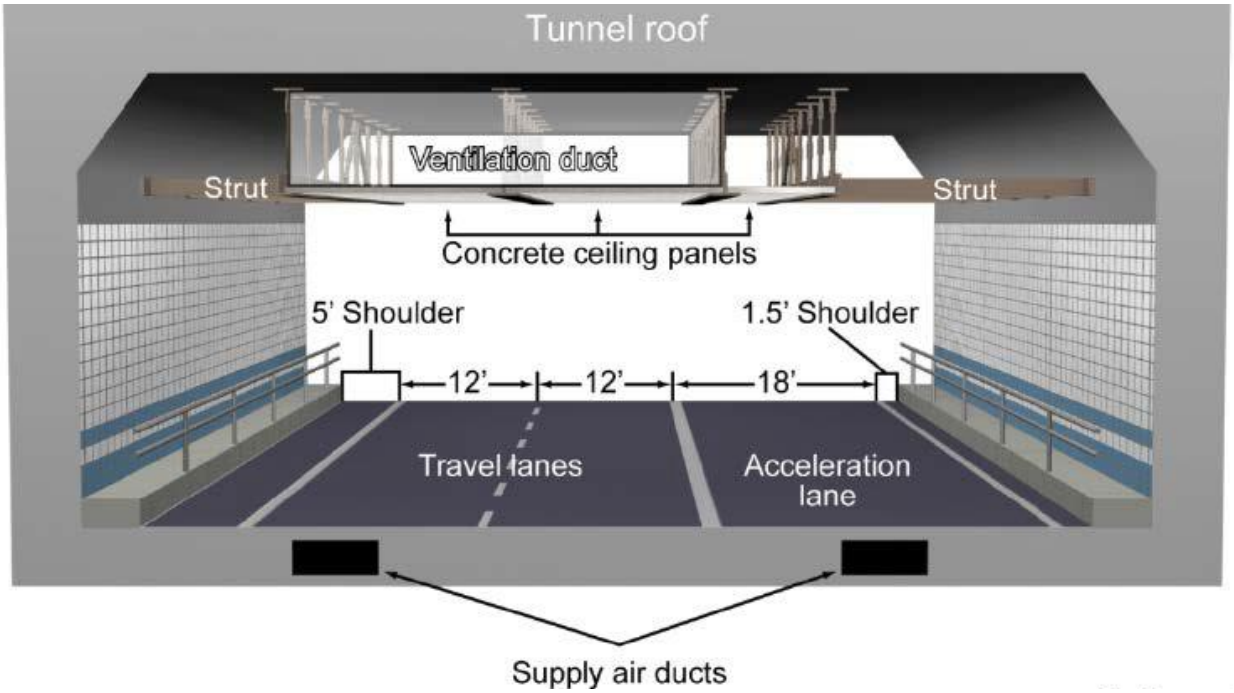


Figure 2.2: Diagram of Tunnel Assets



Tunnel systems function with lighting, ventilation, fire protection, drainage, 24/7 oversight, and electrical power. Tunnel assets include not only the structural elements of a tunnel (roof, walls, floor, and columns), but also roadway assets (pavement, fencing), and safety/operations assets (ventilation ducts, struts, hanging panels, lighting, pumps, fire suppression, etc.). Tunnel assets are not only located in the actual tunnel – the system also includes 13 vent buildings and the equipment in them (electrical gear, ventilation fans, and pump stations).

Inspection Practices and Inventory Data

FHWA created National Tunnel Inspection Standards (NTIS) in July, 2015. MassDOT made its first inventory report (including age, length, and type) in December, 2015. Among other things, the NTIS requires biannual inspections and an updated inventory with condition data for all structural and non-structural assets.

All tunnels must be inspected at the enhanced "element level" by the spring of 2018. MassDOT has begun inspecting all of its tunnels and is moving toward completion of the inspections. MassDOT maintains a stricter inspection protocol for overhead elements (annual) and lights (semi-annual).

Investment Levels and Strategies

This initial round will produce an inventory of all assets with condition. Once the database is populated with several years' worth of data, it can be used to develop deterioration models and to support investment levels. The wide range of tunnel assets and components vary in design life from months to decades, making this analysis somewhat involved.

For the 2018-2022 CIP, MassDOT has for the first time separated bridge and tunnel investments through creation of a tunnel capital program.

Per the requirements of the Metropolitan Highway System (MHS) Trust Agreement, MassDOT has retained a third-party consultant to conduct a Triennial Inspection of the MHS. The MHS consists of the Boston Extension of the Massachusetts Turnpike (I-90), the facilities built by the Central Artery and Tunnel project, the Sumner and Callahan tunnels, and the Tobin Bridge. The triennial inspection will provide an independent determination of the state of good repair of the MHS, including the Tunnels, and also make recommendations for capital investments. The report will be filed in the fall of 2018, and MassDOT anticipates the findings will complement current efforts to develop a long-range strategy for the tunnel asset class.

2.1.2 Traffic Signs

In 2014, the Highway Division Traffic Section initiated a project to inventory all traffic signs on State-owned roads. The project used vehicle-mounted LiDAR (Light Detection and Ranging) and high resolution photography, coupled with visual inspection, to capture the location, type and retro reflectivity (ability to reflect light, critical for nighttime visibility) of the entire State-owned sign inventory, as well as signage on state-numbered routes under local jurisdiction (a total of approximately 250,000 signs). The data is maintained in a web GIS-based asset and work management system, VUEWorks, which provides both desktop and mobile access to the inventory.

Through analysis of the sign inventory data, the Highway Division has developed projects for each Highway District to upgrade signs on secondary roads across the state. The projects will replace signs that have degraded retroreflectivity, are poor condition, or do not meet current standards (e.g., size). Additionally, these projects will selectively trim roadside vegetation where site lines have been compromised due to the encroachment of vegetation. The projects for all six Districts have been advertised and are at various stages of procurement or construction, and all will be in the construction phase for calendar year 2018. The six contracts total in excess of $4.2 million.

2.1.3 Drainage Culverts

The Highway Division began to inventory highway drainage culverts in the spring of 2016 through an innovative process based on record construction plans. Using desktop GIS tools, Highway Staff overlaid aerial photography, roadway centerline, and wetland resource data with scanned construction plans to identify the location, type and size of State-owned culverts. Each Highway District has prioritized the inventory work in descending order of roadway functional classification, beginning with the Interstate system. The inventory process is taught to seasonal interns which provides the temporary staff with practical application of the GIS technology, as well as continued progress for the Highway Division. Currently there are 4,200 locations identified and the effort is estimated to be 70% complete.

The data will be used to identify needs for culvert inspection, and ultimately maintenance or replacement. To facilitate this assessment, the Highway Division applied for and was awarded a grant from FHWA to pursue a pilot project for the integration of asset management and extreme weather vulnerability. The project will model the behavior of streams with culvert and bridge data to predict performance during extreme events. The Highway Division expects this project to prioritize culvert locations or watersheds for more in-depth analysis through assessment of risk, and further the resiliency of State-owned infrastructure.

2.1.4 Pedestrian Infrastructure

To meet the obligation of the development of an ADA Transition Plan, MassDOT has implemented a program to reconstruct substandard curb ramps on State-owned roads. In 2012 an inventory was created to look at all 26,000 curb ramps throughout the Commonwealth; almost 6,700 were found to be failing or missing. The failed locations have been prioritized using a set of factors based on the nationally recognized approach of *NCHRP Report 803 - Active Trans Priority Tool*. To date, eight pedestrian ramp projects, each accounting for hundreds of individual ramps, have been advanced to construction since 2013. As of FY17, the number of failed or missing curb ramps has been reduced to 5,200. Four projects are currently advertised and will begin construction in 2018, with 13 additional projects scheduled for advertisement through 2021.

The inventory data is maintained on the GeoDOT system and is updated by District staff as locations are reconstructed, and the system is also used to track planned locations. A public-facing dashboard is currently in development and will be available in calendar year 2018.

In addition to curb ramp locations, the Highway Division has also prioritized construction and maintenance of sidewalks themselves. Sidewalk inventory data is stored within the Massachusetts Road Inventory File, which is maintained by the MassDOT Office of Transportation Planning (OTP). Historically this data has been periodically updated by OTP, but recent advances in the OTP GIS systems have made it easier for Highway Division staff to edit road inventory data. A complete refresh of the state-owned sidewalk inventory is currently underway. Once complete, the sidewalk data will provide the Highway Division with accurate information from which to prioritize sidewalk needs.

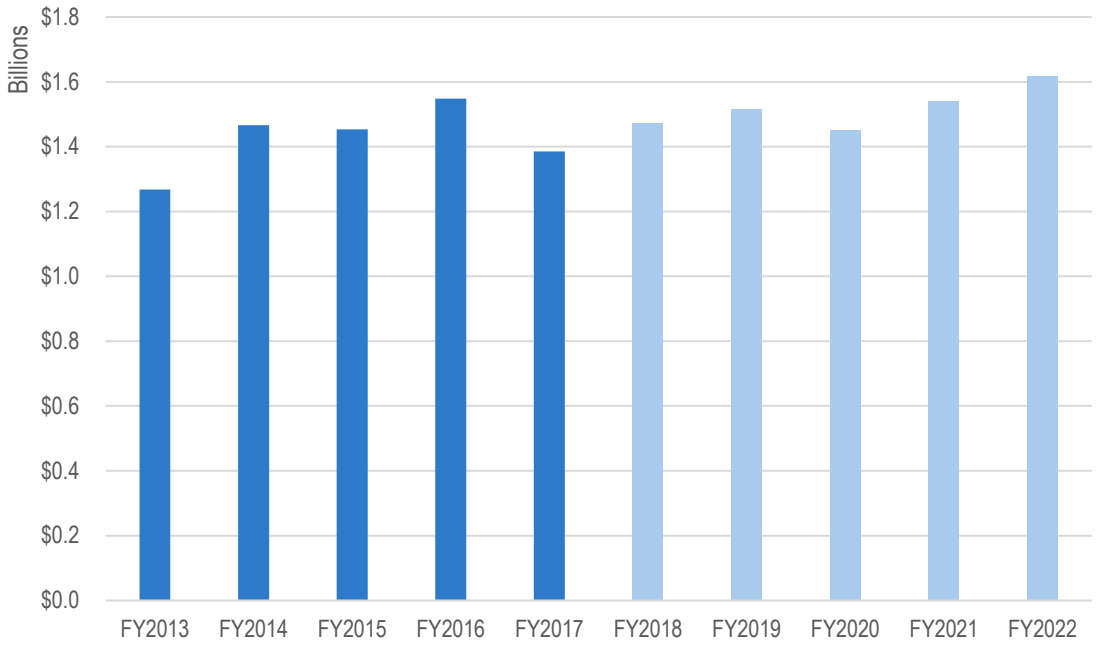
2.1.5 Utility Structure Inventory

The Highway Division has drawn upon the LiDAR data from the traffic sign inventory effort to also identify utility structures within state-owned roadways. All visible structures were located, including drainage manholes and inlets, and an initial use of this data will be to track cleaning of drainage structures by contractors in the spring.

2.2 Investment in the Highway Division

Between FY2013 and FY2016, MassDOT spent approximately $1.43 billion per year on Highway Division capital projects. Over the FY2018-FY2022 CIP period, MassDOT expects to spend approximately $1.52 billion per year. Figure 2.3 includes all categories of Highway Capital expenditures in the years 2013-2022. The major components are construction and maintenance contracts, related design, environmental and right-of-way expenditures, and the Chapter 90 program.

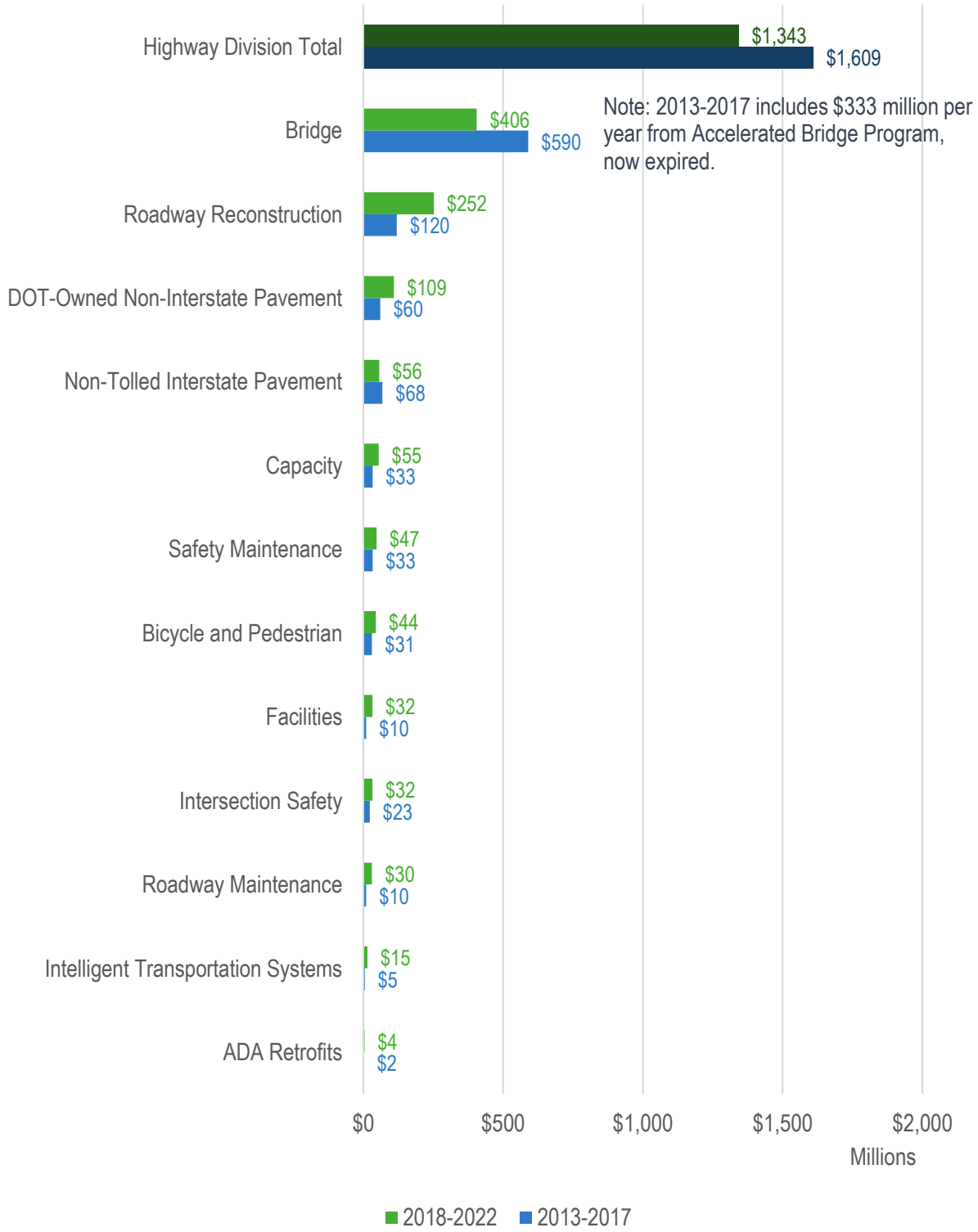
Figure 2.3: Actual and Projected Highway Capital Expenditures, 2013-2022



Source: Historical data derived from Legislative Revenue and Expenditure Reports. Projections derived from the 2018-2022 CIP.

Annual average investment in each Highway Division capital program in the 2017-2021 and 2018-2022 CIPs is shown in Figure 2.4. Note that capital programs do not perfectly align with asset classes.

Figure 2.4: Average Annual Investment in Selected Highway Division Programs, 2013-2017 Actuals and 2018-2022 CIP



2.3 Performance and Forecasts in the Highway Division

The Highway Division has mature processes to forecast performance based on investment levels for State-owned pavements and bridges. This year's report documents recent work the Highway Division has done to further refine these processes.

2.3.1 Pavement Performance

FHWA's Final Rule on pavement performance measures requires DOTs to report four condition metrics for pavement: **percentage of Interstate and Non-Interstate pavements in good and poor condition.**

Ranges are defined for "good", "fair" and "poor" in terms of International Roughness Index (IRI) (G < 95, P > 170 inches/mile), rutting (G < 0.20, P > 0.40 inches), and fatigue/alligator cracking percentage (G < 5%, P > 20% for asphalt). **If all three metrics are rated "Good," the pavement is rated "Good." If 2 or more metrics are rated "Poor," the pavement is rated "Poor." All other pavements are rated "Fair."**

DOTs are required to begin collecting IRI, rutting, fatigue/alligator cracking percentage, and inventory data for Interstate pavements on January 1st, 2018, and for Non-Interstate NHS pavements beginning on January 1st, 2020. Further, the final rule states that if for more than three consecutive years more than 5% of a DOT's Interstate pavement is classified as poor, the DOT must obligate and set aside National Highway Performance Program (NHPP) funds for Interstate pavement.

While FHWA's metrics will be required for reporting purposes, MassDOT continues to use the Pavement Serviceability Index (PSI) – computed from the same three metrics, plus raveling and two other forms of cracking (transverse and longitudinal) – to identify road segments for repair. Municipalities follow their unique measures, as described in Chapter 6.

Targets and Forecasts for Pavement

The Final Rule requires that State DOTs establish 2- and 4-year targets – regardless of ownership – for the full extent of Interstate and Non-Interstate NHS relative to the FHWA pavement performance measures. MassDOT has collaboratively set the following performance targets for pavement (all, not just NHS) in good or excellent condition relative to PSI, as reported in the FY2016 Tracker:

- **Interstate Pavement in Good or Excellent Condition**
  - 85% in 2018.
  - 88% in 2020.
  - 90% long-term.
- **Non-Interstate Pavement in Good or Excellent Condition**
  - 62% in each year moving forward.

Tables 2.1 and 2.2 show condition forecasts for MassDOT Interstate and Non-Interstate pavement from 2017-2022, developed by the Pavement Management Section in dTIMS. MassDOT uses deterioration curves developed specifically for Massachusetts highways that relate pavement quality to repairs undertaken by the Department. Taken collectively, these curves relate overall condition of the Commonwealth's pavements to annual investments in capital projects and operational repairs. MassDOT also considers impacts on safety, bicycle and pedestrian mobility, and stormwater management in selecting capital and maintenance work. The projections in Tables 2.1 and 2.2 assume the levels of investment in the CIP. The pavement models were developed in 2015 based on 2014 condition data. Data collection is currently nearing completion for 2017, and new models will be released at the beginning of 2018.

Table 2.1: Forecast Condition of MassDOT Interstate Pavement, 2018-2021

Condition	2018	2019	2020	2021
Excellent/Good	89%	92%	94%	95%
Fair	9%	6%	5%	4%
Poor	2%	2%	1%	1%

Table 2.2: Forecast Condition of MassDOT Non-Interstate Pavement, 2018-2021

Condition	2018	2019	2020	2021
Excellent/Good	46%	42%	38%	38%
Fair	32%	34%	36%	25%
Poor	22%	24%	26%	37%

Figures 2.5 and 2.6 show the percentage of pavement in "Good" and "Excellent" condition and in "Poor" condition between 2012 and 2016, and projected from 2015 to 2021, assuming 2018-2022 CIP funding.

Figure 2.5: Condition of MassDOT Interstate Pavement, 2012-2021

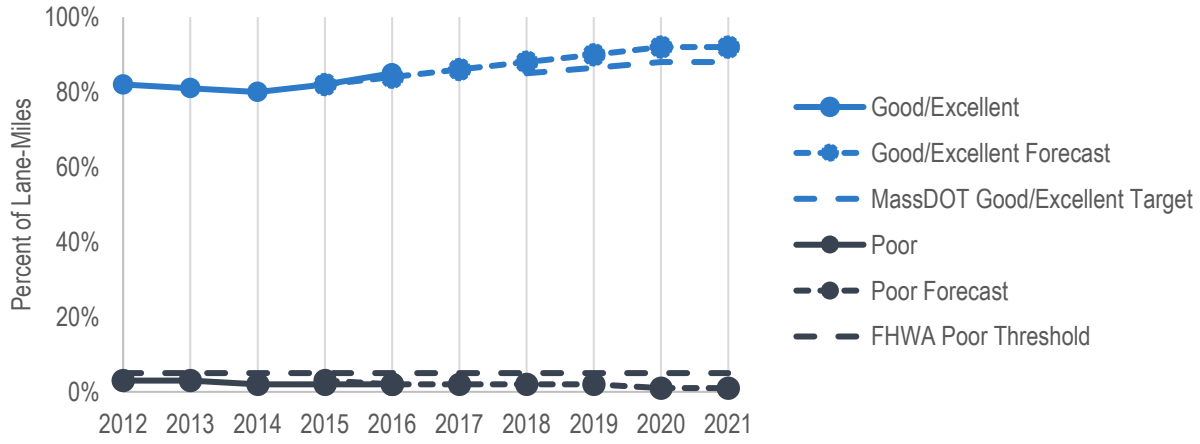
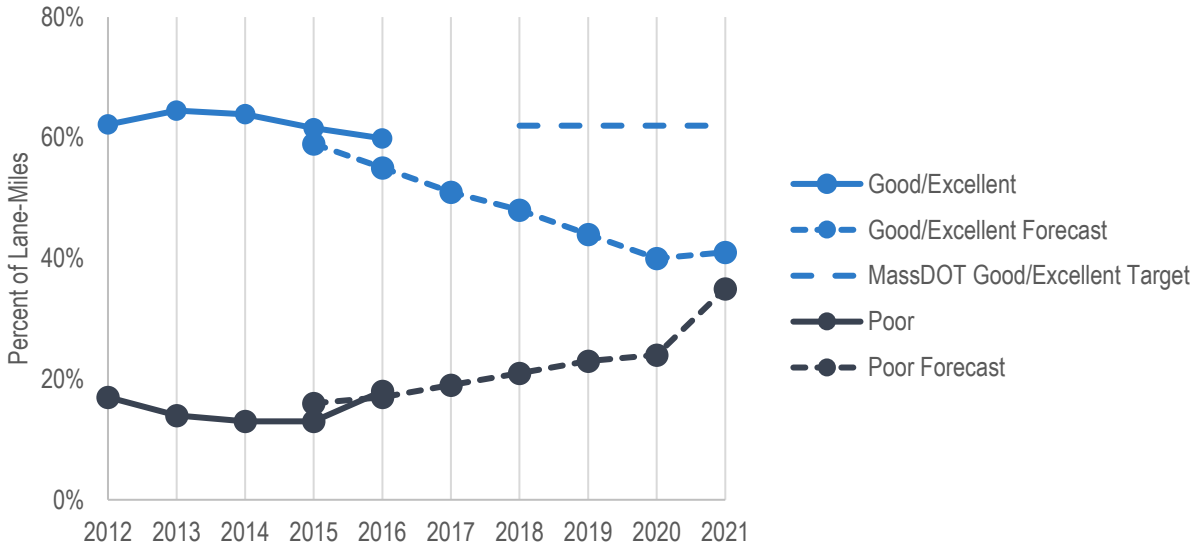


Figure 2.6: Condition of MassDOT Non-Interstate Pavement, 2012-2021



MassDOT forecasts that it will exceed its performance targets for Interstate Pavement through 2020, but will miss its targets for Non-Interstate Pavement in both of those years. It should also be noted that actual performance of Non-Interstate Pavement has slightly exceeded the forecast trend in 2015 and 2016.

2.3.2 Strategy to Improve Non-Interstate Pavements

In 2015, the Highway Division Pavement Management Section condition models anticipated that sustained levels of investment would result in a decline in Non-Interstate, State-owned pavement condition. This information was considered in the development of the 2017-2021 CIP, and resulted in an approximately 80% increase to the Non-Interstate program budget. The increase was accomplished, in part, by redirecting funds destined for the Interstate program.

While substantial, the increased investment will not result in achievement of the current long term target of 62% good or excellent condition of the Non-Interstate system. Furthermore, the target itself is to solely prevent further decline of the system beyond 2015 condition. As this investment translates to projects, and the projects themselves begin to result in condition outcomes, the Highway Division is evaluating its overall management of the pavement life cycle for changes that will improve long-term performance, and the current investment level will be reevaluated.

The Highway Division will address performance of the Non-Interstate system with three steps:

1. Ensure Non-Interstate program investments are focused primarily on pavement condition through control of project scope.
2. Increase use of preservation to economically increase useful life of pavements
3. Revise predictive modeling based on 1 and 2 to determine if additional funding is required.

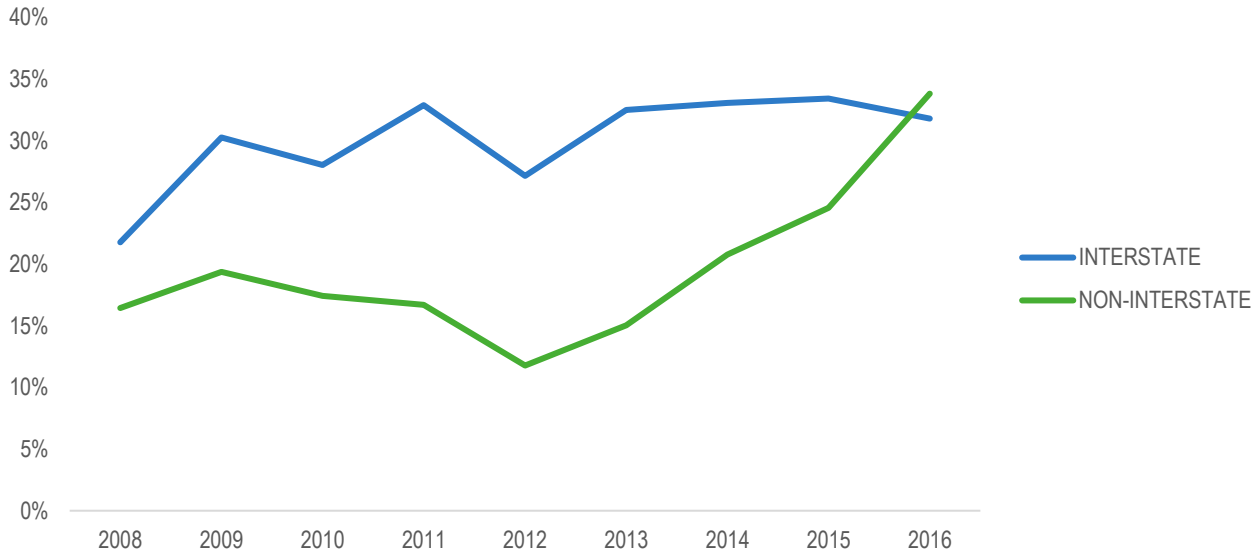
Project Scope

The benefits gained through pavement management best practices can be impacted when the additional non-paving scope is included. The addition of non-pavement work can quickly increase this cost per mile or change the scope of a paving project entirely, effectively reducing the condition improvement for every dollar invested in the paving program.

- **Pavement-related work** includes the installation of the selected pavement treatment, maintenance to drainage structures, control of traffic, pavement marking installation, and traffic police/flaggers.
- **Non-pavement work** includes bridge maintenance, stormwater betterments, guardrail and barrier work, traffic signals, ITS, signs, sidewalk and pedestrian ramp work, and minor widening.

While non-pavement work makes pavement projects more expensive, it provides benefits to the corridor as a whole. For example, harmonizing pavement activities with maintenance to bridges, safety systems, and other supporting infrastructure can produce economies of scale and limit repeat disruption to roadway users. To better understand this practice, the Highway Division analyzed all resurfacing projects from the last eight years to calculate the value of "non-pavement" work performed on Interstates and Non-Interstate, State-owned roads. The results of this analysis are illustrated in Figure 2.7.

Figure 2.7: Percent of Resurfacing Program Annual Spending on Non-Pavement Work



- **For Interstate paving projects, non-pavement work accounts for approximately 30% of the program's annual expenditures.** The majority of this investment is to bridges, where that work typically consists of deck repairs, bridge joint work, and replacement of the wearing surface. These are important preservation actions which can stem deterioration to underlying bridge components. The second largest non-pavement investment is to safety infrastructure, typified by median barrier installations and replacement of guardrail which has reached end of service life.

- **For State-owned, Non-Interstate paving projects, non-pavement spending has more than doubled since 2012.** Similar to the Interstate program, bridge and safety investments are substantial portions of the non-pavement spending. Unlike the Interstate program, investments to pedestrian and bicycle infrastructure are substantial and have seen a steady rise since 2012. The increase in non-pavement spending presents a challenge as the Highway Division attempts to improve the condition of Non-Interstate pavements.

The bundling of maintenance activities within resurfacing projects is standard practice at the Highway Division. The Pavement Management Section develops per-mile costs for modeling purposes, and these costs are based on the latest projects put to bid, inclusive of all bundled activities proposed within those projects' scopes of work. These costs are at the core of the decision-making engine in the pavement model. Changing project costs can have a substantial impact on the predicted performance of the pavement.

- **For the Interstate program**, where categorical spending has remained relatively constant, there is a high level of confidence in the costs and the performance modeling.
- **For the Non-Interstate program,** where there is significant fluctuation in spending on non-pavement work, it is more challenging to model future performance based on current investments.

The Division will be issuing guidance on the amount of non-pavement work that can be included in paving projects using Interstate/Non-Interstate funding. For example, if a proposed resurfacing project has a structurally deficient bridge within its limits, and a bridge scope is proposed which exceeds a set percentage of the overall project, alternative funding would be required to proceed with the work, or the work should be performed under a separate project. By establishing a maximum budget for non-pavement work, the Pavement Management Section can better predict future outcomes and inform investment decisions.

Pavement Preservation

A team of FHWA, MassDOT, Municipal, consultant, and contractor engineers are currently participating in a Pavement Preservation Task Force with the goal of furthering preservation activities on all roads of the Commonwealth. Anticipated deliverables from this effort include a Pavement Preservation Policy. The Policy will include a guide intended to give pavement program managers tools to employ low-cost pavement treatments and extend pavement life. This guide will be available to decision-makers at both state and local levels and will serve to increase preservation treatments statewide, making the overall program more efficient. Control of project scope is particularly important to realize the efficiency of pavement preservation.

Investment Needs

States are required to submit a Transportation Asset Management Plan to in order to demonstrate a plan for stewardship of National Highway System pavements and bridges. This document, which the Highway Division will submit in draft by April 30, 2018, will become central to the future capital planning discussions. As approximately 64% of DOT Non-Interstate roads are on the National Highway System, the investment strategies identified for the Non-Interstate NHS within the document will inform subsequent capital planning discussions to improve DOT Non-Interstate roads.

2.3.3 Bridge Performance

The National Bridge Inventory Standards (NBIS) define a bridge as a structure with a span length of over twenty feet. More than 5,000 structures in the Commonwealth are thus defined as "NBI Bridges," of which 1,569 are owned by municipalities and most of the remainder are owned by MassDOT. In addition, the MBTA owns 1,038 bridges and the Rail and Transit Division owns 270 bridges. 2,270 bridges in Massachusetts are on the NHS. Of these, 73 are owned by municipalities and the remainder – 2,167 NHS bridges – are owned by MassDOT.

FHWA's final rule on bridge performance measures has defined two condition metrics for bridges: **percentage of NHS deck area on bridges that are in good and poor condition**. FHWA defines bridge condition using the nine-point National Bridge Inspection Standards (NBIS) scale shown in Figure 2.8, where higher values indicate better condition. "Good" condition begins at a rating of 7, and "Poor" is defined as "structurally deficient" (SD), a rating of 4 or lower. MassDOT has adopted the FWHA performance measure.

Current Performance for NHS Bridges

Figure 2.8: NBIS Rating Scale

Photo Credit: Google

MAP-21 and the FAST Act introduced a modified approach to evaluating bridge condition: for NHS bridges the new performance measure retains the familiar concept of structural deficiency but now also considers bridge deck size. Where the old metric divides the number of structurally deficient bridges by the total number of bridges, the new measure divides the total deck area of structurally deficient bridges by the total deck area of all bridges on the network. By this new measure, an individual bridge affects network condition proportional to its size, whereas previously all bridges were considered equal.

The NHS consists of Interstates and roadways which serve major transportation, commercial and other strategic transport facilities. Approximately 44% of Massachusetts bridges are on the NHS; however, over 70% of bridge deck area is on the NHS. Because of the multi-lane facilities which the structures carry, NHS bridges are on average three times the size of non-NHS structures.

As of October 1st, 2017, 15% of the National Highway System bridge area in Massachusetts is currently structurally deficient, which exceeds the maximum threshold of 10% identified in the Federal legislation. By the deck area measure, Massachusetts is ranked next to last nationally. Massachusetts shares the bottom tenth of the list with other cold-weather states including Rhode Island, Connecticut, New York, Michigan, and Washington, where infrastructure is subject to freeze/thaw cycles and impacts from deicing chemicals.

The penalty for states that exceed the threshold is a forced apportionment of National Highway Performance Program funds to NHS bridges, in the amount of 50% of the 2009 Highway Bridge Program. Though Massachusetts is subject to a penalty, the focused investment to bridges which began with the Accelerated Bridge Program in 2008 (and continues at historically elevated levels today) exceeds the level required by the penalty.

Future Performance and Targets for NHS Bridges

MassDOT has identified the following targets for bridge condition:

Structurally Deficient Deck Area on NHS Bridges

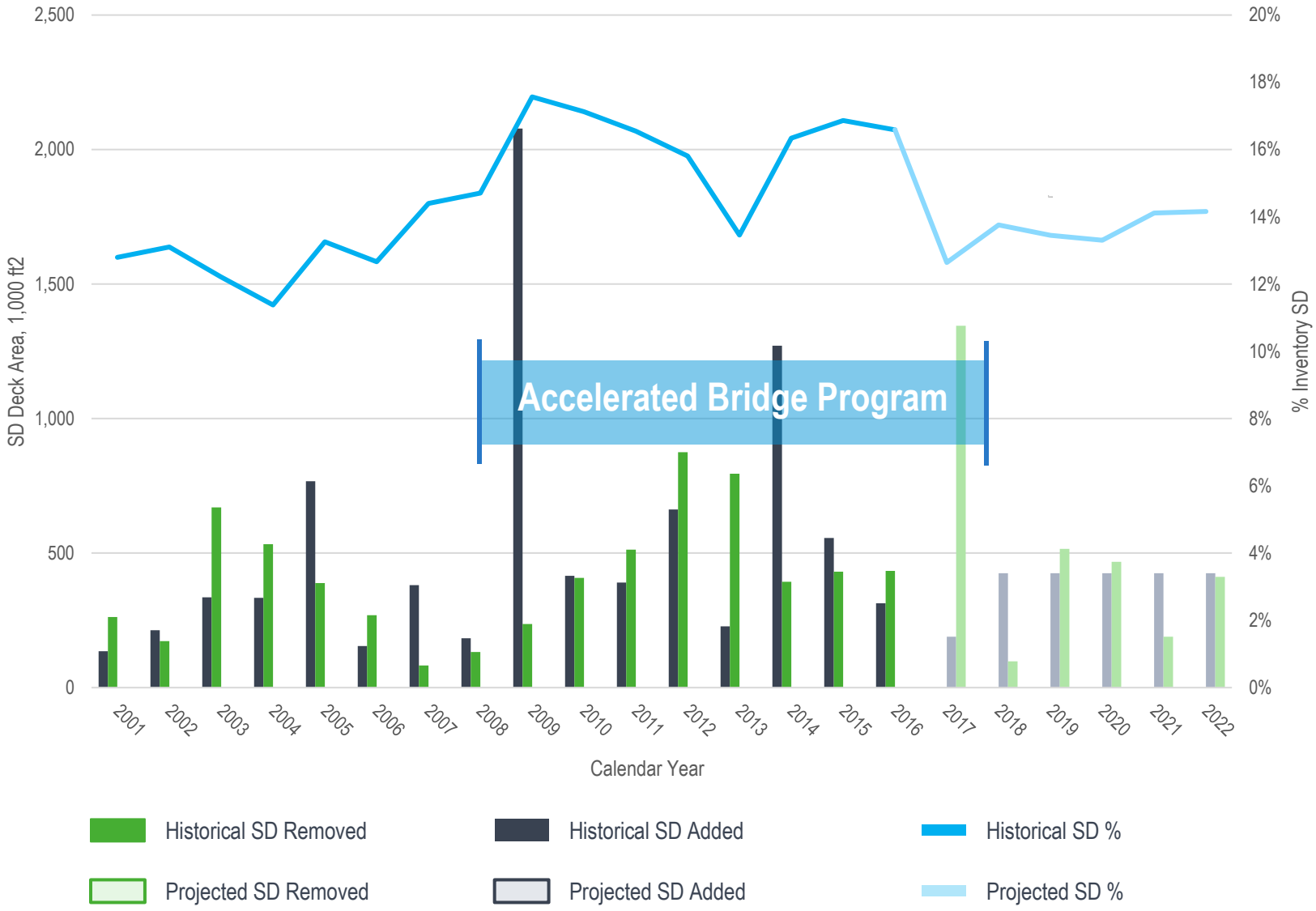
- 14% in 2018.
- 13% in 2020.
- Less than 10% (i.e., the FHWA maximum) in the long-term.

Figure 2.9 (next page) illustrates historical trends of structurally deficient deck area on NHS bridges and predicts future performance through completion of the current CIP. The Highway Division calculated the historical "growth" and "removal" of structurally deficient area by analyzing archived bridge condition data. Growth is the total new structurally deficient area identified by inspection for a given year. Conversely, removal is the total structurally deficient area repaired/replaced during the year. Accounting for growth and removal, the trend-line represents Highway Division performance concerning the deck area measure. For example, if growth exceeds removal in a year then the overall network structurally deficient area will increase for that particular year. When organized in this manner, major events in the recent history of Massachusetts bridges are easily recognizable:

- In 2009, at the creation of MassDOT, the state bridge inventory of what was the Massachusetts Highway Department was combined with the bridges of the Massachusetts Turnpike Authority and the Department of Conservation and Recreation (DCR). This addition of over 500 bridges included 1.5 million square feet of structural deficient area, which is apparent in the 2009 growth measurement. Presently, close to 1 million square feet of these bridges remain structurally deficient.
- The $3 billion Accelerated Bridge Program began in 2009. While not focused solely on the NHS, and not applied to structures on the Massachusetts Turnpike, the results of the program are apparent in the increased removal rates in the past eight years.
- The significant increase in 2014 is overwhelmingly attributed to five bridges; two sections of the Tobin Bridge, the Gilmore Bridge in Boston, and two section of the Springfield Viaduct.

Future growth of structural deficiency has been projected at the average rate observed between 2001 and 2016 (exclusive of the 2009 growth resulting from the merger), which is calculated at 425,000 square feet per year, or approximately 1.5% of the inventory. **The Highway Division is on pace to achieve its 2018 target of 14% but will be challenged to reach its 2022 target of 13%.**

Figure 2.9: Structurally Deficient Bridge Area – 2001-2022



Modeling Bridge Condition into the Future

The assumed growth rate is the most uncertain piece of this analysis, and is contingent upon two variables:

- **Bridge size can vary considerably |** While the average bridge on the NHS is approximately 13,000 square feet, there is wide variability within the overall system. The Braga Bridge between Somerset and Fall River, at 500,000 square feet, is the largest bridge in the state inventory and accounts for almost half the projected removal for calendar year 2017. With size now incorporated into the performance measure, a single large structure can have a pronounced effect on system condition. Though comparatively few, there are other large structures in the inventory which could become structurally deficient shortly and impact network condition.
- **The inventory of fair bridges |** The average age of NHS bridges is now over 50 years, which is approximately the life expectancy of materials and details employed in that era of bridge construction. Consequently, there is an increase in the number of bridges rated fair, the condition state which precedes structurally deficient. A sample of large bridges currently rated fair is illustrated in Figure 2.10.

For the Highway Division to achieve its long-term target for the NHS, simply replacing bridges at a rate equal to the growth of structural deficiency will not be successful.

Figure 2.10: Examples of the Largest NHS Bridges in Massachusetts Rated "Fair"

I-391 over Connecticut R. | 388ksf

I-93 over MA-28, Somerville | 327ksf

I-290 Viaduct, Worcester | 177ksf

I-93 Viaduct, Charlestown | 174ksf

US-202 over Connecticut R. | 112ksf

I-90 over Westfield R. | 110ksf

The Highway Division will likely need to increase investments to preservation activities to prevent fair bridges from additional deterioration. The Bridge Section is adapting predictive modeling to process more detailed inspection data, which will be used to more accurately predict deterioration rates while accounting for increased preservation.

The upcoming Highway TAMP will detail an overall strategy of maintenance, preservation and capital replacement for National Highway System Bridges, along with investment levels to achieve the long term goal of less than 10% structural deficient area for the system.

2.4 Highway Division Progress in 2017 and Next Steps

The 2016 Annual Report proposed next steps for the Highway Division. This section lists these goals and describes the progress that MassDOT has made toward achieving them:

- **Meet the targets defined in the MassDOT Tracker for Interstate and Non-Interstate pavement |** The condition of the Interstate system currently exceeds targets and planned investments are expected to continue the trend. The Non-Interstate is not currently forecasted to meet performance targets, and the Highway Division is implementing programmatic improvements to the delivery of Non-Interstate system projects which are expected to maximize the efficiency of the current investment level. Future investment levels will be considered based on these changes.

- **Progress toward the FHWA maximum of 10% of deck area on SD bridges |** Significant progress in this measure is expected by the end of calendar year 2017, with an overall reduction of approximately 2% forecasted (16% to 14%). An analysis provided in this report predicts current investments will likely maintain this improvement but condition is not expected to meet the 10% target within the current CIP (2018-2022). The TAMP will provide a plan to achieve this target.

- **Begin to verify culverts identified on maps through inspections |** MassDOT has made significant progress on the "desktop" inventory of culverts (70%) and will use this information as part of a risk-based, extreme weather vulnerability pilot in 2018.

- **Verify the remainder of the sign inventory and record additional tunnel, ancillary structure, sidewalk and bicycle facility assets, |** MassDOT has completed its sign inventory, and it has been used to advertise projects to replace degraded signs on secondary roads statewide. MassDOT will submit an "element-level" tunnel inventory in the spring of 2018, as required by FHWA.

- **Identify locations where bicycle and pedestrian facilities are needed |** MassDOT is nearing completion of the Statewide Bicycle Plan and Statewide Pedestrian Plan and will publish them in 2018. As of June 30, 2017, the number of failed pedestrian ramp locations has been reduced from 6,700 to 5,200.

- **Expand the use of the GeoDOT site for dissemination of data to the public |** The Massachusetts Project Intake tool, a collaborative project between the Office of Transportation Planning, MassDOT IT, and the Highway Division, went live in November, 2017. The innovative on-line tool both streamlines and enriches the project initiation process for both internal and municipal project proponents. The tool allows users to compare potential

project locations with a library of geographic information, including environmental, social equity, mobility, safety and infrastructure condition layers. The system was built with a collaborative workflow between the project proponent and Highway District Planners, which will improve the quality of information available for project evaluation and scoring.

3. 0 The MBTA

Figure 3.1: Asset Management Scope

The Massachusetts Bay Transportation Authority (MBTA) is America's fifth largest transit system (behind New York, Chicago, Los Angeles, and Washington DC). It serves 175 member cities and towns with an approximate 3,200 square miles and over 4.7 million residents. The MBTA averages approximately 1.3 million trips each weekday.

*"**Transit asset management (TAM)** means the strategic and systematic practice of procuring, operating, inspecting, maintaining, rehabilitating, and replacing transit capital assets to manage their performance, risks, and costs over their life cycles, for the purpose of providing safe, cost-effective, and reliable public transportation."*

- FTA Transit Asset Management Final Rule, 49 CFR 625

3.1 Moving Ahead for Progress in the 21st Century (MAP-21) requirement

Pursuant to MAP-21 (P.L. 112-141) and the implementing regulations (40 CFR 625 and 630), the MBTA General Manager (defined as the "Accountable Executive") is required to implement and resource both Safety and Transit Asset Management Programs. The FTA Transit Asset Management Final Rule published in July 2016, effective October 2016, prescribed three core deliverables to baseline all agencies across the United States by October 2018:

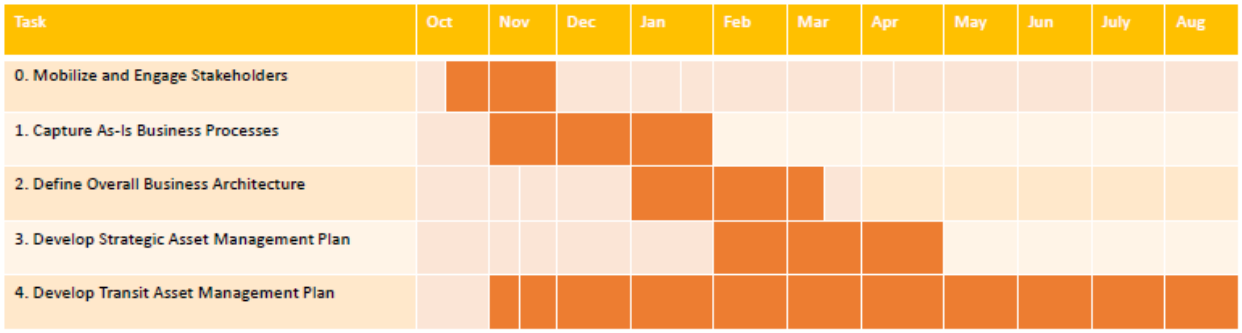
1. The Transit Asset Management Plan (TAMP)
2. Asset Inventory Module
3. Performance Measures and Targets

During 2017, the MBTA Asset Management team began implementing these requirements. The development of all three deliverables are underway and will be completed in advance of the October 2018 deadline. The MBTA has actively worked directly with the FTA+ to provide feedback on the performance measures and targets requirements. In addition, several peer agencies across the United States have been working with the MBTA to share their performance measures and targets so that we may benchmark where we are in comparison. The MBTA will continue working with these agencies as well as the FTA to refine the process and report useful data to the National Transit Database.

3.2 The MBTA Transit Asset Management Plan

A critical Federal requirement is the implementation of a Transit Asset Management Plan (TAMP). The TAMP shall include, at a minimum, an inventory of all capital assets, a condition assessment of inventoried assets, a description of analytic processes or decision support tools used to select capital investments, a prioritization of investments and the investment decisions being in alignment with the Agency Safety Plan requirements (risk). The plan will also include information on the agency's TAM policies, implementation strategy, and TAM improvement program. The timeline for completing the TAMP is shown in Figure 3.2.

Figure 3.2: TAMP Timeline



Teams of subject matter experts will conduct several tasks to obtain and validate MBTA asset data, the organizational asset management maturity level, resources to deliver the plan and establish solutions, and scopes and resource requirements via the Transit Asset Management Improvement Program. The MBTA seeks to compose a plan that not only meets the new FTA requirements but also seeks to align itself to the MBTA Strategic Plan; the MBTA's key initiatives such as Focus 40 and the Fleet and Facilities Plan; industry best practices; and recognized standards to aid benchmarking for continual improvement.

The TAMP development process began in October 2016 and is scheduled to be completed prior to the deadline.

3.3 Performance Measures and Targets

The MBTA is required to produce performance measures and targets as depicted in Figure 3.3 (next page). In 2012, MAP-21 mandated FTA to develop a rule establishing a strategic and systematic process of operating, maintaining, and improving public capital assets effectively through their entire life cycle. The TAM Final Rule 49 USC 625 became effective October 1, 2016, and established age-based measures for rolling stock and equipment, condition-based measures for facilities and performance-based measures for fixed guideway assets as a minimum standard for transit operators.

Figure 3.3: FTA Performance Metrics

Assets: *Only those for which agency has direct capital responsibility*	**Performance Measure**
Equipment: Non-revenue support-service and maintenance vehicles	Percentage of non-revenue vehicles met or exceeded Useful Life Benchmark
Rolling Stock: Revenue vehicles by mode	Percentage of revenue vehicles met or exceeded Useful Life Benchmark
Infrastructure: Only rail fixed-guideway, track, signals and systems	Percentage of track segments with performance restrictions
Facilities: Maintenance and administrative facilities; and passenger stations (buildings) and parking facilities	Percentage of assets with condition rating below 3.0 on FTA TERM Scale

Useful Life Benchmark
The expected lifecycle of a capital asset for a particular Transit Provider's operating environment, or the acceptable period of use in service for a particular Transit Provider's operating environment

The requirements state that 2017 is an optional year for reporting; however, the MBTA saw this as an opportunity to evaluate data sources and processes to establish the measures for 2018 performance measures and targets as this would be an annual requirement and adopted the FTA Useful Life Benchmarks by which to measure revenue and non-revenue vehicles and equipment. Between January and October of this year, the MBTA developed and submitted a package of TAM performance measures and targets required by a new FTA rulemaking.

These performance targets, and the data collected to develop them, will be used during the CIP process to help prioritize reliability projects impacting vehicles (revenue and non-revenue), facilities, stations, and fixed guideway infrastructure on all modes employed at the MBTA. Through this process, the MBTA team collected information on revenue vehicles, non-revenue vehicles, fixed guideway, and facilities (including stations, parking, maintenance, and administrative buildings), set performance baselines informed by the asset inventory, age, and condition information collected, and set performance targets where possible based on several factors including scheduled maintenance activities and programmed capital investment.

The performance measures and targets were signed off by the General Manager in August 2017 and the final submission was submitted to the Boston Metropolitan Planning Organization (MPO) in October 2017.

3.4 Asset Inventory Module

The National Transit Database (49 U.S.C. § 5335) requires each transit operator that benefits from 5307 and 5311 funds to submit an annual report containing information on capital investment, operations, and service provided.

In 2012, MAP-21 amended 49 U.S.C. § 5335 requiring 5307 and 5311 recipients to begin reporting asset and condition information to the National Transit Database (NTD). Beginning in 2018, 5310 recipients providing public transportation will also be required to report basic profile and asset information to NTD as part of the Transit Asset Management rule (49 U.S.C. § 5326).

The Asset Management team is also collecting asset inventory and condition data on vehicles, facilities, and fixed guideway infrastructure to prepare the Asset Inventory Module required by the FTA. Once collected and validated, this information will also be used to direct capital funds to the assets in greatest need of replacement or rehabilitation to be in full compliance with the new Federal requirements.

The MBTA commenced the process to meet the requirements for the Asset Inventory Module in October 2017 (once the FTA released the data templates), and submit the required information through the National Transit Database by

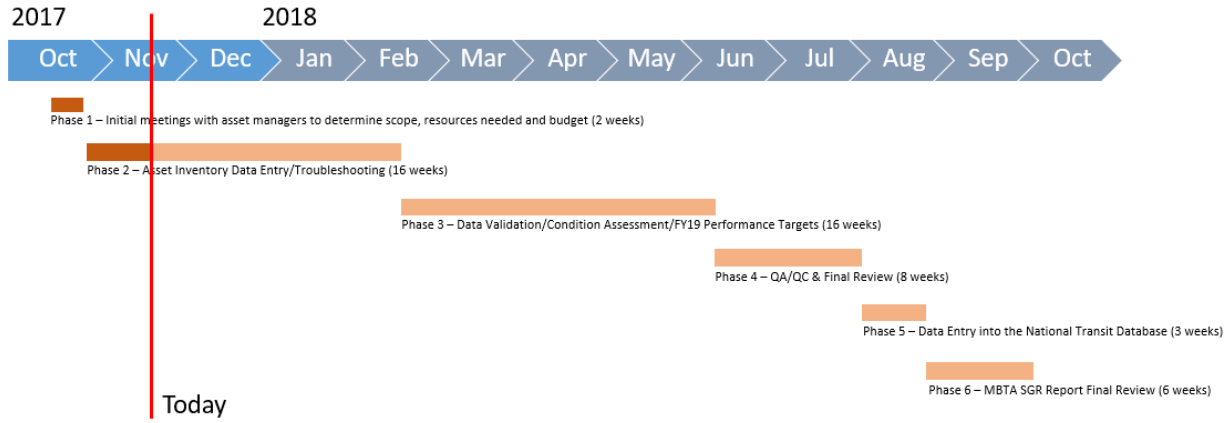
October 2018 as part of the annual reporting cycle. The Asset Inventory Module is scheduled to have been fully completed by 2021 (as Facilities are only required to have a minimum of 25% of the conditions reported each Federal fiscal year). The MBTA expects to exceed this 25% requirement as it baselines all facilities in the system over the next several years. The MBTA will leverage this effort to capture additional asset classes to create a more holistic view of its Agency Asset Register.

The transit inventory will be validated during this process and will aid the population of the Infrastructure Enterprise Asset Management System. Figures 3.4 and 3.5 show the asset categories that must be reported on to the NTD and the timeline for completion for the majority of the asset categories reportable to the NTD.

Figure 3.4: Asset Inventory Module Categories

1	Maintenance Facilities		12	Revenue Vehicles - Bus
2	Administrative Buildings		13	Revenue Vehicles - Heavy Rail
3	Passenger Facilities		14	Revenue Vehicles - Light Rail
4	Parking Facilities		15	Revenue Vehicles - Commuter Rail Locomotives & Coaches
5	Guideway Elements		16	Revenue Vehicles - Ferry
6	Bridges & Culverts		17	Revenue Vehicles - The RIDE
7	Tunnels		18	Non-Revenue Vehicles
8	Power Systems		19	Security Systems
9	Signal Systems		20	Environmental Equipment
10	Track Systems		21	Automated Fare Collection
11	Communication Systems		22	Information Technology

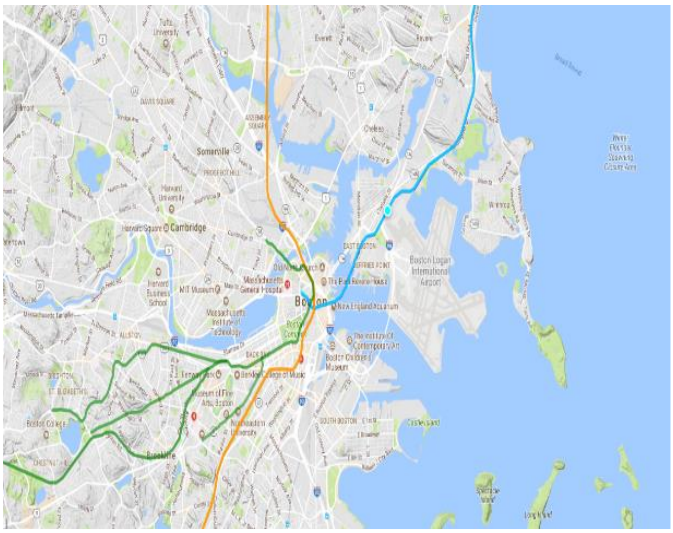
Figure 3.5: Asset Inventory Module Initial Data Collection Timeline



3.5 Transit Infrastructure Enterprise Asset Management System (EAMS)

In January 2017, the MBTA embarked on implementing a new EAMS for all transit infrastructure across the Authority creating an inventory of record for all infrastructure. This tool includes features with the potential to be used for tasks such as complete life-cycle management, flexible preventative maintenance scheduling, requisitioning and purchase orders, inventory and warehousing capability, financial and human resource management, warranty management, mobile wireless handheld options and web based software interfaces. The project will also intergrate with all key MBTA business systems including the State of Good Repair Database.

Figure 3.6: Example of Transit Lines Mapped in GIS



The MBTA is implementing the system in two phases. Phase 1 is concerned with the Blue Line track only and scheduled to be populated and functional in January 2018 followed by Phase 2, which includes all remaining infrastructure to be fully populated and functional by December 2020. This type of implementation is typically a 3-year implementation with a phased go live for each area.

Multiple achievements have been realized for both Phase 1 and 2, such as GIS mapping of key assets, latitude and longitude coordinates of key fixed guideway assets, track mapped and populated in GIS with street map overlay, initial testing of mobile hardware for in field working. Hardware infrastructure implementation and configuration, testing and validation of tunnel system wireless for maintenance crews. An example for the Blue Line is shown in Figure 3.7.

Figure 3.7: Example Track Hierarchy for the Blue Line

The complexity of this project, both technical and strategic can be depicted with a typical view of a station asset and the multiple assets within the station (Figure 3.8, next page).

Figure 3.8: Diagram of Assets in a Typical Transit Station

Architectural

1. Wall System
2. Ceiling Systems
3. Floor Materials
4. ADA Tactile Edging
5. Entrance Canopies
6. Fare Gate Barriers
7. Customer Service Booth
8. Escalators
9. Elevators
10. Elevator Enclosure and Cars
11. Signage and Supports
12. Green Roof
13. Building Façade Design/ Materials
14. Staircases
15. Platform Barriers/Screens
16. Steel Structures
17. Concrete Structures
18. Retaining Walls
19. Slurry Walls
20. Secant Pile Walls
21. Underground Structures
22. Waterproofing
23. Fire Protection/Ratings

Mechanical

24. Heating
25. Air Conditioning
26. Tunnel Ventilation
27. Emergency Exhaust Systems
28. Over-track Exhaust Systems

Electrical

29. Decorative/Architectural Lighting Systems in Public Areas
30. Back of House Lighting Systems
31. Electronic Signs
32. Power Systems

Plumbing

33. Sanitary Systems
34. Track Drainage
35. Cavern Drainage Systems
36. Water Supply

Fire Protection

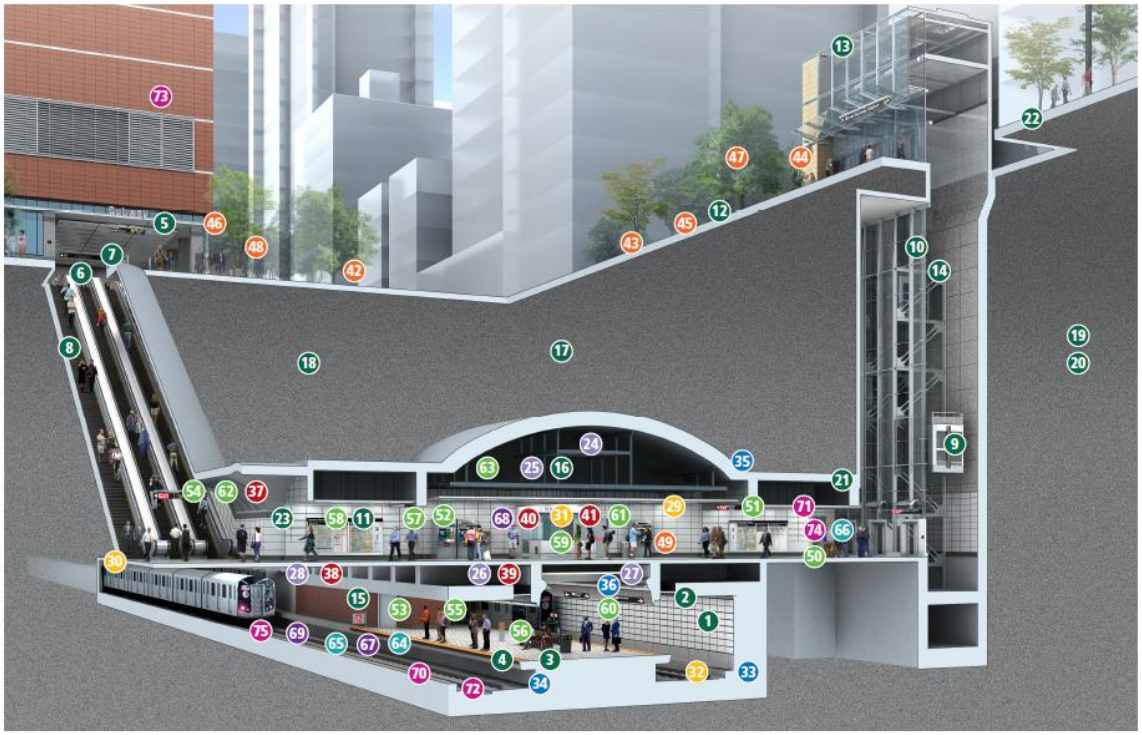
37. Wet Sprinklers
38. Dry Sprinklers
39. Water Mist Systems
40. Halon Systems
41. Inergin Systems

Amenities

42. Street Restoration
43. Sidewalk Restoration
44. Signage
45. Pavement Markings
46. Street Lights
47. Trees and Landscaping
48. Bus Shelters
49. Fare Vending Equipment

Communication Systems

50. Fiber Optic Network
51. CCTV
52. Intrusion Access Control
53. Fire Alarm
54. Public Address and Customer Information Signs
55. Help Point and Safe Point Intercoms
56. Emergency and Office Telephone Systems
57. Mobile Communications Network
58. Supervisory Control and Data Acquisition Systems
59. Emergency Alarm (Blue Light & Emergency Shutdown of 3rd Rail)
60. Emergency Booth Communication Systems
61. Time Clock Synchronization
62. Induction Loop Intercom (ADA wireless system for deaf)
63. WiFi Networks



Track

64. Track Fixation (attachments)
65. Rail
66. Rail Switches and Crossovers

Signal Systems

67. Component Infrastructure
68. Wayside Signal Display Boxes
69. Track Circuit Hardware

Traction Power

70. Trackbed Infrastructure
71. SCADA Train Control System
72. Third Rail (and third rail material)
73. Substation
74. Power Control Room
75. Regenerative Braking Equipped Railcar

3.6 MBTA Process Improvements

Engineering (Infrastructure)

Piloted the introduction of post-processed Light Detection and Ranging (LiDAR) data to formulate the new shape file for the linear corridor. Awaiting final delivery of the post processed LiDAR data to complete all lines, finalizing linear referencing system and reconciling physical assets in the field with corresponding EAMS records in the database, then add the geospatial data to the record for mapping purposes.

Introduced a pilot for Building and Bridge department to use rugged tablets for streamlining data entry, service request management, and Work Order closure in the EAMS. In addition, the following is being concluded:

- Final stages of introducing the Facilities group into the EAMS
- Final Stages of introducing NRV maintenance into the EAMS
- B&B Bridge Inspections completely moved to the EAMS

Materials (Supply Chain)

- Piloting the use of handheld scanners for purposes of material issues, cycle counts, and inventory counts
- Barcoding of all bin locations in the main warehouses underway. Looking to expand barcoding in CY 2018 to include remote part issuing and serialize part data capture.

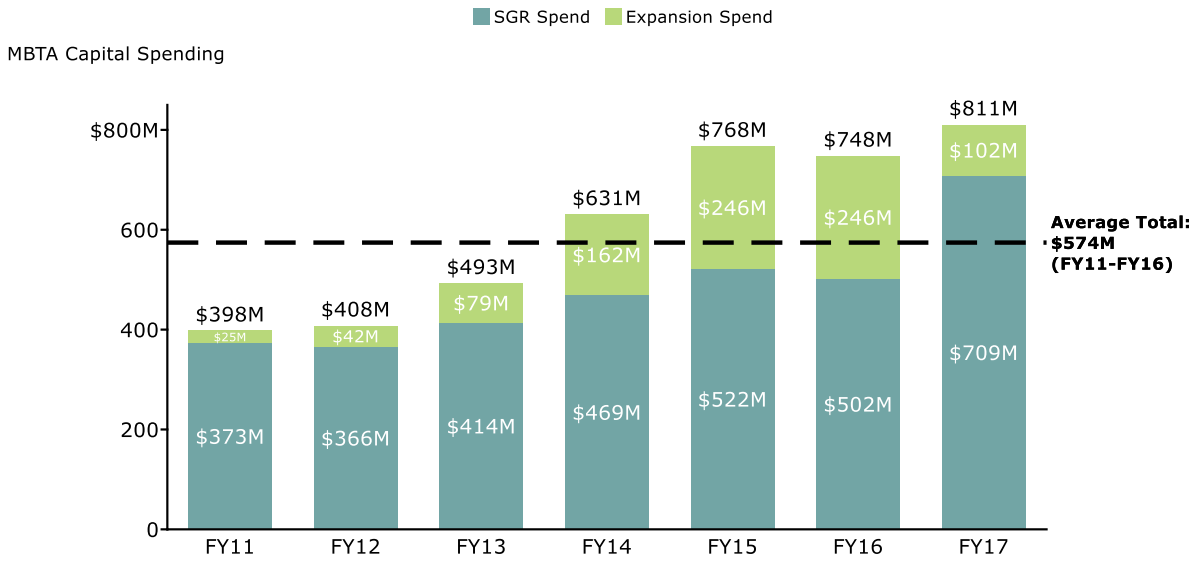
High Level (IT)

- Working to establish framework from which to manage Positive Train Control (PTC) and perform configuration management from within the EAMS
- Initial stages of the system upgrade for the EAMS
- Establishing standard policy across the organization to manage changes to the system

3.7 MBTA Capital Investment

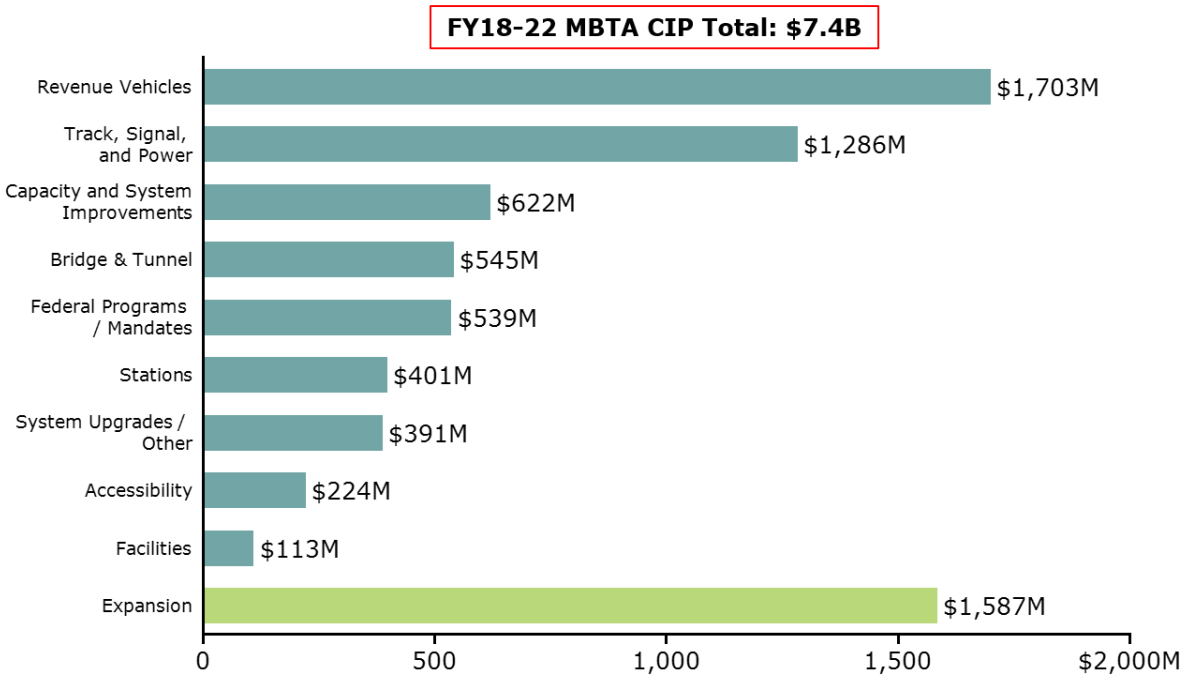
In FY 2017, the MBTA invested $811 million in its capital program – the most ever. Of this total, $709 million was spent on state of good repair projects, which was 40 percent greater than FY 2016. The trend over time is shown in Figure 3.9.

Figure 3.9: MBTA Capital Investment FY 2011 through FY 2017



The FY2018-2022 MBTA Capital Investment Plan (CIP) includes $7.4 billion in capital projects over five years, including $5.8 billion in State of Good Repair projects across all asset classes. This breakdown is shown in Figure 3.10.

Figure 3.10: FY 2018 – FY 2022 MBTA Capital Investment Plan



3.8 MBTA Progress in 2017 and Next Steps

The 2016 Annual Report proposed next steps for the MBTA. This section lists these goals and describes the progress that the MBTA has made toward achieving them:

- **MBTA Asset Management Governance Council |** Establishment of a MBTA Asset Management Governance Council consisting of senior MBTA leadership to complement the PAMAC to define, enforce, and resource the TAM Program throughout the Authority.
- **Establish performance targets for key asset classes |** Pursuant to the TAM final rule, during FY 2017 the MBTA established performance baselines and reported some performance targets for rolling stock, equipment, facilities, and fixed guideway assets. During FY 2018, these targets will continue to be refined as new asset inventory and condition data is collected and validated to establish performance measures and targets for FY19.
- **Verify additional data in the SGR Database and add inventory for additional assets to the SGR Database |** The asset inventory and condition data collected through the Asset Inventory Module process will provide a new source of validated asset data that may be integrated into the SGR database.
- **Fully implement the EAMS system for infrastructure |** Implementation of EAMS for transit infrastructure commenced in 2017 and will continue to progress through 2018. The MBTA expects to complete Phase 1 of the EAMS rollout by 2018 and Phase 2 by the end of December 2020.
- **Develop a Transit Asset Management Plan for the MBTA |** Although not listed as a next step in the 2016 report, developing a TAM plan as required by the FTA rule is a critical priority for the MBTA in the coming year and will help drive decisions regarding asset management policies, approaches, and tools across the organization.
- **Develop a Transit Asset Management Improvement Program for the MBTA |** Although not listed as a next step in the 2016 report, developing a TAM Improvement Program as required by the FTA rule for improvement to the Authority's TAM Processes is a critical priority for the MBTA in the coming year and will help drive decisions regarding asset management improvement activities across the organization.

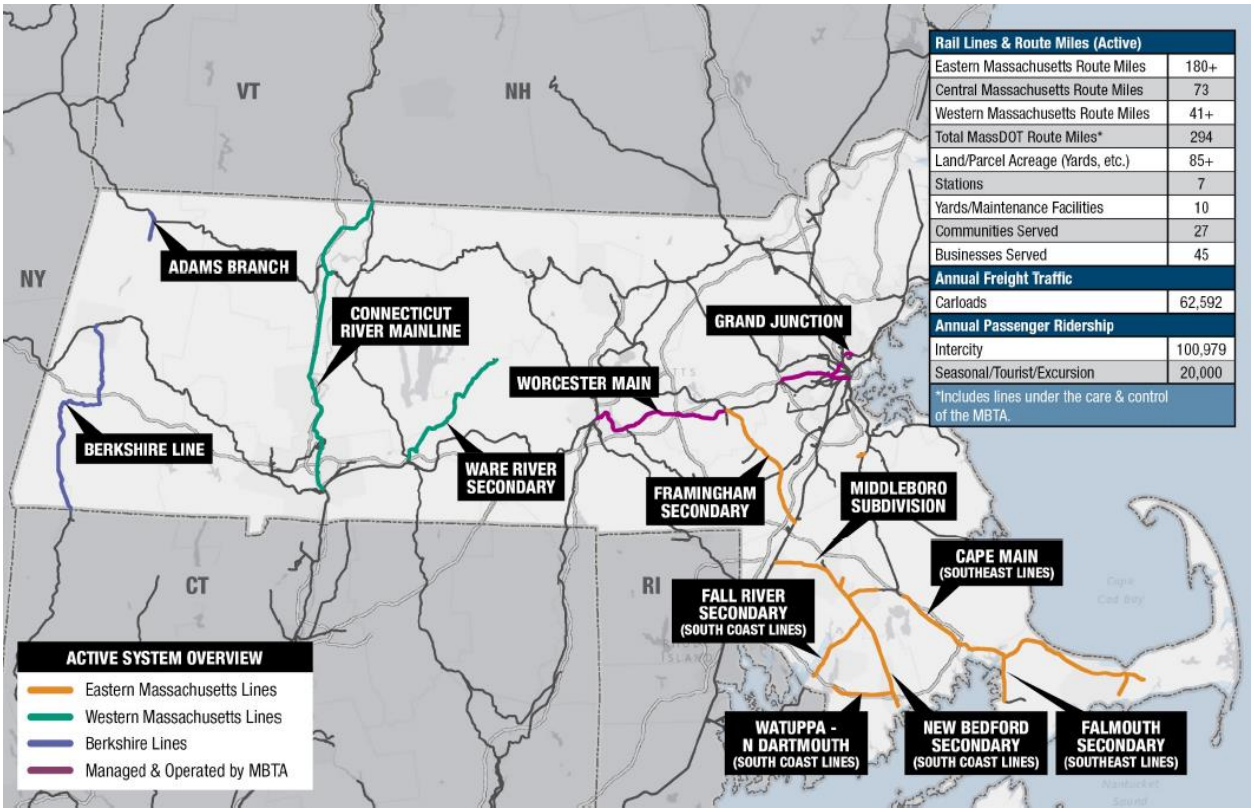
4. 0 The MassDOT Rail and Transit Division

The MassDOT Rail and Transit Division oversees and funds the rail and transit networks outside of the MBTA's service area. It both owns and oversees railroads used for passenger and freight service. It also collaborates with 15 regional transit authorities (RTAs) that use buses, vans, and para-transit vehicles to serve 26 million annual passenger trips on 258 routes in 231 communities.

4.1 Rail Assets

The Rail and Transit Division assets include 294 route-miles of active rail across 10 lines. Assets on these lines include track and right-of-way, grade crossings, bridges, culverts, and interlockings and switches. In addition, the Rail and Transit Division owns a small fleet of surplus MBTA locomotives and carriages that are used for passenger rail pilots and as substitute vehicles for the MBTA. The extent of the MassDOT-owned system is shown in Figure 4.1.

Figure 4.1: Map of the MassDOT-Owned Rail System



Nearly 60% of the active railroad system in Massachusetts is currently publicly-owned (25% MassDOT, 32% MBTA, 1% MWRA/Amtrak/Federal). Since 2010, MassDOT has acquired the South Coast Lines, the Boston Terminal Running Track, the West First Street Yard, the Grand Junction Branch, the Connecticut River Line, the Boston Main Line, the Berkshire Line, the Framingham Secondary, and the Adams Branch. MassDOT's acquisition of rail lines since 1995 has sought to serve customers better by increasing investment in maintenance beyond what had been possible for private owners.

The Rail and Transit Division maintains an Excel-based inventory of its rail lines, including track type, weight, and condition. This spreadsheet also includes bridges and grade crossings (with the equipment installed there). The Rail and Transit Division has begun to coordinate with MassDOT's GIS team to transfer this inventory to a geospatial database tool that will be accessible online throughout the department.

4.2 Transit Assets

The 15 RTAs own revenue vehicles, non-revenue vehicles, and maintenance facilities and administration buildings. The majority of the RTAs have adopted Transportation Asset Manager (TransAM), an open-source asset management platform. The system went live in 2016 and contains an inventory of revenue and support vehicles, facilities, and equipment. TransAM includes age and condition of assets as fields and can forecast SGR and compute backlog.

The RTAs have complete datasets for revenue and non-revenue vehicles in TransAM. Given the small number of RTA maintenance facilities, the age and condition of each facility are well-known and will be included in TransAM moving forward. The RTAs also are required to submit an annual inventory of revenue vehicles to the National Transportation Database.

Both MassDOT (for its intercity bus fleet and sub-recipients of Federal Funding) and the RTAs are completing transportation asset management plans (TAM Plans) by October 2018, as required by FTA.

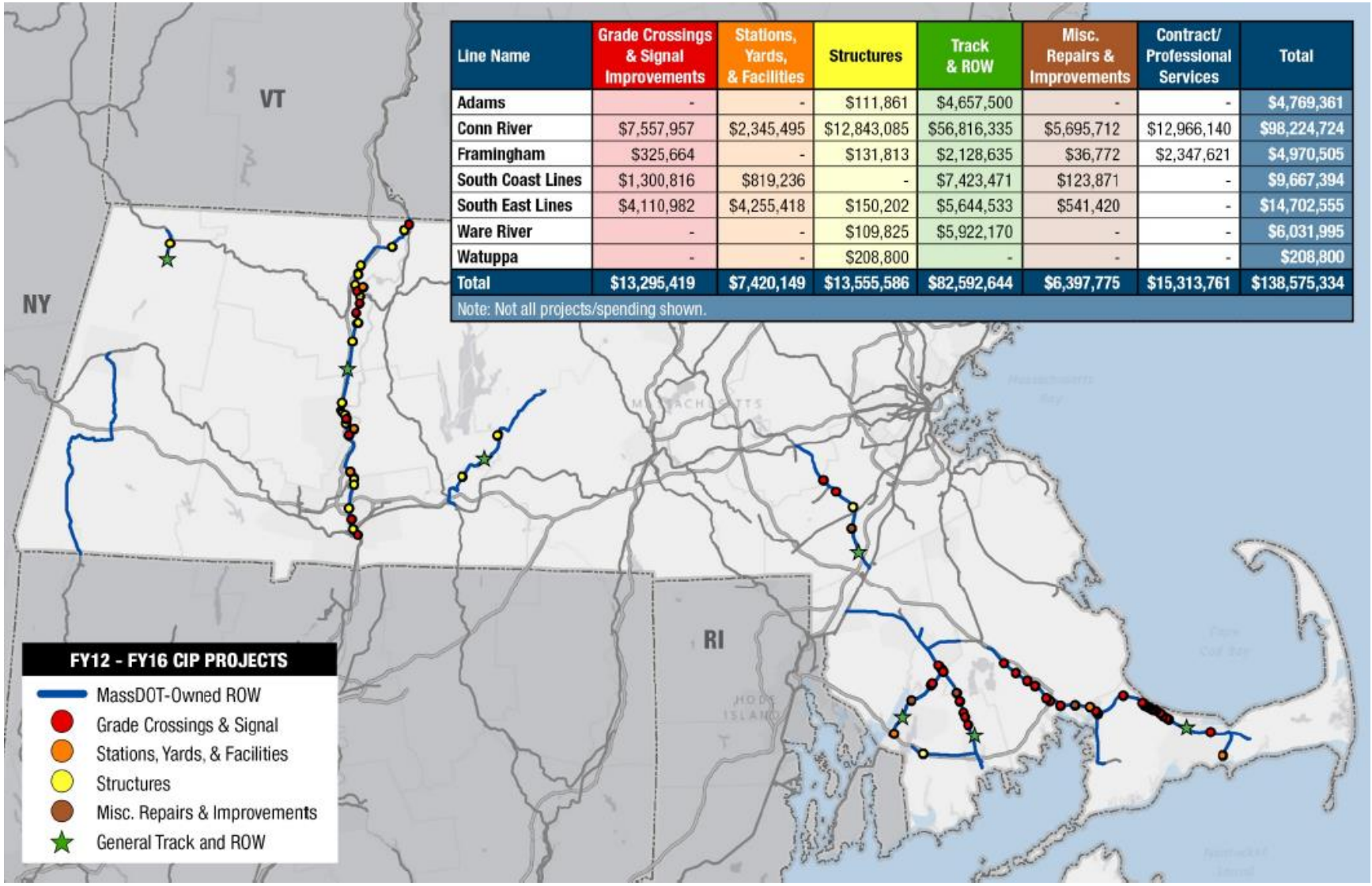
4.3 Investment in the Rail and Transit Division

Between 2012 and 2016, MassDOT invested approximately $140 million in improvement of its rail lines. These investments are shown by type in Figure 4.2.

Figure 4.2: CIP Investments in Rail, 2012-2016

Line Name	Grade Crossings & Signal Improvements	Stations, Yards, & Facilities	Structures	Track & ROW	Misc. Repairs & Improvements	Contract/ Professional Services	Total
Adams	-	-	$111,861	$4,657,500	-	-	$4,769,361
Conn River	$7,557,957	$2,345,495	$12,843,085	$56,816,335	$5,695,712	$12,966,140	$98,224,724
Framingham	$325,664	-	$131,813	$2,128,635	$36,772	$2,347,621	$4,970,505
South Coast Lines	$1,300,816	$819,236	-	$7,423,471	$123,871	-	$9,667,394
South East Lines	$4,110,982	$4,255,418	$150,202	$5,644,533	$541,420	-	$14,702,555
Ware River	-	-	$109,825	$5,922,170	-	-	$6,031,995
Watuppa	-	-	$208,800	-	-	-	$208,800
Total	$13,295,419	$7,420,149	$13,555,586	$82,592,644	$6,397,775	$15,313,761	$138,575,334

Note: Not all projects/spending shown.



This CIP funding has accomplished the following:

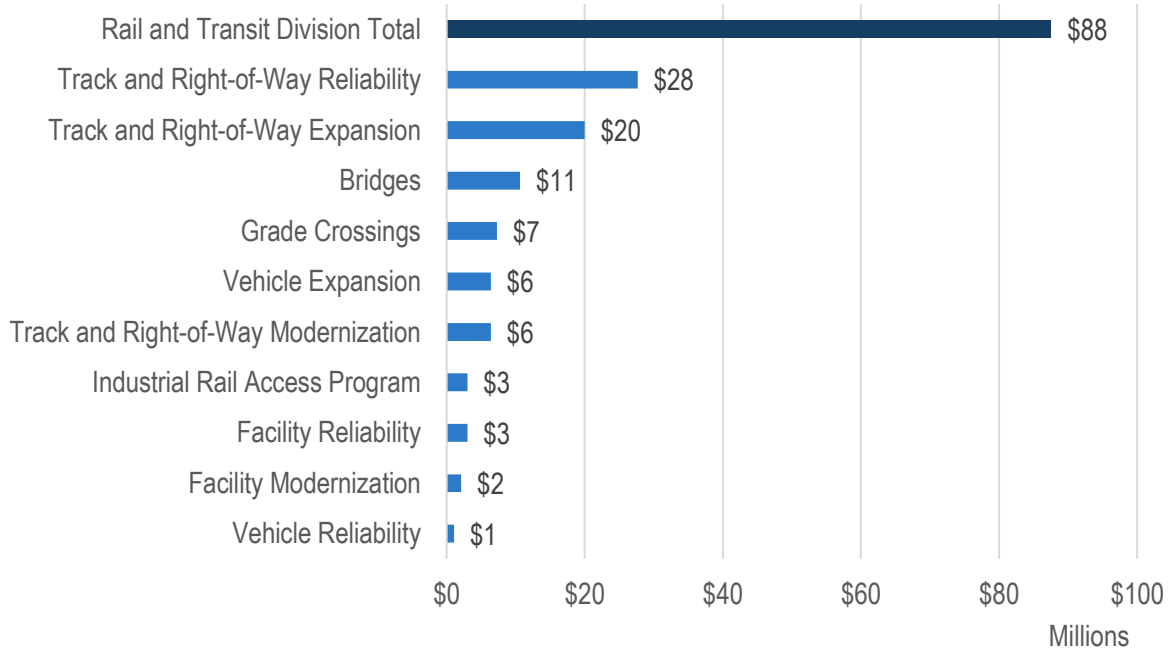
- 24 completed bridge and structure projects.
- 85 completed at-grade crossing projects.
- Piloted tourist rail service on Cape Cod and in the Berkshires.
- Leveraged Federal funds for the Knowledge Corridor, New Bedford and South Coast rail bridges and weight rating improvements.

In FY2017 the Rail and Transit Division replaced or repaired approximately 26,000 rail ties (out of a total 800,000 statewide, or 3%). It also must typically inspect and maintain 163 bridges and over 600 culverts and meet national standards and industry demand for allowable weight (286,000 lb. cars). Examples of typical work done by MassDOT Rail are shown in Figure 4.3.

Figure 4.3: Typical MassDOT Rail Capital Projects

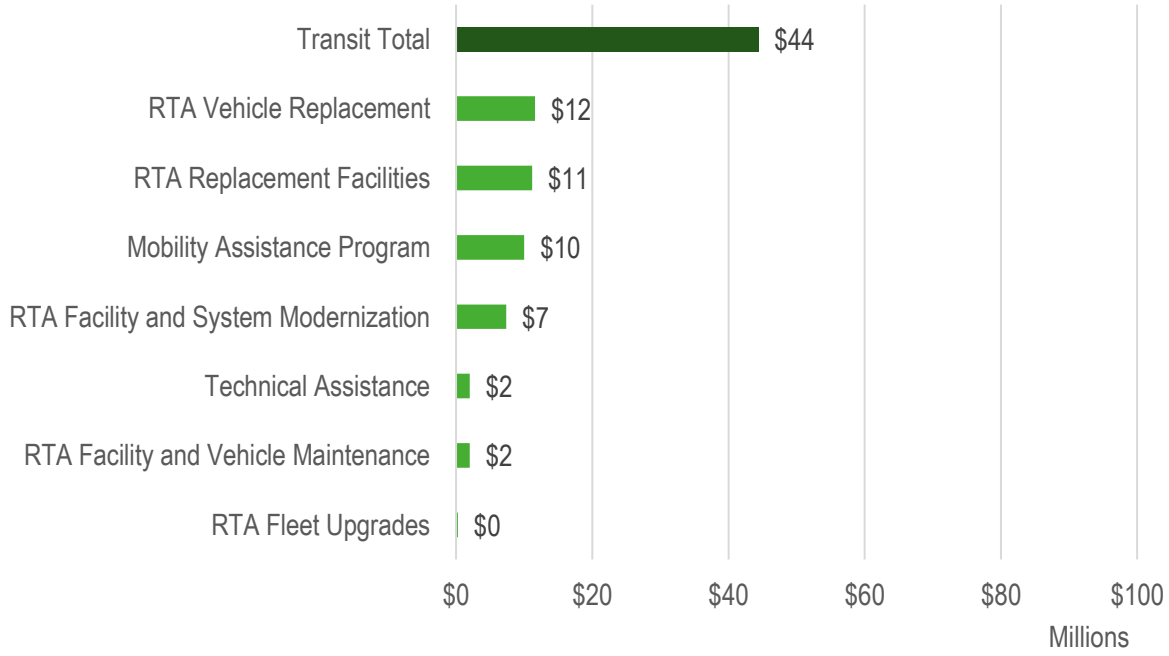
For the 2018-2022 CIP, the Rail and Transit Division has established a new structure of rail programs to better align with its asset classes. The new programs are shown in Figure 4.4 along with their average annual allocation.

Figure 4.4: Average Annual Program Sizes for Rail in the 2018-2022 CIP



Program sizes for transit are shown in Figure 4.5.

Figure 4.5: Average Annual Program Program Sizes for Transit in the 2018-2022 CIP



4.4 Performance and Forecasts in the Rail and Transit Division

Figure 4.6: FTA Performance Metrics

Assets: *Only those for which agency has direct capital responsibility*	**Performance Measure**
Equipment: Non-revenue support-service and maintenance vehicles	Percentage of non-revenue vehicles met or exceeded Useful Life Benchmark
Rolling Stock: Revenue vehicles by mode	Percentage of revenue vehicles met or exceeded Useful Life Benchmark
Infrastructure: Only rail fixed-guideway, track, signals and systems	Percentage of track segments with performance restrictions
Facilities: Maintenance and administrative facilities; and passenger stations (buildings) and parking facilities	Percentage of assets with condition rating below 3.0 on FTA TERM Scale

Useful Life Benchmark

The expected lifecycle of a capital asset for a particular Transit Provider's operating environment, or the acceptable period of use in service for a particular Transit Provider's operating environment

MassDOT is in the process of defining performance measures for its rail assets.

RTAs are subject to FTA performance management requirements adopted in July, 2016. The FTA rule sets performance measures for the assets shown in Figure 4.6. It is the responsibility of the RTA to set their targets for these measures and to share them with their MPOs. The RTAs are responsible for reporting the data to the National Transit Database. MassDOT is working closely with the RTAs to understand their projected performance targets and to develop their required TAM plans by the October, 2018 deadline.

The 2017 Tracker reports that RTA fixed-route buses are between 1.8 and 8.1 years old while demand-response buses are between 1.5 and 5.7 years old.

FTA uses a five-point Transit Economic Requirements Model (TERM) scale to rate the condition of assets. A score of 0 is failure while 5 is new. RTA TERM scores for 2017 are: between 2.8 and 4.8 for fixed-route vehicles; between 2.6 and 5.0 for demand-response vehicles; and between 3.0 and 5.0 for facilities.

4.5 Rail and Transit Division Progress in 2017 and Next Steps

The 2016 Annual Report proposed next steps for the Rail and Transit Division. This section lists these goals and describes the progress that MassDOT has made toward achieving them:

- **Establish performance targets for key assets |** MassDOT is still working toward this goal in collaboration with the RTAs.
- **Develop a new Statewide Rail Plan |** The Statewide Rail Plan will be published in late 2017.
- **Continue to perform work to better the condition of all rail lines |** In the 2018-2022 CIP, MassDOT has increased average annual spending on its rail lines to $88 million, as compared to $63 million in the 2017-2021 CIP. This additional funding will be used to fund bridge and culvert rehabilitation and replacement, and track and right-of-way improvements across the Commonwealth.

  MassDOT is requesting "Infrastructure for Rebuilding America" (INFRA) funding to upgrade more than 31 miles of rail and 20 bridge structures on the route of the New England Central Railroad. The work in Massachusetts is necessary to close the last "gap" in the 286,000 lb. rail network that is being built in Vermont and Connecticut.

- **Verify RTA asset inventories |** The RTAs have agreed to share asset inventory and relevant data and MassDOT will provide technical assistance in meeting new Federal regulations and guidance.
- **Collaborate with RTAs to interpret and implement FTA guidance, including performance measures and TAM Plans |** MassDOT is working closely with the RTAs to understand their projected performance targets and to develop required TAM plans for MassDOT and its sub-recipients by the October, 2018 deadline.
- **Complete a TAM evaluation for Department-owned rail |** The MassDOT Rail and Transit Division anticipates completion in February, 2018.

5. 0 The MassDOT Aeronautics Division

The MassDOT Aeronautics Division is a steward for 36 public use airports across the Commonwealth. The Massachusetts Port Authority (Massport) owns and operates Boston Logan International Airport, Hanscom Field, and Worcester Regional Airport independently of MassDOT. In addition to the public use facilities, the Aeronautics Division oversees a variety of private landing strips, seaplane bases, and heliports.

While the Aeronautics Division performs top-down planning and makes recommendations to individual airports, it does not own facilities; 22 of the public-use airports under its purview are managed by cities and towns, while 14 have private owners. MassDOT provides grants of mostly Federal aid to airports through the CIP process. Publicly owned airports can also apply directly to the FAA Airport Improvement Program for projects identified and justified in master plans, environmental analyses, airport inspections and financial evaluations.

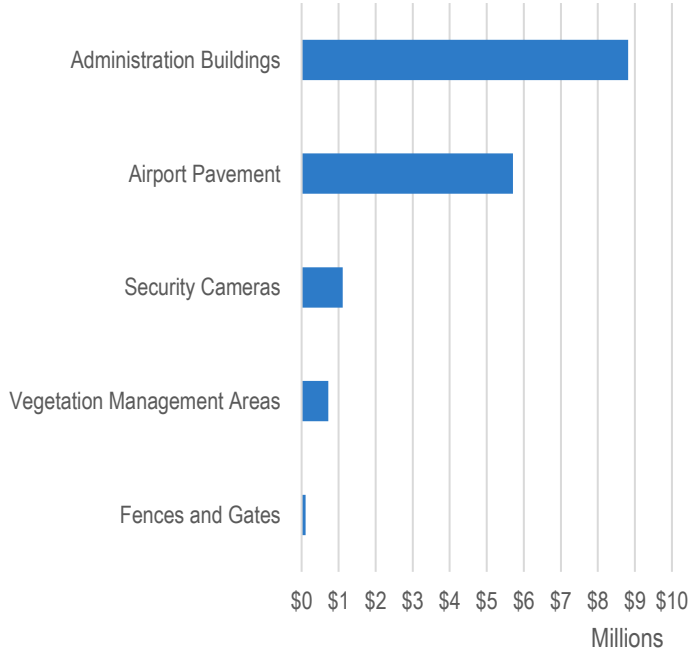
5.1 Aeronautics Division Assets

The Aeronautics Division does not directly own assets but funds improvements to airports in response to performance metrics.

- **Airport Pavement |** The Federal Aviation Administration (FAA) will fund pavement projects on runways, taxiways, and aprons based on their existing condition and useful service life. Airports overseen by MassDOT own over 40 million square feet of pavement.
- **Vegetation Management Areas |** Airports receive funding to clear trees and brush from areas in and adjacent to runway approaches, in order to remove hazards to flight.
- **Fencing and Gates |** In 2001, the Massachusetts Aeronautics Commission, (forerunner to the MassDOT Aeronautics Division) issued a security directive (AD-001a) requiring the installation of security fencing and access gates at public use airports (where appropriate) to restrict access to an airport's Air Operations Area (AOA), and to protect other sensitive areas (such as fuel farms) located on airport property. The security directive was adopted by MassDOT in 2009 when the Aeronautics Commission was disbanded.
- **Security Cameras |** The aforementioned 2001 security directive (AD-001a) also called for the installation of video surveillance cameras to monitor access gates leading to an airport's AOA. The provision is mandatory for airports with commercial air passenger service, and the remaining airports are encouraged to comply with the directive as funding permits.
- **State Airport Administration Buildings |** MassDOT funds the rehabilitation of general aviation administration buildings, which often serve both customer service and operational functions.

5.2 Investment in the Aeronautics Division

Figure 5.1: Average Annual Aeronautics Division Capital Investments by Asset Class, 2017-2021



Massachusetts relies heavily on matching grants from the FAA's AIP, as do all states. Recognizing that not all airport sponsors are eligible for Federal funding, MassDOT initiated the Airport Safety and Maintenance Program (ASMP), which can provide state-funded grants-in-aid to close the gap for these sponsors.

The ASMP serves to leverage funds for safety, maintenance, and security projects that have been selected for the CIP. ASMP typically supports a state share of 80% and a local airport share of 20% with no Federal participation. These projects are often routine maintenance that address deficiencies noted in MassDOT airport inspections (such as pavement condition, security issues and vegetation overgrowth). Airport planning and new construction and equipment grants are also eligible.

Planned annual average investment in each asset class from 2017-2021 is shown in Figure 5.1.

5.3 Performance and Forecasts in the Aeronautics Division

Pavement represents one of the largest capital investments in the Massachusetts statewide airport system, and the condition of these pavements is important both from cost-effectiveness and safety standpoints. Timely airport pavement maintenance and rehabilitation are crucial because repairs are much more costly once the condition deteriorates below a certain level. Additionally, airport pavement weaknesses, such as cracks and loose debris, pose a significant safety risk to aircraft.

The FAA requires that pavements be inspected every three to five years. **A new statewide pavement assessment was completed by an outside contractor in June, 2017, with the next scheduled for 2020 and every three years thereafter.** In the intervening years (FY2018/2019), MassDOT Aeronautics staff will accomplish annual in-house assessments to ensure annual tracking of pavement condition data.

MassDOT uses a Pavement Condition Index (PCI), described in Figure 5.2. PCI was developed and proposed by the FAA and ranges from zero to 100 – "good" PCI is defined as 75 and above for runways. Statewide, MassDOT measures

Figure 5.2: Airport Pavement Condition Index

the percent of system airports with overall good PCI across all their runways. **In the June, 2017 pavement condition assessment, the average PCI for runways at non-Massport facilities was 68.**

MassDOT has collaboratively set the following performance targets for airport PCI:

- 72 in 2018.
- 74 in 2020.
- 75 in the long-term.

As an element of the 2017 Pavement Condition Assessment, the Aeronautics Division projected condition under different annual funding levels from 2017 to 2023. Using this model, PCI under MassDOT's planned funding level was forecast from 2017 to 2027. **MassDOT is projected to meet its targets in the short, medium, and long-term.**

5.4 Aeronautics Division Progress in 2017 and Next Steps

The 2016 Annual Report proposed next steps for the Highway Division. This section lists these goals and describes the progress that MassDOT has made toward achieving them:

- **Perform the first of the triennial survey of airport pavement condition |** The 2017 Pavement Condition Assessment was completed in June, 2017.
- **Advance statewide implementation of the AIR-Port system |** MassDOT has opted to focus on the implementation of a MassDOT Enterprise IT project management and capital planning system at this time.
- **Begin the process of developing the successor to the 2010 MSASP |** MassDOT will begin to develop the next statewide airport system plan in 2018.

6. 0 Municipalities

Massachusetts is comprised of 351 cities and towns (collectively "municipalities"). The Commonwealth provides aid to municipalities to support the upkeep of their pavement and bridge assets, primarily through the "Chapter 90" reimbursement program and the Municipal Small Bridge Program. Municipalities may support preservation on pavement and bridges with their own funds in addition to State Aid. Municipalities are also allocated Federal aid through metropolitan planning organizations (MPOs) that cover urban regions.

6.1 Municipal Assets

Municipalities own many of the same assets and asset classes as MassDOT; in addition to bridges and pavement, they may be responsible for signs and signposts, streetlights, sidewalks, ramps for the disabled, traffic signals, retaining walls, and maintenance vehicles and equipment.

6.2 Investment in Municipalities

Chapter 90

MassDOT provides municipal aid for roadway projects through the Chapter 90 Program. Chapter 90 projects are 100% reimbursable, meaning that municipalities are not required to contribute to them, though municipalities may contribute significantly to the general upkeep of their roadway network. Permissible uses of Chapter 90 funds include resurfacing and related work (e.g., bridges, right-of-way acquisition, shoulders, side road approaches, landscaping, drainage, sidewalk, traffic control and service facilities, and lighting).

Municipalities are allocated Chapter 90 funds based a composite of three factors:

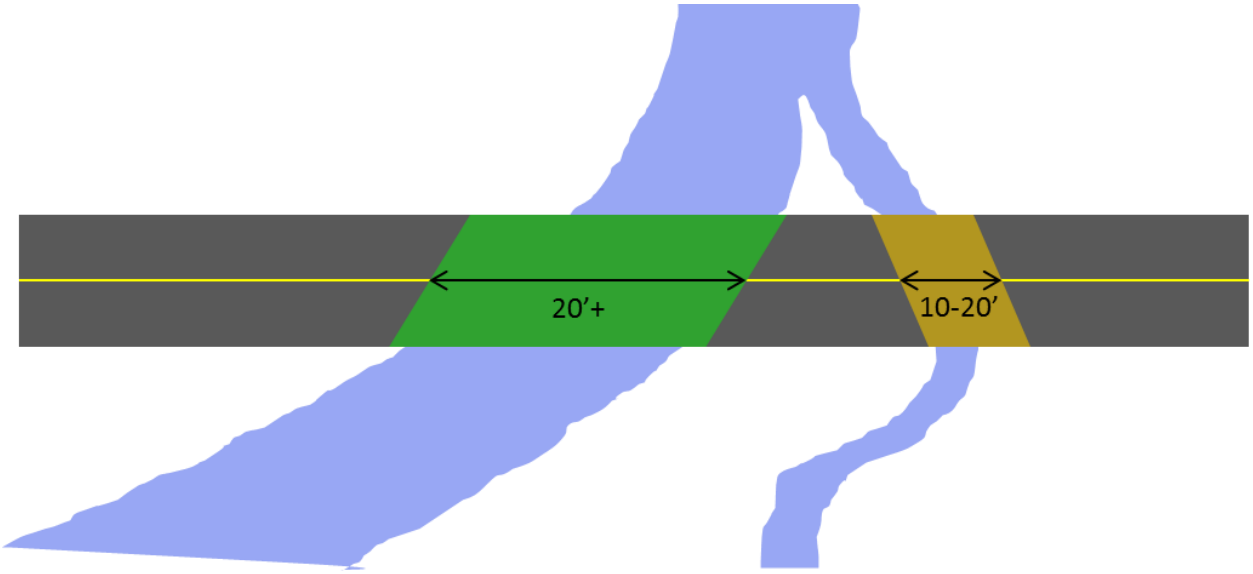
- Road miles – 58.33%.
- Population – 20.83%.
- Employment – 20.83%.

After the total apportionment for a city or town is calculated, municipalities apply for reimbursement against it on a project-by-project basis.

Municipal Small Bridge Program

The Legislature conceived the Municipal Small Bridge program to assist municipalities with replacement and preservation of "small bridges" owned by municipalities. A small bridge is one between 10 and 20 feet in span length, as shown in Figure 6.1.

Figure 6.1: Span Length of NBI and BRI Structures

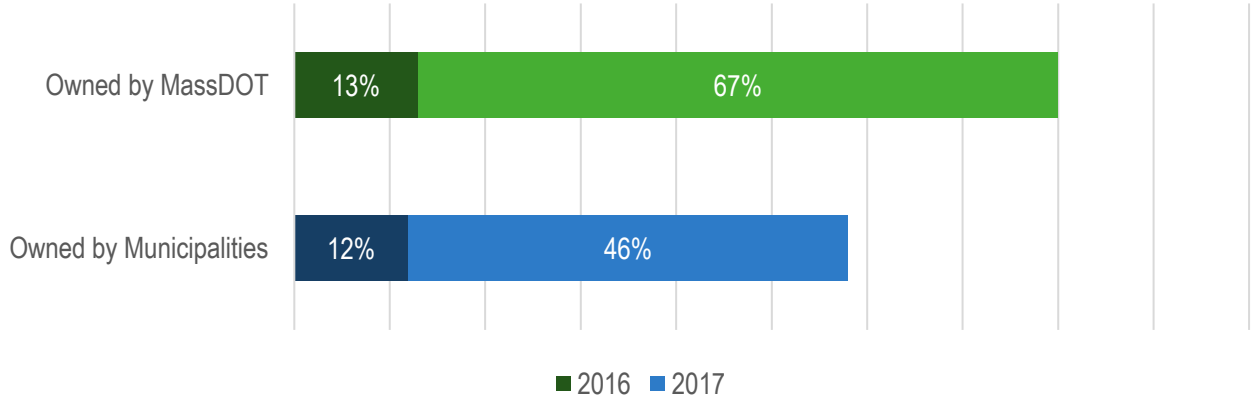


Small bridges do not meet the Federal definition of a bridge (i.e., National Bridge Inventory (NBI) bridges), so they are not eligible for Federal bridge funds.

MassDOT's goal is to inspect small bridges with the same biannual frequency as is required for NBIs (which have a 20-foot span length or greater), and the initial round of statewide inspections is underway. There are currently 1,584 known small bridge locations in the state (this number is updated periodically due to field confirmation), with approximately 1,200 owned by municipalities, and the remainder owned by MassDOT.

The overall inventory is 64% complete (up from 13% last year). Over 400 structures have been inspected in 2017. Based on current data, approximately 11% of municipally-owned small bridges inspected recently are rated SD. Seventy percent of small bridges are located in Districts 1, 2, and 3 (i.e., west of I-495). Significant progress on inspections has been made since 2016, as shown in Figure 6.2.

Figure 6.2: BRI Inspection Progress, 2016 and 2017



The Legislature has established the Municipal Small Bridge Program at $50 million over five years. The municipality is responsible for procuring a pre-approved designer, securing right-of-way, securing permits, procuring a pre-approved contractor, and administrating the construction contract. MassDOT's only responsibility is to select the projects and reimburse the funds spent up to a $500,000 maximum per sponsor. In "Round 1" in FY2017, 36 projects were approved of 50 eligible projects submitted – 24 replacements and 12 rehabilitations. For Round 2 (FY2018), 18 new applications are under review along with the 14 applications not approved in Round 1. MassDOT has distributed $16 million to cities and towns since November, 2016.

6.3 Performance in Municipalities

Municipal pavement management in Massachusetts occurs both at the local level in cities and towns and at the regional level in Metropolitan Planning Organizations (MPOs) and Regional Planning Councils (RPCs). While municipalities have managed the condition of local roads for centuries, regional pavement management in Massachusetts began in response to the Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA). ISTEA both established the mandate for MPOs and tasked them with coordinating local pavement management and pavement management systems.

In addition to the regional mandate, ISTEA also required States to procure and maintain management systems for State-owned roads on the National Highway System (NHS) and Federal-Aid System. MassDOT has operated a statewide Pavement Management Section since 1986 and currently uses the Deighton Total Infrastructure Management System (dTIMS) to manage State-owned pavement and locally-owned NHS pavement.

6.3.1 Regional Pavement Management

The 1991 mandate for coordinated regional pavement management was implemented in Massachusetts though harmonization of then-current pavement management data systems and software applications. The Massachusetts Highway Department (which merged into MassDOT in 2009) chose not to pursue a unified statewide pavement management system for local roads due to the time and money already invested in a large number of independent software applications across the Commonwealth. This harmonization effort included:

- A unified GIS-based inventory that survives as MassDOT's Road Inventory File.
- Indexing of all local pavement condition indices with the Highway Department's condition index.
- Communication and peer exchanges among State, regional, and local pavement managers.

In 1996, regional organizations produced a pavement management plan and began coordinated data collection in 2000, with a second round in 2004. Today, regional pavement management is no longer mandated, but MPOs remain committed to it and Massachusetts continues to invest in it with State funding through the Chapter 90 program. However, the license fees for fully-modern pavement management software strains the resources of MPOs, and some have expressed a desire for MassDOT to acquire a standard system for regions.

6.3.2 Municipal Pavement Management

Of the 351 cities and towns in Massachusetts, 142 responded to the MMA that they currently operate a pavement management software application. An additional 82 responded to the MMA that they do not, and 127 did not respond to the survey.

The 142 municipalities using software packages break out as follows:

- 38 use BETA Group, Inc.
- 24 use Vanasse Hangen Brustlin, Inc. (VHB).
- 12 use a system from an RPC.
- 24 have developed a system in-house.
- 51 using other systems.

The remaining 45 municipalities use systems from Cartegraph, Environmental Partners, iWorq, MicroPaver, PASER, Paver, People GIS, RSMS, Softworks, Stantec, StreetScan, VFI5, VUEWorks, Weston and Sampson, and World Tech Engineering.

Each of these vendors uses a different pavement condition index. These indices cannot be quantitatively translated due to varying combinations of ride quality and condition metrics, but they can be aligned with MassDOT's pavement serviceability index (PSI) using qualitative comparisons (e.g., Good/Fair/Poor).

Using this alignment, data from BETA Group, the Cape Cod Council, the Old Colony Regional Planning Council, Pioneer Valley Planning Commission, Stantec, and VHB – accounting for 46% of the statewide municipal lane-mileage – can be combined to show that Massachusetts' municipal pavement is currently at a condition of 70 ("fair-to-good"). Trends from the Pioneer Valley Planning Commission (PVPC) over the past five years demonstrate a steady decline in pavement condition in its constituent cities and towns, though municipalities that invest in pavement beyond their Chapter 90 State reimbursement have maintained a more steady state.

A comparison of annual investment can be made with the MassDOT-owned Non-Interstate system. In the most recent Highway predictive model (2015), where the state system was at 64% good and excellent (compared with the current estimate for Municipal Roads of 70%), the projection to maintain condition was an annual investment of $200 million. The municipal lane mile inventory is eight times the size of the state system, and is currently funded through Chapter 90 at $200 million. At face value, this would suggest that municipally owned roads are underfunded, though there are many qualifiers for this comparison, including contrasting levels of traffic between the two systems.

The Massachusetts Municipal Association (MMA) stated in 2014 (https://www.mma.org/boost-needed-ch-90-local-road-funding) that cities and towns across the Commonwealth need to spend at least $639 million annually to maintain and bring 30,000 miles of local roads into a state of good repair (SGR). Estimated annual budget to attain SGR was self-reported by municipalities in 2017 as between $10,000 and $60,000 per centerline mile.

6.4 Municipal Progress in 2017 and Next Steps

The 2016 Annual Report proposed next steps for MassDOT in supporting municipalities. This section lists these goals and describes the progress that MassDOT has made toward achieving them:

- **Populate and verify an inventory of BRI bridges, including those owned by municipalities |** MassDOT's inventory of BRI bridges is currently 64% complete and ongoing.
- **Launch a version of the geoDOT site geared toward municipalities |** The Office of Transportation Planning will now allow representatives from municipalities and planning organizations full membership to the MassDOT GeoDOT site, and will offer a suite of applications designed for local use including the MaPIT Tool (Massachusetts Project Intake Tool).
- **Collaborate with municipalities to share pavement data with MassDOT and with other nearby municipalities |** During the production of this Annual Report, MassDOT has begun to study data tools in use by other states, specifically by New Hampshire.

7. 0 Transportation Asset Management Plans

7.1 The Highway Division

The Highway Division will submit its inaugural "compliant" NHS Transportation Asset Management Plan (TAMP) to the Federal Highway Administration. The report is a requirement for all states and will detail the inventory, performance, life-cycle cost, financial plan and investment strategies employed for the management of NHS bridges and pavement. This document will also be used to inform future MassDOT investment levels for NHS bridge maintenance, preservation, and capital programming.

The Highway Division expects to complete a compliant TAMP for submittal in April, 2018.

7.2 The MBTA

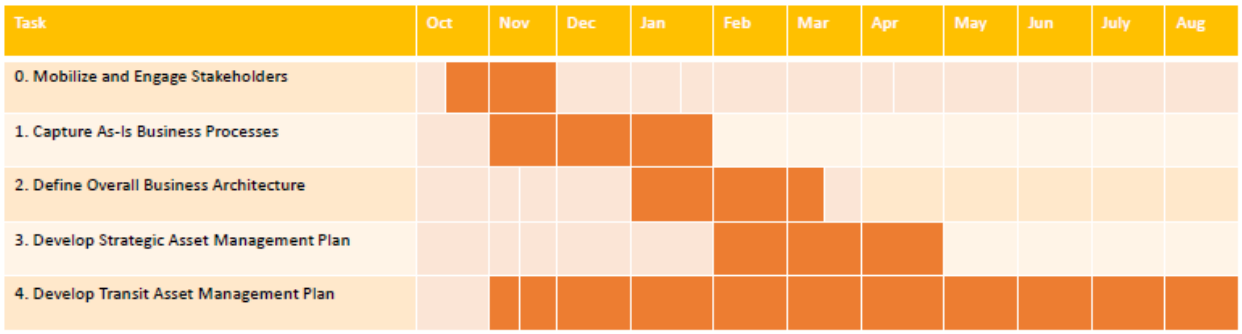
The FTA has required all transit agencies across the United States to submit three core deliverables by October, 2018:

- The Transit Asset Management Plan (TAMP).
- Asset Inventory Module.
- Performance Metric.

As a Tier I agency, the MBTA is required to include all of the elements shown in Figure 7.2 (next page).

The MBTA has formed working groups to obtain and validate MBTA data concerning assets, the organizational maturity level, resources and next steps. The Authority seeks to compose a plan that not only meets the new FTA requirements but also seeks to align itself to the MBTA Strategic Plan, industry best practices and recognized standards to aid benchmarking for continual improvement in its program. A timeline for TAMP development is shown in Figure 7.1.

Figure 7.1: TAMP Timeline



7.3 The Rail and Transit Division

The Rail and Transit Division is required to submit two TAM Plans to FTA: a group plan for its Federal Aid sub-recipients and an individual plan for its fleet of intercity coach buses.

Required elements of a TAM plan are summarized in Figure 7.2.

Figure 7.2: TAM Plan Elements

MassDOT is making progress toward submitting both TAM Plans by October, 2018.

7.4 RTAs

The 2016 FTA rule will require the RTAs to develop Transit Asset Management Plans (TAM plans) in some form. Tier I agencies must complete an individual TAM plan. Tier II agencies (i.e., many RTAs) may complete a group TAM plan in cooperation with a sponsor. **MassDOT will be a sponsor and will collaborate with Tier II RTAs as needed to interpret and implement these requirements by the deadline of October, 2018.**

8. 0 The Road Ahead

For 2018, The Council recommends that MassDOT pursue unified asset databases across its divisions to the greatest degree possible wherever divisions own the same types of assets. The clearest application of this principle is for bridges. MassDOT owns bridges through its Highway Division, Rail and Transit Division, and the MBTA. Rail bridges are not yet included in the Highway Division's bridge inventory system or bridge condition model.

Specific next steps for each division are summarized below:

MassDOT

- **Continue to roll out geoDOT and MaPIT for collaborative project planning |** geoDOT – MassDOT's publicly-available GIS database and online mapping/geospatial environment – continues to grow its data offerings and capabilities. In 2017, MassDOT has begun to release modal plans using interactive "Story Map" applications. MaPIT is MassDOT's new project submission tool for highway projects.

Highway Division

- **Implement programmatic improvements to the delivery of Non-Interstate system projects |** These improvements are expected to maximize the efficiency of the current investment level, and future investment levels will be considered based on these changes.
- **Progress toward the FHWA maximum of 10% of deck area on SD bridges |** An analysis provided in this report predicts current investments will likely maintain this improvement but condition is not expected to meet the 10% target within the current CIP (2018-2022). The TAMP will provide a plan to achieve this target.
- **Continue to make progress on the "desktop" culvert inventory |** Use this information as part of a risk-based, extreme weather vulnerability pilot in 2018.
- **Submit an "element-level" tunnel inventory |** Due in the spring of 2018.
- **Identify locations where bicycle and pedestrian facilities are needed |** MassDOT is nearing completion of the Statewide Bicycle Plan and Statewide Pedestrian Plan and will publish them in 2018. As of June 30, 2017, the number of failed pedestrian ramp locations has been reduced from 6,700 to 5,200.

MBTA

- **MBTA Asset Management Governance Council |** Establishment of a MBTA Asset Management Governance Council consisting of senior MBTA leadership to complement the PAMAC to define, enforce, and resource the TAM Program throughout the Authority.
- **Establish performance targets for key asset classes |** Pursuant to the TAM final rule, during FY 2017 the MBTA established performance baselines and reported some performance targets for rolling stock, equipment, facilities,

and fixed guideway assets. During FY 2018, these targets will continue to be refined as new asset inventory and condition data is collected and validated to establish performance measures and targets for FY19.

- **Verify additional data in the SGR Database and add inventory for additional assets to the SGR Database |** The asset inventory and condition data collected through the Asset Inventory Module process will provide a new source of validated asset data that may be integrated into the SGR database.
- **Fully implement the EAMS system for infrastructure |** Implementation of EAMS for transit infrastructure commenced in 2017 and will continue to progress through 2018. The MBTA expects to complete Phase 1 of the EAMS rollout by 2018 and Phase 2 by the end of December 2020.
- **Develop a Transit Asset Management Plan for the MBTA |** Although not listed as a next step in the 2016 report, developing a TAM plan as required by the FTA rule is a critical priority for the MBTA in the coming year and will help drive decisions regarding asset management policies, approaches, and tools across the organization.
- **Develop a Transit Asset Management Improvement Program for the MBTA |** Although not listed as a next step in the 2016 report, developing a TAM Improvement Program as required by the FTA rule for improvement to the Authority's TAM Processes is a critical priority for the MBTA in the coming year and will help drive decisions regarding asset management improvement activities across the organization.

Rail and Transit Division

- **Complete the Massachusetts Rail Plan |** This plan is expected to be complete in December, 2017.
- **Complete a TAM Plan for MassDOT Rail Assets |** This plan is expected to be complete in February, 2018.
- **Continue to negotiate with the RTAs for asset data sharing**.

Aeronautics Division

- **Begin the process of developing the successor to the 2010 MSASP |** MassDOT will begin to develop the next statewide airport system plan in 2018.

Municipalities

- **Populate and verify an inventory of BRI bridges, including those owned by municipalities |** MassDOT's inventory of BRI bridges is currently 64% complete and ongoing.
- **Collaborate with municipalities to share pavement data with MassDOT and with other nearby municipalities |** MassDOT will continue to explore ways that municipalities can share pavement data with MassDOT and with each other, and means for MassDOT to support pavement condition modeling capabilities in communities and in regions. Where applicable, the results of the Highway Division Pavement Preservation Task force should be shared with municipalities.