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SECTION 1. INTRODUCTION

The Western Turnpike (WT) is a collection of assets which include highways, roadways, bridges and related support facilities that are owned and operated by the Massachusetts Department of Transportation (MassDOT). These assets are located along the I-90 corridor from the New York/Massachusetts border to Mile Marker 122.65 which is just west of the I-95/I-90 interchange (Interchange 14) in Weston. MassDOT is responsible for the safe and efficient operation of the WT, one of the most important elements of the Massachusetts transportation network. The WT serves thousands of motorists daily, including commuters traveling to work, truckers moving goods into and out of the state, and visitors who come to enjoy the state's many cultural, recreational, and historic attractions.

In accordance with the provisions of the Trust Agreement under which the WT is financed and operated, MassDOT is required to have the WT assets inspected by an independent consultant at least once every three fiscal years and to submit a report setting forth: (i) the independent consultant's findings as to whether the WT has been maintained in safe and good repair, working order and condition, and (ii) the consultant's recommendations as to the proper maintenance, repair and operation of the WT during the ensuing three fiscal years and an estimate of costs necessary for such purposes.

TranSystems was retained by MassDOT to act as the independent consultant for the 2015 Triennial Inspection of the WT assets and was tasked with the following:

- Perform a visual inspection on a representative sample of assets from each asset class that have not been inspected since the previous triennial inspection. Perform an independent verification (QA) of a representative sample size of assets that have been inspected or assessed within the last three years by MassDOT or independent third parties.
- Gather available information in MassDOT's possession relating to inspections, maintenance or repair activities, and new construction of WT assets performed since the previous triennial inspection. Meet with MassDOT staff to identify and discuss any areas of concern or special interest.
- Record the visual inspection condition information on a customized ESRI Data Collection Application using a tablet to be inclusive of GIS data points (Latitude/Longitude) and digital photographs.
- Create an Asset Inspection Manager (database) for storage and processing of the condition information collected with the Data Collection Application. Import data from the previous Triennial Inspection Access databases into an Asset Inspection Manager to supplement new inspection data.
- Prepare estimated costs necessary to update and/or maintain the WT assets in a State of Good Repair for the next twenty (20) years.
- Prepare a report detailing the results of inspections and the associated projected costs necessary to maintain the WT in a State of Good Repair.

SECTION 2. DISCUSSION OF ASSETS

The Western Turnpike (WT) is composed of transportation assets that were previously under the jurisdiction of the former Massachusetts Turnpike Authority. The WT includes The Massachusetts Turnpike Interstate 90 (I-90) and all associated facilities from the I-90 Mile Marker 0.0 at the New York/Massachusetts border in West Stockbridge, MA to Mile Marker 122.65 in Weston, MA.

The WT is a key interstate highway providing a vital east/west connection across the Commonwealth, as well as links to I-91, I-84, I-290, I-395, and I-495. The Western Turnpike traverses MassDOT Districts 1, 2, 3, and 6 from west to east, respectively. The WT assets consist of a wide range of features including bridges, culverts, buildings, interchanges and the roadway. The associated facilities are used to support maintenance operations, toll operations, state police patrols, radio communications and administrative operations. Assets such as maintenance facilities, police barracks, communication towers/facilities, toll plazas and administration buildings are included. Many of these assets were constructed around the same time period and are at various stages of disrepair based on the past level of maintenance and rehabilitation.

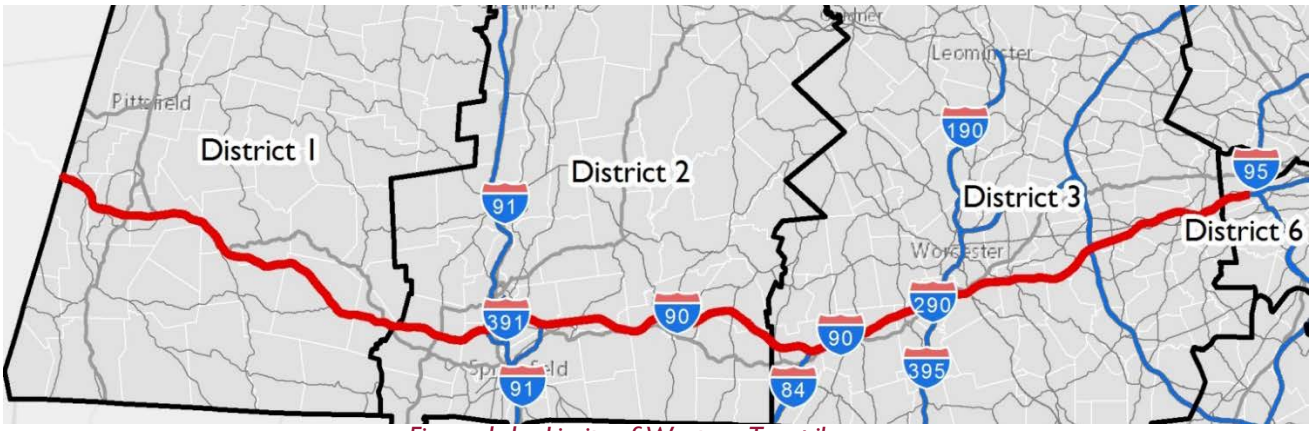

Figure 1-1 - Limits of Western Turnpike

The WT assets experience a wide range of operating conditions. These conditions include: damp, corrosive environments; vehicle exhaust; severe winter conditions, including exposure to deicing agents, freeze/thaw cycles and snow plowing operations; vibration from heavy traffic loadings and machinery; and unanticipated events such as incidents involving over-height vehicles and vehicle collisions, all of which have impacts on the infrastructure. Constant wear, harsh New England weather, and the increasing age of the Western Turnpike adds to the need to inspect the condition of these assets to undertake the required maintenance/corrective action to preserve their function and value.

2.1 History

Until November 2009, the Massachusetts Turnpike Authority owned and operated the Western Turnpike. The Massachusetts Turnpike Authority was originally created in 1952 by the Commonwealth of Massachusetts to construct, maintain, repair, enlarge, improve and operate an express toll highway, which became known as the Massachusetts Turnpike. The first section of the

Massachusetts Turnpike, which extended approximately 123 miles from the New York /Massachusetts border in West Stockbridge, MA to Route 128/I-95 in Weston, MA, opened to traffic in May 1957. The 12 mile extension of the Massachusetts Turnpike from Route 128/I-95 to downtown Boston was opened to traffic in September 1964.

In March 1997, the Commonwealth of Massachusetts enacted legislation that established two systems to be owned and operated by the Massachusetts Turnpike Authority: the Western Turnpike and the Metropolitan Highway System (MHS). The Western Turnpike is now defined as the express toll highway, designated as Interstate 90 (I-90), which extends from the Town of West Stockbridge to, but not including, the interchange of I-90 and State Route 128/I-95 in the Town of Weston. At that time, the MHS network consisted of the Boston Extension and the three tunnels connecting downtown Boston with Logan Airport and points north.

In 2009, all Massachusetts Turnpike Authority assets were transferred to MassDOT jurisdiction.

2.2 Overview of Western Turnpike

The Western Turnpike is an express toll highway with 15 interchanges at various intervals throughout its length. Interchange 1 in West Stockbridge is the western most interchange. Interchange 13 in Natick is the eastern most interchange. Interchanges 14 and 15, at the eastern end of the WT connect the WT to I-95/Route 128 and the Boston Extension, respectively and are considered part of the MHS. At each interchange, the eastbound and westbound on and off traffic is funneled through a central toll plaza. In addition to the public access provided at the interchanges, there are multiple restricted access points located at maintenance facilities, police barracks and service plazas throughout the facility.

The Western Turnpike spans four MassDOT Districts: 1, 2, 3 and 6. District 1 is in the western part of the state with limits extending from mile 0 (the New York Border) to approximately mile 36.5 between the border of the Towns of Russell and Westfield. There are two interchanges (1 & 2) within District 1. The limits of District 2 are from approximately mile 36.5 (border between the Towns of Russell and Westfield) to approximately mile 74 (border between the Towns of Brimfield and Sturbridge). There are six interchanges within the limits of District 2 (3 to 8) including the link to I-91. The limits of District 3 extend from the eastern limit of District 2 at the Sturbridge town line (approximately mile 74) to the western limit of District 6 at the Weston town line (approximately mile 116). There are seven interchanges along I-90 within District 3 (9 to 10, 10A, 11to 13) including links to I-84, I-395, I-290 and I-495. The eastern end of the WT extends into District 6 from the Weston town line until its end at mile 122.65 (Ridgeway Rd.) although this section is under the jurisdiction of District 3.

2.3 Western Turnpike Asset Classes

In the development of the 2015 Triennial Inspection and associated report, TranSystems has utilized the following nomenclature:

- *Asset Class* – Overall category of a type of asset (i.e. Bridge, Maintenance Facilities, Pipe Culverts, etc.)
- *Asset* – Specific facility or structure (i.e. Bridge L-05-051 (4GB), toll plaza at Interchange 12, etc.)

- *Element* – Specific parts of an asset (i.e. a bridge has deck, superstructure and substructure elements. Toll Plaza has booth, canopy, equipment, etc.)

The Western Turnpike contains the following Asset Classes:

Bridges - There are 250 bridges in the Western Turnpike system. These structures include bridges over I-90, structures carrying I-90 over other roads and waterways, and interchange ramp bridges. Most of these bridges are short, one to four span structures, however, three of these bridges, I-90 over the Chicopee River, I-90 over the Connecticut River, and I-90 over the Westfield River, are long span structures.

Maintenance Facilities – There are seven Maintenance Facilities in the WT System. The facilities are comprised of several buildings that support the maintenance and operations of I-90. The buildings types include vehicle maintenance garages, bulk storage for roadway salt, storage facilities and office buildings for operations.

- M1 – Lee
- M2 – Blandford
- M3 – Chicopee
- M4 – Warren
- M5 – Auburn
- M6 – Weston
- M7 – Weston

Service Plazas – Within the WT system, there are eleven Service Plazas (five EB, six WB) and there are only three buildings that are the responsibility of MassDOT within these plazas. They are as follows:

- Eastbound - Lee Service Plaza: Visitor Info Center
- Eastbound - Charlton Plaza: Visitor Info. Center
- Eastbound - Natick Plaza: E-ZPass Service Center

The main service buildings, including the gas station and grounds, are no longer operated or maintained by MassDOT.

Meter Stations - There are two meter stations in the WT system located at the Westfield and Chicopee River bridges. These free standing structures consist of a single room and house electrical panels and equipment. One of the two facilities appears to have been abandoned from its original purpose and has been replaced by smaller electrical panels mounted on a pole near the building.

Communication Towers/Facilities - There are 14 communication tower/facilities in the WT system. They are located outside the roadway corridor. These consist of towers and buildings that are either associated with maintenance facilities and state police barracks or are structures that are not associated with another facility.

Police Barracks - There are three police barracks in the WT system used to support the Massachusetts State Police Troop E. They are located in Weston (E-1), Charlton (E-2) and Westfield (E-3). At the Weston Police Barracks, there is a new barracks currently being constructed and the current barracks is

scheduled to be demolished. In addition, there is one former police barracks that is currently being used as an Emergency Operation Center and to support the cashless toll plaza system conversion.

Walls – There are seven walls within the WT, two metal bin walls and five noise walls. The noise walls are constructed of wood lagging with timber or steel posts.

Sign Support Structures – There are 58 sign support structures within the limits of the Western Turnpike. The sign support structures are comprised of overhead truss and cantilevered structures that support guide signs.

Box Culverts -There are 47 box culverts contained within the Western Turnpike. These culverts are typically comprised of cast-in-place concrete structures that span under I-90 to allow water to flow under the roadway. There are three major components of the box culverts: the wingwalls, the barrel and the channel.

Roadway Pavement - The Western Turnpike consists of approximately 246 miles of mainline roadway (122.65 miles each direction). In the westbound direction there are 289 lane miles and in the eastbound direction there are 274 lane miles.

Roadway Assets - For the purpose of this Triennial Inspection, the roadway has been organized into 1 mile long sections for a total of 246 sections. A sample size of 20 sections of roadway was inspected as part of this Triennial Inspection effort. Inspections conducted as part of this asset class included an assessment of the following elements: guardrail, median barrier, side slopes, curbing, catch basins, and roadside appurtenances including signage, fencing, lighting and ITS and CCTV equipment.

Interchanges - There are 15 interchanges on the Western Turnpike that consist of the ramps, area/pavement around the toll plazas and the parking areas. For the purposes of this report, the interchanges are being broken into two asset classes similar to the roadway: Interchange Pavement and Interchange Assets. Specific elements evaluated as part of the Interchange Assets include guardrail, median barrier, catch basins, light standards, signs, curbing/edging, and side slopes.

Pipe Culverts - There are 472 pipe culverts within the limits of the Western Turnpike. This includes 354 pipe culverts along the mainline highway and 118 pipe culverts at the interchanges. These culverts are primarily comprised of concrete and corrugated steel pipe.

Toll Plazas - There are 15 toll plazas located at the Interchanges on the Western Turnpike. Specific elements evaluated as part of the Toll Plaza asset class are booths/canopy, building, electrical and mechanical equipment, and plumbing.

A breakdown of the assets by District is shown in Table 2-1.

Number of Assets Located by District						2015 Insp. Sample Size
Asset Class	**District 1**	**District 2**	**District 3**	**District 6****	**Total**	
Bridges	51	81	110	8	250	52
Maintenance Facilities	2	2	1	2	7	7
Service Plazas *	4	2	5	0	11	3
Light Meter Stations	0	2	0	0	2	2
Comm Towers/Facilities	4	4	5	1	14	12
Police Barracks	0	1	2	1	4	4
Walls	2	2	3	0	7	7
Sign Support Structures	4	16	33	2	55	40
Box Culverts	14	12	20	1	47	29
Roadway Pavement (lane miles)	150	143	230	40	563	46
Roadway Assets (miles)	72	76	92	6	246	20
Interchanges***	2	6	7	0	15	13
Pipe Culverts	126	141	187	10	464	60
Toll Plazas	2	6	7	0	15	13

Table 2-1 – Western Turnpike Assets by Asset Class

* Service Plazas is the total number of plazas not the number of MassDOT maintained assets.
** Assets are physically located within District 6, but under the jurisdiction of District 3.
*** Interchanges have not been broken down into asset classes for this table since the specific quantities are unknown.

SECTION 3. INSPECTION METHODOLOGY

Since being transferred to MassDOT jurisdiction in 2009, several of the Turnpike asset classes including bridges and pavement have been incorporated into the MassDOT routine inspection program. As such, several asset classes, including bridges, sign support structures and pavement are being inspected and assessed more frequently than the three year requirement stipulated in the bond covenants. In recognition of this, MassDOT instructed TranSystems to conduct an independent verification (QA) of a representative number of assets to confirm that the process and assessments which have been performed provide a reasonable assessment of the existing conditions.

For assets that do not have a regular inspection program and had not been inspected since the previous triennial inspection, TranSystems was directed to perform a visual inspection on a representative sample of the total inventory of the asset class.

3.1 Sample Size

With the understanding that MassDOT's intent for the 2015 Triennial Inspection was to inspect a portion of the total number of assets in each asset class, a representative sample set of assets from each asset class was established for the triennial inspection program. (Note: In the interest of public safety, the representative sample set was modified to ensure that a large proportion of assets with the lowest ratings in previous inspections were included in the sample set). The asset class sample sets were calculated to achieve a 90% confidence level and a 10% margin of error. The confidence level is a measure of how certain it is that a sample accurately reflects the asset population within its margin of error. The margin of error in this case is a percentage that describes how closely the condition of the sample is to the "true value" in the asset population.

$$Sample\ Size = \frac{\frac{z^2 \times p(1-p)}{e^2}}{1+(\frac{z^2 \times p(1-p)}{e^2 N})}$$

Equation 3-1 – Sample Size Equation

Population Size = N
Margin of error = e
Z-score = z
Population proportion = p = .50
For a 90% confidence level, z = 1.65

3.2 Field Inspection Process

Similar to past triennial inspections, the 2015 inspections were performed as a visual inspection of the representative sample of assets in order to determine the general condition of the asset. The inspections were performed by two-person teams utilizing a tablet with a customized ESRI Data

Collection Application to record condition information and gather GIS data points (Latitude/Longitude) of the asset. Digital photographs were also taken and stored with the ESRI Data Collection Application. The previous triennial inspection information was utilized by the inspection teams so that they could denote any changes in condition.

The approach to inspection of assets generally followed one of the three following approaches:

Buildings/Facilities
Buildings were inspected from the exterior and interior from the ground or building floor level, respectively. An overall condition rating for exterior and interior structural elements was based on visually inspecting the exterior and each interior room of the building. An overall condition rating for the mechanical and electrical systems was based on visually inspecting each element of the system. No testing of the mechanical and electrical systems was performed as part of this inspection effort. Examples of specific assets in this class are police barracks, maintenance facilities, light meter stations, communication towers/facilities, etc.

Roadway Pavement/Roadway Assets
Assets along the Western Turnpike right-of-way were inspected visually. Crews inspected assets and elements within a given section of roadway (1 mile increments). An overall condition rating was assigned for each asset and element along the roadway right-of-way. Examples of assets and elements on the roadway are pavement; sign support structures, interchanges, guardrail, curbing, side slopes, pavement markings, delineators, signs, fencing, drop inlets, lighting, etc.

Bridges
The condition rating for bridge assets was furnished by MassDOT from the 4D Bridge Management System. Crews visually verified the condition for the sample set of these assets by visiting the bridges and reviewing the previous inspection report to validate the condition of the bridge and the inspection process. Our verification effort was concentrated on bridges that MassDOT or consultants other than TranSystems or sub consultants under contract with TranSystems had performed.

3.3 Condition Coding Scale

The past triennial inspections used a modified version of the National Bridge Inspection Standards (NBIS) condition coding guide for all inspected assets not just for assessing the condition of the bridges. For consistency and comparison with past condition coding, these guidelines were continued in 2015 and are presented in Table 3-1.

The visual inspections performed included elements of the asset including any electrical, mechanical, and plumbing, but did not include hands-on inspections or compliance verification with current codes or design.

Rating	Description
R	Removed
N	Not Applicable
H	Hidden/Inaccessible
UR	Under Repair
X	Unknown
9	Excellent Condition - *Newly constructed.*
8	Very Good Condition - *No problems noted; No repairs are required. Examples include but are not limited to concrete floors, walls or columns exhibiting sporadic hairline cracks (temperature and shrinkage), isolated areas of honeycombing on concrete surfaces, water/rust stains on parapets, etc.*
7	Good Condition - *Some minor problems noted. Potential exists for minor maintenance. Examples include but are not limited to replacing burnt out light bulbs, tightening loose nuts/bolts, patching pot holes, removing excessive water from drainage grates, touch up painting of surfaces, etc.*
6	Satisfactory Condition - *Structural elements show some minor deterioration. Potential exists for major maintenance. Examples include but are not limited to removing and replacing damaged section of safety rails, removing and replacing isolated areas of deteriorated concrete, removing deteriorated sections of fireproofing, cleaning and painting isolated areas of rusted structural steel, etc.*
5	Fair Condition - *All primary structural elements are sound but have minor section loss, measurable cracking or spalling. Potential exists for minor rehabilitation. Examples include but are not limited to removing and replacing isolated areas of deteriorated concrete beyond the layer of reinforcing steel, repairing cracks in concrete exceeding of 1/16" in width with epoxy crack injection, removing and replacing damaged drainage grates or guardrail, blast cleaning and painting significant areas of structural steel, etc.*
4	Poor Condition - *Advanced section loss to structural steel, deterioration or spalling of concrete, moderate traffic impact damage to guardrail, attenuators, overhead signs, etc. Potential exists for major rehabilitation. Examples include but are not limited to removing and replacing significant areas of deteriorated concrete and reinforcing steel, adding cover plates to structural steel exhibiting loss of section, slurry wall leak injection, removing and repaving sections of bituminous concrete pavement, removing and replacing sections of guardrail and attenuators damaged by traffic impacts, etc.*
3	Serious Condition - *Advanced deterioration has seriously affected primary structural components with the possibility of local failures. Fatigue cracks in steel, shear cracks in concrete, advanced seepage of water through walls, severe traffic impact damage to sections of guardrail, attenuators, overhead signs, etc. may be present. Repair or rehabilitation is required immediately.*
2	Critical Condition - *Advanced deterioration of primary structural elements. The need for rehabilitation is urgent. The facility should be closed until indicated repair is completed.*
1	"Imminent" Failure Condition - *Major deterioration or section loss is present in critical structural components or obvious vertical or horizontal movement is affecting stability. Facility is closed but corrective action may put it back in limited service. Study should be conducted to determine the feasibility for rehabilitation.*
0	Failed Condition - *Facility is closed and out of service. Facility is beyond corrective action.*

Table 3-1 – Condition Coding Scale

3.4 Asset Condition Data Collection

The two-person inspection teams utilized a tablet with a customized version of the ESRI Data Collection Application to record the condition information of each asset.

A data collection map was developed for each asset class that allowed for inspectors to input information specific to each asset including the sub-elements of the asset. The data input was similar to information that was gathered in previous triennial inspections in order to effectively compare condition data from previous years with the 2015 condition data.

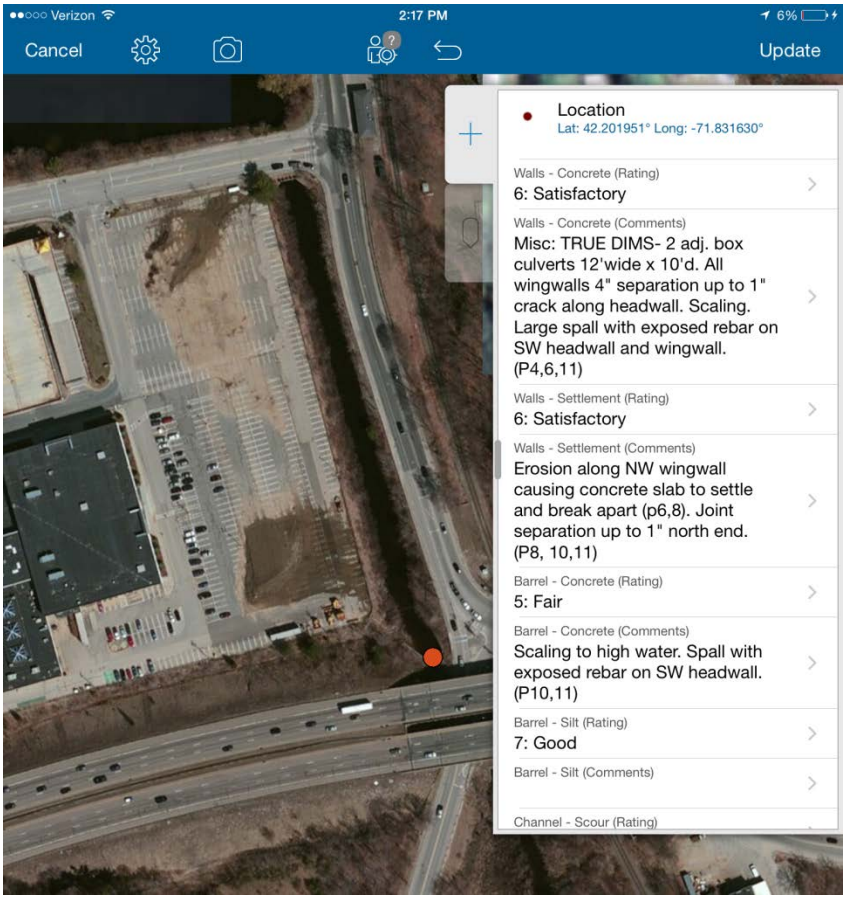

Figure 3-1- Screenshot of ESRI Data Collection Application developed for the Triennial Inspection

SECTION 4. SUMMARY OF FINDINGS

A full presentation of the conditions observed during field inspections is included in Appendix A-1. The following provides a brief summary of notable observations/evaluations encountered.

4.1 Bridges

Overall Condition Rating: *Satisfactory (6)*

Note: Inspections of Western Turnpike bridges are now incorporated into MassDOT's inspection program. This includes performing a routine inspection of each bridge at a minimum of every two years. Based on this fact, MassDOT determined that a full visual inspection of each bridge was not required as part of this Triennial Inspection Program. MassDOT directed TranSystems to conduct an audit inspection of a representative number of bridges (49). These "audit inspections" were done to verify the conditions noted in the routine reports. **The audit inspections confirmed that the MassDOT inspection process and reports were valid.**

These inspections noted a few changes to the structures since the last inspection including: recent repairs to various elements; structures that have recently been painted; and additional concrete deterioration of the deck and substructure. See Appendix A-1 for 2015 inspection audit forms and photos.

Based on the data provided by MassDOT, the three primary items in the Routine Inspection Report (i.e. Item 58 - Deck, Item 59 - Superstructure, and Item 60 - Substructure) are generally in satisfactory condition. See Appendix A-3 for bridge inspection reports printed from the MassDOT 4D bridge management system.

Overall Condition	*# of Assets*	*%*
Good	10	4%
Satisfactory	181	72%
Fair	56	23%
Poor	3	1%
Total	250	100%
Structurally deficient (SD)	8	3.2%

There are eight structures considered structurally deficient with one or more of the Items in poor condition. There are four structures with Item 58-Deck in poor condition, one structure with Item 59-Superstructure in poor condition, and two structures with Item 60-Substructure in poor condition. In addition, there is one structure with both Item 59-Superstructure and Item 60-Substructure in poor condition as follows (See Appendix A-3 for bridge inspection reports):

- Millbury: M-22-038 (4LP); I-90 INT 11 Ramps over I-90 [Item 58-Deck Poor(4)] (A-3, pgs. 2750-2770)
- Palmer: P-01-054 (4MB); Flynt Street over I-90 [Item 58-Deck Poor(4)] (A-3, pgs. 1768-1850)
- Auburn: A-17-048 (4KJ); I-90 EB over Route 12 [Item 58-Deck Poor(4)] (A-3, pgs. 2509-2527)
- Auburn: A-17-048 (4KK); I-90 WB over Route 12 [Item 58-Deck Poor(4)] (A-3, pgs. 2528-2548)
- Framingham: F-07-045 (4PH); I-90 EB over MDC Reservoir 3 [Item 59-Superstructure Poor(4)] (A-3, pgs. 3271-3291)

- West Stockbridge: W-22-019 (4HA); I-90 EB over Williams River [Item 60-Substructure Poor(4)] (A-3, pgs. 75-98)
- Auburn: A-17-045 (4KP); I-90 INT 10 Ramp over I-90 [Item 60-Substructure Poor(4)] (A-3, pgs. 2438-2464)
- Framingham: F-07-045 (4PJ); I-90 WB over MDC Reservoir 3 [Item 59-Superstructure & Item 60-Substructure Poor(4)] (A-3, pgs. 3292-3310)

4.2 Maintenance Facilities

Overall Condition Rating: *Satisfactory (6)*

Overall Condition	# of Assets	%
Satisfactory	7	100%

See Appendix A-1, Maintenance Facilities, pgs. 1 – 238 for 2015 inspection findings.

Typical conditions that were noted on the building exterior include: broken, damaged and inoperable windows; cracking in CMU blocks; walls out of plumb; cracked mortar joints; spalled and cracked concrete walls; spalled and cracked foundations; separated roof membrane and areas of ponding water on the roof. Typical conditions that were noted to the building interior include: peeling paint on walls, doors and windows; dents and corrosion to doors; scrapes and impact damage to walls; evidence of water leakage with water stains and missing ceiling tiles; cracked floor tiles; and holes in CMU blocks.

Typical conditions noted to the electrical and mechanical systems include: minor to moderate deterioration with paint loss to heating systems including pipes, heating elements and boilers; light fixtures not functioning; minor corrosion to electrical panels with missing or damaged covers; damaged or missing conduit and open junction boxes with exposed wires.

Some of the typical conditions that were noted to the surrounding site include: overgrown vegetation with scattered debris; map cracking, potholes and vegetation growth in the pavement; settled and/or displaced curbing; and spalls, delaminations, cracks and impact damage to retaining walls.

4.3 Service Plazas

Overall Condition Rating: *Good (7)*

Overall Condition	# of Assets	%
Good	3	100%

See Appendix A-1, Services Plazas, pgs. 1 – 6 for 2015 inspection findings.

The overall condition of the three buildings maintained by MassDOT located within the Service Plazas (Visitors Info Centers & EZPass Service Center) is considered to be good.

4.4 Meter Stations

Overall Condition Rating: *Satisfactory (6)*

Overall Condition	# of Assets	%
Good	1	50%
Fair	1	50%
Total	2	100%

See Appendix A-1, Meter Stations, pgs. 1 – 2 for 2015 inspection findings.

The Meter Station at the Chicopee River Bridge appears to be decommissioned. The general condition of this light meter structure is in fair condition. The other Meter Station structure located at the Westfield River Bridge appears to be in use and houses relatively new electrical equipment with some elements requiring minor maintenance. The overall condition of this structure is good.

4.5 Communication Towers/Facilities

Overall Condition Rating: *Good (7)*

Overall Condition	# of Assets	%
Good	8	57%
Satisfactory	6	43%
Total	14	100%

See Appendix A-1, Communication Towers/Facilities, pgs. 1 – 12 for 2015 inspection findings.

In general, the towers are in good condition with all primary structural elements in good to very good condition. Typical conditions noted include: cracks in concrete foundations; and small areas of light rust on bracing members. The utility cables associated with the towers are generally in good condition with several cables appearing to be relatively new.

The buildings are older and exhibit deteriorating elements. Conditions noted include: water staining on the walls; scattered debris inside the building; and overgrown vegetation outside the building. The access roads to the facilities are in satisfactory condition with the following conditions noted: erosion of the dirt roads; and map cracking to bituminous pavement.

4.6 Police Barracks

Overall Condition Rating: *Satisfactory (6)*

Overall Condition	# of Assets	%
Satisfactory	4	100%

See Appendix A-1, Police Barracks, pgs. 1 – 16 for 2015 inspection findings.

The barracks are all approximately the same age and built with similar construction methods and materials. The typical conditions noted for the interior of the buildings include: water staining on ceiling tiles; missing/worn floor tiles; holes through CMU walls exposing utilities; and multiple broken or missing fixtures.

The building mechanical and electrical systems are in satisfactory to good condition with a few elements in fair condition. Typical conditions include: minor corrosion on heating components; missing junction box covers with loose wires; poor ventilation with components exhibiting heavy dust build-up and rust; and out dated equipment. The sewer and water elements are in good condition.

The exterior of the buildings are in satisfactory to good condition with several minor elements in poor to serious condition. Typical conditions noted include; exterior doors with peeling paint, damaged or missing weather seals, and dents and damage; windows that were cracked, inoperable, or missing/deteriorated seals; walls and roofs exhibit scaling, cracked bricks, and spalling. The elements in poor and serious conditions exhibit split paneling, failed siding, spalled concrete, and deteriorated flashing.

The site conditions of the buildings are in fair to good condition with an element in poor condition. The access roads exhibit cracking, vegetation growth, settlement and pot holes. Drainage grates are misaligned and exhibits debris and vegetation. The element in poor condition exhibits damaged/missing fence.

The new barracks (currently under construction) in Weston was not inspected or included in the condition rating for this Triennial Inspection.

4.7 Walls

Overall Condition Rating: *Satisfactory (6)*

Overall Condition	# of Assets	%
Very Good	1	14%
Good	4	58%
Satisfactory	1	14%
Poor	1	14%
Total	7	100%

See Appendix A-1, Walls, pgs. 1 – 7 for 2015 inspection findings.

The overall condition of the timber noise barrier walls is considered to be good.

The two metal bin walls at MM 35.4 and MM 32.15 are in satisfactory and poor condition, respectively. Both metal bin walls exhibit signs of settlement by warping and leaning. The wall at mile 32.15 exhibits areas of advanced section loss with sections of the wall no longer retaining backfill. The wall at 35.4 typically exhibits small areas of section loss, with some small longitudinal cracks near the posts.

4.8 Sign Support Structures

Overall Condition Rating: *Good (7)*

Overall Condition	# of Assets	%
Very Good	2	4%
Good	37	67%
Satisfactory	15	27%
Fair	1	2%
Total	55	100%

See Appendix A-1, Sign Support Structures, pgs. 1 – 40 for 2015 inspection findings.

The elements that make up the sign support structures are typically in satisfactory to very good condition. The concrete foundations typically exhibit the most amount of deterioration, exhibiting conditions of map cracking, scaling and spalling, and light rust to anchor bolts. The supports for the signs exhibit bent diagonals of a truss type structure and light rust on the nuts and washers. The overhead signs typically exhibit light fading to the text and reflectivity.

4.9 Box Culverts

Overall Condition Rating: *Satisfactory (6)*

Overall Condition	# of Assets	%
Good	7	15%
Satisfactory	23	49%
Fair	12	26%
Poor	4	8%
Serious	1	2%
Total	47	100%

See Appendix A-1, Box Culverts, pgs. 1 – 29 for 2015 inspection findings.

Twelve of the box culverts are considered bridges (10'-20' span) by MassDOT and are stored in the 4D database. Regularly scheduled inspections appear to be happening on six of them; however, the others have not been inspected since the previous triennial inspection and have no information in 4D.

TranSystems conducted an audit inspection on the six box culverts that have been inspected by MassDOT since the previous triennial inspection to verify the conditions noted in the routine reports. **The audit inspections confirmed that the MassDOT inspection process and reports were valid.**

Approximately 80% of the elements for the box culvert inventory rated between fair and good condition. There are five structures with elements rated in serious condition and one structure with elements rated in critical and serious condition. There are five box culverts that are in overall poor or worse condition as follows:

- Lee at Mile Marker 9.2 – overall poor condition (A-1, pg. 3 of 29)

- Lee at Mile Marker 13.7 – overall poor condition (A-1pg. 5 of 29)
- Becket at Mile Marker 15.9 – overall serious condition (A-1pg. 6 of 29)
- Otis at Mile Marker 21.4 – overall poor condition (wing walls in critical condition) (A-1pg. 10 of 29)
- Auburn at Mile Marker 90.7 – overall poor condition (A-1pg. 23 of 29)

None of these five box culverts are considered bridges by MassDOT and they do not have regularly scheduled inspections.

The wing walls for the box culvert in Otis are considered to be in critical condition due to significant changes since the previous triennial inspection. We notified the District 1 Maintenance Engineer of our findings on 9/3/15 via phone and email.

The northwest wing wall of this culvert is approximately 20 feet from the roadway and is no longer attached to the box culvert structure. All of the reinforcing bars are broken and the wall is leaning approximately 1.5 feet outward. The embankment from the roadway down to the wing wall appears to be eroding at this location. If the wingwall were to fail, the guardrail and roadway could be compromised at that location. The southeast wingwall is in similar condition, but less severe and is further away from the roadway.

The box culvert in Becket has been coded in serious condition for the past 18 years. The condition of the interior and exterior is unknown due to the culvert being filled with stagnant murky water which is almost to the top of the head wall.

Culverts considered in overall poor condition exhibit some of the following conditions: Significant spalling at the joint of the head wall and wing wall causing separation; large amounts of debris and silt inside and outside the culvert barrel; embankment erosion; and channel scour.

Other typical culvert conditions include: spalled, scaled, cracked and delaminated concrete in the wing walls and concrete barrels; minor erosion of the channel and embankments; efflorescence through the construction joints; active water leaks; vegetation; and reduced flow due to silt and debris.

4.10 Roadway Pavement

Overall Condition Rating: *Good (7)*

MassDOT conducts routine assessments of roadway pavement utilizing and in-house semi-automated collection system. During the timeframe of the triennial inspection effort MassDOT collected pavement condition data for the full length of the Western Turnpike. The complete results from this assessment are included in Appendix A-4 and summarized here.

	Westbound		Eastbound	
Condition	*Lane Miles*	*%*	*Lane Miles*	*%*
Excellent	173	59%	79	29%
Good	83	28%	146	53%
Fair	26	9%	43	16%
Poor	7	4%	6	2%
Total	289	100%	274	100%

TranSystems conducted an independent inspection of the roadway pavement condition while inspecting the roadway assets. A sample size of 20 miles of roadway pavement was inspected on the Western Turnpike. **It was confirmed that the MassDOT pavement inspection process was valid by comparing the MassDOT data and our data.**

4.11 Roadway Assets

Overall Condition Rating: *Satisfactory (6)*

A sample size of 20 – 1mile sections of roadway was inspected as part of this Triennial Inspection effort. Elements inspected as part of this asset class include guardrail, median barrier, pavement markings, catch basins, light standards, roadway signs, fencing, edging, and side slopes. See Appendix A-1, Roadway, pgs. 1 – 25 for 2015 inspection findings.

Guardrail - Overall Condition Rating: Satisfactory Condition (6)
Typical conditions noted for the guardrail include: areas of minor to heavy collision damage and areas of light to moderate rust.

Median Barrier - Overall Condition Rating: Satisfactory Condition (6)
Typical conditions noted for the concrete median barrier or steel median guardrail include: concrete spalling with exposed reinforcing steel; cracks in the concrete; rust on the steel guardrail; leaning guardrail posts; collision damage.

Pavement Markings - Overall Condition Rating: Satisfactory Condition (6)
Typical conditions noted for the pavement markings include: worn, chipped and faded markings.

Catch Basins - Overall Condition Rating: Satisfactory Condition (6)
Typical conditions noted for the catch basins include: partially to completely clogged grates and spalling of concrete around frame of grate.

Light Standards - Overall Condition Rating: Very Good Condition (8)
No conditions noted.
Roadway Signs - Overall Condition Rating: Satisfactory Condition (6)
Typical conditions noted for the roadway signs include: minor collision damage; cracking of sign panel; and fading of the sign.

Fencing - Overall Condition Rating: Satisfactory Condition (6)
Typical conditions noted for the fencing include: light to moderate rust on the posts and chain link; damaged posts and chain link; and vegetation/debris across fence.

Edging - Overall Condition Rating: Good Condition (7)
Typical conditions noted for the edging include: minor settlement at isolated locations.

Side Slope - Overall Condition Rating: Satisfactory Condition (6)
Typical conditions noted for the side slope include: heavy vegetation growth; minor to moderate erosion; debris within paved waterways; and erosion around the paved waterways.

4.12 Interchange Pavement

Overall Condition Rating: *Satisfactory (6)*

See Appendix A-1, Interchanges, pgs. 1 – 126 for 2015 inspection findings.

Typical conditions noted for the interchange roadway pavement include: map cracking, pot holes, and patches.

4.13 Interchange Assets

Overall Condition Rating: *Satisfactory (6)*

See Appendix A-1, Interchanges, pgs. 1 – 126 for 2015 inspection findings.

These areas were typically all constructed around the same time and exhibit many of the same conditions. Generally the assets of the interchanges rate between fair to good. Inspections conducted as part of this asset class included an assessment of the following elements: guardrail, median barrier, catch basins, light standards, signs, curbing, edging and side slopes.

Guardrail - Overall Condition Rating: Satisfactory Condition (6)
Typical conditions noted for the guardrail include: areas of minor to moderate collision damage and twisted wooden blocks and broken wooden posts.

Median Barrier - Overall Condition Rating: Satisfactory Condition (6)
Typical conditions noted for the concrete median include: shallow spalls, map cracks; vegetation growth at base; and collision damage.

Catch Basins - Overall Condition Rating: Satisfactory Condition (6)
Typical conditions noted for the catch basins include: partially to completely clogged grates and spalling of concrete around frame of grate.

Light Standards - Overall Condition Rating: Good Condition (7)
Typical conditions noted for the light standards include: missing anchor bolt covers; loose hand access panels; and cracking/spalling of the concrete bases.

Roadway Signs - Overall Condition Rating: Satisfactory Condition (6)
Typical conditions noted for the roadway signs include: minor collision damage; cracking of sign panel; and fading of the sign.

Curbing - Overall Condition Rating: Good Condition (7)
Typical condition noted for the curbing includes: chipping of edges; minor settlement at isolated locations; minor misalignment; and vegetation growth at the joints.

Edging - Overall Condition Rating: Good Condition (7)
Typical condition noted for the edging includes: minor settlement at isolated locations and vegetation growth.

Side Slope - Overall Condition Rating: Satisfactory Condition (6)
Typical conditions noted for the side slope include: minor areas of poor cover; minor erosion; and an isolated area of washout at Interchange 10 Ramp E with minor undermining of the curb line.

4.14 Pipe Culverts

Overall Condition Rating: *Fair (5)*

Overall Condition	# of Assets	%
Very Good	2	<1%
Good	82	18%
Satisfactory	283	61%
Fair	92	20%
Poor	5	1%
Total	464	100%

See Appendix A-1, Pipe Culverts, pgs. 1 – 46 for 2015 inspection findings.

One of the pipe culverts is considered a bridge (10'-20' span) by MassDOT and is stored in the 4D database. It has been inspected since the previous triennial inspection by MassDOT. It is located in Russell at mile marker 34.6 and the structure number is R13022-BCH-DOT-BRI.

TranSystems conducted an audit inspection on this pipe culvert to verify the conditions noted in the MassDOT report. **The audit inspection confirmed that the MassDOT inspection process and report were valid.**

There are five pipe culverts considered to be in poor condition with the remaining pipe culverts in mostly fair to good condition. Pipe culverts in fair to good condition typically exhibited scaling and spalling to head walls, light rust with some section loss to the end of corrugated steel pipe, erosion around the head wall, and/or silt and vegetation debris build-up in the channel and barrel of pipe.

The following five pipe culverts are considered to be in poor condition:

Stockbridge at Mile Marker 4.55 - 42" reinforced concrete pipe (RCP) (pg. 1 of 46)
Stockbridge at Mile Marker 6.80 - 36" reinforced concrete pipe (RCP) (not inspected in 2015)
Lee at Mile Marker 9.30 - 36" reinforced concrete pipe (RCP) (pg. 5 of 46)
Becket at Mile Marker 15.50 - 54" reinforced concrete pipe (RCP) (pg. 7 of 46)
Becket at Mile Marker 17.00 - 42" reinforced concrete pipe (RCP) (not inspected in 2015)

These reinforced concrete pipe culverts exhibit the following conditions: headwall completely disconnected from barrel; settlement and undermining of the wing walls and head walls; severe erosion behind the head wall; large amounts of debris and silt inside and outside the culvert barrel; and heavy vegetation around the channel.

4.15 Toll Plazas

Overall Condition Rating: *Satisfactory (6)*

See Appendix A-1, Toll Plazas, pgs. 1 – 117 for 2015 inspection findings.

More than 90% of the elements of the toll plazas were between fair and good condition with greater than 70% in good condition. There are two Toll Plazas that each had an element rated in in serious condition as follows:

Interchange 9 at MM 78.31: The toll booth access tunnel exhibited large spalls with exposed reinforcing steel in the walls and ceiling.

Interchange 12 at MM 111.18: The toll booth islands exhibit spalls with exposed reinforcing steel.

Typical conditions noted to the toll booth access tunnels included: spalling in the roof of the tunnel; water staining and efflorescence in the tunnel roof and walls, corrosion to conduits from water leakage; peeling paint; ponding water on the tunnel floors; and deteriorated insulation on the utility conduits.

Typical conditions noted to the toll booth canopy included: moderate to severe rust to the underside of the structural members with peeling paint; section loss noted to the canopy columns with peeling paint; and spalls to the column foundations.

Typical conditions noted to the toll booths included: damage/deteriorated flashing; corrosion at the base of the toll booth shell; ceiling panels on the interior of the booths are dislodged with water damage; random doors jammed/difficult to open; peeling paint; cracked windows with deteriorating glazing; damaged/broken light fixtures in various locations; and multiple fire extinguishers are missing.

Typical conditions noted to the travel lanes going through the toll plaza included: layers of soot and corrosion buildup on the various components; edge spalling around loop detectors and to the concrete islands; thick layers of oil deposits; and map cracking throughout the pavement with several pot holes.

Typical conditions noted to the support building include: peeling paint throughout the interior; isolated worn and broken floor tiles; cracks in basement floor; cracks and holes on the CMU walls; missing sealant through conduit penetrations; dislodged/missing ceiling tiles with water stains; broken/damaged light fixtures; cracked windows with minor deterioration to glazing; chips/spalls/cracks/soot buildup to exterior walls; missing/ deteriorated insulation on pipes; missing radiator covers; water leaking at or around boiler; exhaust fans not working at time of inspection; missing/broken junction box covers; rust on utility pipes; and missing door handles.

Typical conditions noted for the surrounding site include: silt/debris build up in the drainage inlets; minor chipping/damage to curb; overgrown vegetation with accumulation of debris to the surrounding site; and fence and guardrails with damage and light rust.

SECTION 5. STATE OF GOOD REPAIR

MassDOT's goal is to maintain the assets of the I-90 Western Turnpike Corridor in a State of Good Repair in an effort to sustain asset reliability and safety for the long-term benefit of the Commonwealth. A state of good repair is achieved when performance measure targets are met and sustained. When this is achieved, the assets (individually and as a system) are functioning properly over their life-cycle at minimum practical cost.

The current condition state of each asset is time dependent and fleeting depending upon asset specific deterioration rates. Performance measure targets are asset dependent and established by the owner. Two performance targets are presented in this report: short-term goal (5 years); and long-term goal (20 years). Minimal practical cost is achieved upon careful execution and coordination of regular planned maintenance strategies, asset preservation actions, implemented repair and rehabilitation programs, and even consideration of complete replacement of the asset when prudent.

The following short and long term performance measures were developed for the Western Turnpike inventory of assets. These performance measures may differ from the statewide performance measures because of the importance of this corridor to statewide travel as well as its classification as an interstate highway.

5.1 Bridges

A State of Good Repair is achieved when the physical condition of the bridge elements, components, and entire bridges are functioning properly and sustained through regular maintenance, preservation, and replacement actions. The performance measures for bridges include both short-term and long-term goals for the following parameters: overall condition rating; structural deficiency; and bridge health index.

Performance Measure	Short-Term Goal	Long-Term Goal
Overall Condition Rating ≥ 6	80%	90%
Structurally Deficient*	< 10% (SF of deck area)	0% = no SD Bridges
Health Index	80%	90%

* Statewide Long Term Goal: <3% structurally deficient

5.2 Pavement

A State of Good Repair is achieved when the physical condition of the pavement is fairly smooth and sustained through regular maintenance, preservation, and replacement actions. The performance measures for pavement includes both short-term and long-term goals for the following parameters: overall condition rating; and international roughness index.

Performance Measure	Short-Term Goal	Long-Term Goal
Overall Condition Rating ≥ 6	80%	90%
International Roughness Index < 120	90% in smooth / good riding quality	100% = smooth / good riding quality

5.3 Maintenance Facilities

A State of Good Repair is achieved when the physical condition of the maintenance facility is in overall Satisfactory Condition. This condition is achieved when the maintenance facility building exteriors, roof(s), interiors, and mechanical and electrical systems are in no less than fair condition and sustained through regular maintenance, preservation, and replacement actions. The performance measure for each maintenance facility includes both short-term and long-term goals for the following parameter: overall condition rating.

Performance Measure	Short-Term Goal	Long-Term Goal
Overall Condition Rating ≥ 6	80%	100%

5.4 Service Plazas

A State of Good Repair is achieved when the physical condition of the service area is in overall Satisfactory Condition. This condition is achieved when the building exteriors, roof(s), interiors, and mechanical and electrical systems are in no less than fair condition and sustained through regular maintenance, preservation, and replacement actions. The performance measure for each service area includes both short-term and long-term goals for the following parameter: overall condition rating.

Performance Measure	Short-Term Goal	Long-Term Goal
Overall Condition Rating ≥ 6	80%	100%

5.5 Meter Stations

A State of Good Repair is achieved when the physical condition of the meter station is in overall Satisfactory Condition. This condition is achieved when the electrical systems and structure(s) are in no less than fair condition and sustained through regular maintenance, preservation, and replacement actions. The performance measure for each meter station includes both short-term and long-term goals for the following parameter: overall condition rating.

Performance Measure	Short-Term Goal	Long-Term Goal
Overall Condition Rating ≥ 6	80%	100%

5.6 Communication Towers/Facilities

A State of Good Repair is achieved when the physical condition of the communication tower/facility is in overall Satisfactory Condition. This condition is achieved when the access road, area perimeter, building exterior(s), roof(s), interiors, and mechanical and electrical systems are in no less than fair condition and sustained through regular maintenance, preservation, and replacement actions. The performance measure for each communication facility includes both short-term and long-term goals for the following parameter: overall condition rating.

Performance Measure	Short-Term Goal	Long-Term Goal
Overall Condition Rating ≥ 6	80%	100%

5.7 Police Barracks

A State of Good Repair is achieved when the physical condition of the police barracks is in overall Satisfactory Condition. This condition is achieved when the site, building exteriors, roof(s), interiors, and plumbing, electrical, and communication systems are in no less than fair condition and sustained through regular maintenance, preservation, and replacement actions. The performance measure for each police barracks include both short-term and long-term goals for the following parameter: overall condition rating.

Performance Measure	Short-Term Goal	Long-Term Goal
Overall Condition Rating ≥ 6	80%	100%

5.8 Walls

A State of Good Repair is achieved when the physical condition of the wall is in overall Satisfactory Condition. This condition is achieved when the wall elements are functioning properly, are in no less than fair condition and sustained through regular maintenance, preservation, and replacement actions. The performance measure for each wall includes both short-term and long-term goals for the following parameters: overall condition rating; and structurally deficient.

Performance Measure	Short-Term Goal	Long-Term Goal
Overall Condition Rating ≥ 6	80%	90%
Structurally Deficient	< 10% (LF of wall length)	0% = no SD Walls

5.9 Sign Support Structures

A State of Good Repair is achieved when the physical condition of the sign support structure is in overall Satisfactory Condition. This condition is achieved when the sign support elements are functioning properly, are in no less than fair condition and sustained through regular maintenance, preservation, and replacement actions. The performance measure for sign support structures includes both short-term and long-term goals for the following parameters: overall condition rating; and structurally deficient.

Performance Measure	Short-Term Goal	Long-Term Goal
Overall Condition Rating ≥ 6	80%	90%
Structurally Deficient	< 10% (# of sign support structures)	0% = no SD Sign Support Structures

5.10 Box Culverts

A State of Good Repair is achieved when the physical condition of the box culvert is in overall Satisfactory Condition. This condition is achieved when the box culvert elements are functioning properly, are in no less than fair condition and sustained through regular maintenance, preservation, and replacement actions. The performance measure for box culverts includes both short-term and long-term goals for the following parameters: overall condition rating; and structurally deficient.

Performance Measure	Short-Term Goal	Long-Term Goal
Overall Condition Rating ≥ 6	80%	90%
Structurally Deficient	< 10% (# of Box Culverts)	0% = no SD Box Culverts

5.11 Roadway Assets

A State of Good Repair is achieved when the physical condition of the roadway is in overall Satisfactory Condition. This condition is achieved when the roadway elements are functioning properly, are in no less than fair condition and sustained through regular maintenance, preservation, and replacement actions. The performance measure for roadway includes both short-term and long-term goals for the following parameter: Overall Condition Rating.

Performance Measure	Short-Term Goal	Long-Term Goal
Overall Condition Rating ≥ 6	80% (Lineal Miles of Highway)	100%

5.12 Interchange Assets

A State of Good Repair is achieved when the physical condition of the interchange is in overall Satisfactory Condition. This condition is achieved when the interchange ramps, and any maintenance, parking, and/or trailer areas are in no less than fair condition and sustained through regular maintenance, preservation, and replacement actions. The performance measure for interchanges includes both short-term and long-term goals for the following parameter: Overall Condition Rating.

Performance Measure	Short-Term Goal	Long-Term Goal
Overall Condition Rating ≥ 6	80%	100%

5.13 Pipe Culverts

A State of Good Repair is achieved when the physical condition of the pipe culvert is in overall Satisfactory Condition. This condition is achieved when the pipe culvert headwalls, structural barrel, and approach waterways are functioning properly, are in no less than fair condition and sustained through regular maintenance, preservation, and replacement actions. The performance measure for pipe culverts includes both short-term and long-term goals for the following parameters: overall condition rating; and structurally deficient.

Performance Measure	Short-Term Goal	Long-Term Goal
Overall Condition Rating ≥ 6	80%	90%
Structurally Deficient	< 10% (# of Pipe Culverts)	0% = no SD Pipe Culverts

SECTION 6. STATE OF GOOD REPAIR ACTION PLAN

6.1 Introduction

Based upon finding of conditions and the State of Good Repair (SGR) goals set forth in Section 5 of this report, a SGR Action Plan has been developed to maintain the assets of the Western Turnpike in a State of Good Repair for the next 20 years. This SGR Action Plan details the activities necessary to restore and/or maintain the assets of the WT in a State of Good Repair. These activities include the performance of a comprehensive and consistent program of routine maintenance (performed annually) as well as scheduled preventative maintenance (performed on a multi-year cycle to the extent required). These routine and preventative maintenance activities are required to maintain assets which are in satisfactory or better condition. The SGR Action Plan also includes certain capital projects to further improve or replace assets when necessary. The activities for each asset class are presented in Appendix A-6 *Projected Future Expenditures.*

6.2 Action Plan Recommendations

The activities for routine maintenance, scheduled preventative maintenance, rehabilitation/replacement and other planned construction activities vary by asset class. The following presents the recommended Action Plan discussed by asset class. It should be noted that MassDOT has provided a separately developed list of capital projects identified to occur over the next 5 years. While TranSystems has developed a recommended SGR Action Plan independent of MassDOT's anticipated expenditures, we have reconciled the SGR Action Plan with MassDOT's proposed program and incorporated the elements of MassDOT's program to avoid overlapping activities.

6.2a Bridges

There are a total of 250 bridges on the Western Turnpike. The majority of these bridges are short-span grade separation bridges (i.e. I-90 over or under local roads); however, the bridge inventory does include longer-span structures over the Chicopee, Connecticut and Westfield Rivers.

For development of the SGR Action Plan, bridges were categorized by their current average condition rating, calculated by taking the average of the deck condition rating (Item 58), superstructure condition rating (Item 59), and substructure condition rating (Item 60). Bridges with an average condition rating greater than or equal to satisfactory (6) can be maintained in their current condition through the following activities:

- Routine Maintenance, consisting of: asphalt pavement crack sealing and patching; drain/scupper cleaning; power washing superstructure and substructure areas below deck joints. This work is required annually to prevent the onset of deterioration to bridge structural members and safety elements.
- Scheduled Preventative Maintenance, consisting of: deck patching, deck joint gland replacement; wearing surface and membrane replacement; steel superstructure cleaning and painting; concrete substructure patching and crack repair. This work is required every 12 years to replace consumable elements which protect the bridge structure, and to arrest any areas of deterioration which may exist.

The SGR Action Plan includes the Routine Maintenance activities for these bridges annually, and Scheduled Preventative Maintenance activities on a rotating 12-year basis.

There are 51 bridges with an average condition rating less than satisfactory (6). These bridges require rehabilitation within the next five years to improve their condition; otherwise they will be at risk to require replacement due to the advancement of existing deterioration.

There are eight bridges that are structurally deficient. Based on their current condition, five bridges are recommended for rehabilitation and three are recommended for replacement.

Separate from the actions described above, MassDOT has a number of bridge projects currently under construction, or under design and scheduled for construction in the next several years. These ongoing and upcoming projects have been considered when developing the SGR Action Plan.

6.2b Maintenance Facilities

There are seven maintenance facilities on the Western Turnpike. Each maintenance facility is composed of a variety of building structures with associated paved roads/driveways/parking lots, drainage, lighting and site vegetation. The structures range from administrative buildings to garages, storage buildings and salt sheds.

For development of the SGR Action Plan, maintenance facilities were categorized by the current average condition of the building elements: exteriors, roofs, interiors and mechanical and electrical systems. Currently, all Maintenance Facilities have an overall average condition rating of satisfactory (6) with no individual element condition less than fair (5). These facilities can be maintained in their current condition through the following activities:

- Building maintenance, consisting of regular, annual maintenance of the building(s) exterior, interior and mechanical/electrical/plumbing systems.
- Site maintenance, consisting of vegetation control and asphalt patching and/or crack sealing.

6.2c Service Plazas

As discussed previously in this report, MassDOT is not responsible for the maintenance and upkeep of many of the elements associated with the service plazas on the Western Turnpike. There are, however, some ancillary roadways as well as three buildings that still fall within the responsibility of MassDOT.

For development of the SGR Action Plan, service areas were categorized by the current average condition of the building elements: exteriors, roofs, interiors and mechanical and electrical systems. Currently, all three buildings have an overall average condition rating of satisfactory (6) with no individual element condition less than fair (5). These buildings can be maintained in their current condition through the following activities:

- Building maintenance, consisting of regular, annual maintenance of the building(s) exterior, interior and mechanical/electrical/plumbing systems.
- Site maintenance, consisting of vegetation control and asphalt patching and/or crack sealing.

6.2d Meter Stations

There are two meter stations on the Western Turnpike. Each meter station is composed of a single building which houses electrical components. One light meter station has been decommissioned and is no longer in service.

For development of the SGR Action Plan, meter stations were categorized by the current average condition of the building elements: exteriors, roofs, interiors and electrical system. Currently, the one operational meter station has an overall average condition rating of satisfactory (6) with no individual element condition less than fair (5). This meter station can be maintained in its current condition through the following activities:

- Building maintenance, consisting of regular, annual maintenance of the building(s) exterior, interior and mechanical/electrical systems.
- Site maintenance, consisting of vegetation control.

6.2e Communication Towers/Facilities

There are 14 communications towers/facilities on the Western Turnpike. Six communication towers/facilities are freestanding, and contain a communication tower, service building which houses electrical components, access road and site vegetation. The remaining eight communication tower facilities are located within another Western Turnpike facility and contain only a communication tower.

For development of the SGR Action Plan, the freestanding communication facilities were categorized by the current average condition of the communication tower elements as well as the access road, area perimeter and building elements: exteriors, roofs, interiors and mechanical and electrical systems. The communication facilities which consist of only a communication tower were categorized by the current average condition of the communication tower elements. Currently, all 14 communication tower facilities have an overall average condition rating of satisfactory (6) and no individual element condition less than fair (5). These facilities can be maintained in their current condition through the following activities:

- Building maintenance, consisting of regular, annual maintenance of the building(s) exterior, interior and mechanical/electrical/plumbing systems.
- Site maintenance, consisting of vegetation control and roadway maintenance (asphalt patching and/or crack sealing or, leveling for gravel roads).

6.2f Police Barracks

There are four police barracks on the Western Turnpike. Each police barracks is composed of a building and associated paved roads/driveways/parking lots, drainage, lighting and site vegetation.

The replacement of the Weston State Police Barracks is currently under construction.

For development of the SGR Action Plan, police barracks were categorized by the current average condition of the site and area perimeter and building elements: exteriors; roofs; interiors; mechanical, electrical and plumbing systems. Currently, the three remaining police barracks have an overall average condition rating of satisfactory (6) with no individual element condition less than fair (5). These police barracks can be maintained in their current condition through the following activities:

- Building maintenance, consisting of regular, annual maintenance of the building(s) exterior, roof, interior, and mechanical/electrical/plumbing systems.
- Site maintenance, consisting of vegetation control and asphalt patching and/or crack sealing.

6.2g Walls

There are a total of seven walls on the Western Turnpike. This total includes two metal bin walls and five noise barrier walls.

For development of the SGR Action Plan, walls were categorized by the current average condition of the wall elements. There are five walls which have an overall average condition rating of satisfactory (6) with no individual element condition less than fair (5). These walls can be maintained in their current condition through the following activities:

- Site maintenance, consisting of vegetation control on an annual basis.

There is one metal bin wall which is currently in satisfactory (6) condition and another which is in poor (4) condition. These walls are recommended for replacement or significant rehabilitation.

6.2h Sign Support Structures

There are 55 sign support structures on the Western Turnpike. These structures are of steel construction and consist of overhead sign bridges (e.g. two supports) and cantilevers (e.g. one support).

The current MassDOT program includes removal and replacement of all sign support structures by 2018.

It is assumed that these new sign support structures will be in a state of good repair upon their installation and that no significant maintenance will need to be performed in the next five year period other than the performance of the inventory inspections.

6.2i Box Culverts

There are a 47 box culverts on the Western Turnpike. All of the box culverts are composed of reinforced concrete construction.

For development of the SGR Action Plan, the box culverts were categorized by the current average condition of the box culvert elements, with emphasis placed on the structural elements (headwalls and barrel). There are 30 box culverts which have an overall average condition rating greater of satisfactory (6) with no individual structural element condition less than fair (5). These box culverts can be maintained in their current condition through the following activities:

- Structural maintenance, consisting of patching and/or crack repair of the concrete headwalls and barrel.
- Site maintenance, consisting of debris and silt removal from the barrel and channel, and vegetation control.

There are 17 box culverts which are recommended for rehabilitation to address deterioration of the concrete (headwalls, wingwalls, or barrel), settlement issues, and/or channel deterioration.

6.2j Roadway Pavement

The Western Turnpike consists of a total of approximately 123 miles from the New York State border to I-90 Mile Marker 122.65 in Weston. This equates to a total roadway mileage of 246 miles, considering both the eastbound and westbound roadways, and totals 563 lane miles.

For development of the SGR Action Plan, the roadway pavement was evaluated on the pavement condition. Based on the results of pavement condition data recently collected by MassDOT, 87% of the Westbound lane miles and 82% of the Eastbound lane miles have a pavement condition of good (7) or greater. This pavement can be maintained in its current condition through the following activities:

- Pavement maintenance, consisting of annual patching and crack sealing of the asphalt pavement, as required.
- Pavement replacement, consisting of milling and repaving the overlay pavement. This work is to be performed every 12 years.

The remaining lane miles have an overall condition of fair (5) or less. The condition of this pavement can be improved to seven (7) or greater through milling and paving within the next 4 years.

6.2k Roadway Assets

The roadway assets consist of: guardrail, median barrier, pavement markings, catch basins, light standards, roadway signs, fencing, edging, and side slope. Similar to the roadway pavement, the roadway assets were sampled over the 123 mile stretch of the turnpike from the New York State Border to I-90 Mile Marker 122.65 in Weston.

For development of the SGR Action Plan, the roadway assets were evaluated on the current average condition of sampled roadway assets (guardrail, median barrier, pavement markings, catch basins, light standards, roadway signs, fencing, edging, and side slope). These roadway assets all have an overall average condition rating of satisfactory (6) with no individual element condition less than fair (5) based on the sample inspected for this triennial report. These roadway assets can be maintained in their current condition through the following activities:

- Routine highway maintenance, consisting of guardrail repairs, median barrier repairs, replacing line striping and delineators, attenuator repairs, mowing, vegetation maintenance, snow and ice removal, trash and roadside removal, side slope maintenance, and drainage maintenance as required.
- Highway element replacement, to be performed as necessary in conjunction with pavement replacement every 12 years.

6.2l Interchange Pavement

There are 15 interchanges on the Western Turnpike. These range from small interchanges with state routes to complex multi-ramp interchanges with other interstate highways.

For development of the SGR Action Plan, the interchange pavement was evaluated by the current average pavement condition. Currently, the interchange pavement has an overall average condition

rating of satisfactory (6). The interchange pavement can be maintained in this current condition through the following activities:

- Pavement maintenance, consisting of annual patching and crack sealing of the asphalt pavement as required.
- Pavement replacement, consisting of milling and repaving the overlay pavement as required. This work is to be performed every 12 years.

6.2m Interchange Assets

There are 15 interchanges on the Western Turnpike. These range from small interchanges with state routes to complex multi-ramp interchanges with other interstate highways.

For development of the SGR Action Plan, the interchange assets were categorized by the current average condition of all interchange assets (guardrail, median barrier, catch basins, light standards, roadway signs, curbing, edging, and side slope). Currently, all interchange assets have an overall average condition rating of satisfactory (6) and no individual asset condition is less than fair (5). These interchange assets can be maintained in their current condition through the following activities:

- Routine highway maintenance, consisting of guardrail repairs, median barrier repairs, attenuator repairs, mowing, line striping and delineator maintenance, vegetation maintenance, snow and ice removal, trash and roadside removal, side slope maintenance, and drainage maintenance as required.
- Highway element replacement, to be performed as necessary in conjunction with pavement replacement every 12 years.

6.2n Pipe Culverts

There are 464 pipe culverts on the Western Turnpike. These consist of reinforced concrete pipe and metal pipe culverts.

For development of the SGR Action Plan, the pipe culverts were categorized by the current average condition of the pipe culvert elements, with emphasis placed on the structural elements (headwalls and barrel). There are 355 pipe culverts which have an overall average condition rating of satisfactory (6) with no individual structural element condition less than fair (5). These pipe culverts can be maintained in their current condition through the following activities:

- Structural maintenance, consisting of patching and/or crack repair of the concrete headwalls and repairs to the steel barrel.
- Site maintenance, consisting of debris and silt removal from the channel, and vegetation control.

There are 109 pipe culverts which are currently in fair (5) or poor (4) condition: 51 are recommended for replacement due to settlement and 58 are recommended for repair due to cracks in the concrete headwalls. These pipe culverts require replacement or repair to address deterioration of the concrete headwalls and barrel settlement.

6.2o Toll Plazas

There are 15 toll plazas on the Western Turnpike. These plazas are programmed for removal under an upcoming MassDOT project. Additionally, a new All-Electronic Tolling System (AETS) is programmed for installation under an ongoing MassDOT project.

6.3 Initial Five Year Action Plan

Major work items identified for the initial five year time period include:

- Rehabilitation or replacement of eight bridges (two deck replacements, three superstructure replacements and three complete bridge replacements)
- Initiation of a program to rehabilitate/replace 109 pipe culverts (40 within the initial five year period)
- Major concrete repairs to 9 box culverts
- Continuation of the ongoing replacement of the Weston State Police Barracks
- Replacement of all structural sign supports
- Initiation of all electronic tolling including installation of AETS facilities and removal of the existing toll plazas
- Installation of Real Time Traffic Monitoring
- Repair/replacement of sections of two metal bin retaining walls

It is anticipated that with completion of these major work items along with implementation of a routine maintenance program the Western Turnpike will meet the criteria of State of Good Repair as defined previously in this Report by the end of the initial five year period.

The following are actions recommended for specific asset classes. These action items are in conjunction with the conduction of a routine and comprehensive maintenance program as described previously in this report.

Bridges

A review of existing conditions reveals eight bridges that are recommended for replacement or significant rehabilitation in the initial five year period. These bridges are:

Municipality	BIN	Facility Carried	Facility Intersected	Estimated Replacement/Rehab Cost ($M)
Framingham	4PJ	I-90 WB	MDC Res 3	$3.6
Framingham	4PH	I-90 EB	MDC Res 3	$3.6
Palmer	4MB	Flynt St	I-90	$2.0
Charlton	4L4	Stafford St	I-90	$2.4
Millbury	4LP	Int. 11 Ramps	I-90	$4.3
West Stockbridge	4HA	I-90 EB	Williams River	$3.7
Auburn	4KP	Int. 10 Ramps	I-90	$5.2
Auburn	4KJ	I-90 EB	Southbridge St.	$6.6
Auburn	4KK	I-90 WB	Southbridge St.	$6.8

The bridges carrying I-90 Eastbound and Westbound over the MDC Reservoir 2 (BIN 4PJ and 4PH) and the bridge carrying Stafford St. over I-90 (BIN 4L4) are currently being designed. All other bridges identified are not yet being designed. It is recommended that design of these bridges commence expeditiously to facilitate construction within the initial five year window.

Police Barracks
The replacement of the Weston State Police Barracks is currently under construction. Costs associated with this replacement are included in the Initial Five Year Plan.

Walls
A section of the metal bin retaining wall at MM 32.1 is failing. Major repairs to this section of the wall should be initiated as soon as possible. Additionally, a second metal bin retaining wall at MM 35.4 is also showing signs of distress and requires rehabilitation. These costs are reflected in the Initial Five Year Plan.

Sign Support Structures
All sign support structures are programmed to be replaced within the Initial Five Year Plan period. These costs are reflected in the Initial Five Year Plan.

Box Culvert
Based on observed conditions, nine box culverts have been identified as in need of major concrete repairs. These repairs should be completed within the initial five year period for the Western Turnpike to be considered in a State of Good Repair at the end of that period. These culverts are:

Municipality	MM	No. of Cells	Cell Depth (ft)	Cell Width (ft)
West Stockbridge	0.90	3	7	16
Lee	13.7	1	9	27
Becket	16.0	1	6	10
Becket	19.0	1	8	16
Otis	21.4	1	5.5	8
Sturbridge	78.3	1	10	20
Charlton	79.9	1	10	18
Charlton	82.3	1	10	18
Auburn	90.7	2	8	8

Roadway
MassDOT is in the process of initiating a Real Time Traffic Monitoring System (RTTMS). Although the RTTMS program has been classified as Category 1 - Modernization, the expenditures associated with this implementation are included in the Initial Five Year Plan since they are programed within this initial time period.

Pipe Culverts
Based upon observed conditions, it is anticipated that approximately 109 pipe culverts will be in need of replacement or significant rehabilitation during the 20 year planning horizon of this Report. It is

recommended that 40 pipe culverts be addressed within the initial five year period to correspond with the defined State of Good Repair at the end of the initial five year period.

Toll Plazas

MassDOT is currently in the process of converting the Western Turnpike to an All Electronic Toll System (AETS). As part of this project, the existing toll plazas on the Western Turnpike will be removed. Much of the construction work associated with this project will be conducted within the initial five year period.

SECTION 7. PROJECTED FUTURE EXPENDITURES

7.1 Introduction

TranSystems has developed a projection of future expenditures necessary to maintain the Western Turnpike in a State of Good Repair. While previous Triennial Reports have focused on a specific list of capital projects to determine future expenditure needs, MassDOT determined that the 2015 Triennial Report would take a different approach. The projected expenditures presented in this report attempt to capture all costs associated with maintaining and operating the Western Turnpike in a State of Good Repair including maintenance needs and indirect costs. In keeping with MassDOT's intent, the projected future expenditures identified in this report reflect the recommended activities to maintain the Western Turnpike in a State of Good Repair and are not fiscally constrained.

The Projected Future Expenditures are presented for each asset class in three cost categories:

1. ***Modernization:*** This category includes projects where the primary goal is to rehabilitate or replace existing assets in poor condition that have outlived their useful lives. But that need should be leveraged to "modernize" the asset to the greatest extent practicable. These improvements can include incorporating new technology or making other enhancements to support economic development, improve mobility, reduce environmental impacts, or increase safety.

2. ***Capacity:*** This category is for projects that add new connections, or expand the existing transportation network. While capacity projects may start with assets that are currently part of the Commonwealth's transportation system, the purpose of capacity projects is to add new assets to the system in order to meet increased new demand, such as a new lane, roadway link, bridge, transit station, service or line, or multi-use path.

3. ***State of Good Repair:*** This category includes activities required to achieve State of Good Repair goals for each asset class. As this cost category spans all asset classes, it includes a variety of activities including:

   - Rehabilitation or replacement
   - Pavement management
   - Maintenance activities
   - Inspection (bridges, sign support structures, pavement, box culverts, pipe culverts, and other regularly scheduled asset inspection costs)
   - Snow and ice removal

These categories are consistent with the categories used in the upcoming Capital Improvement Plan, and are based on the report, Recommendations for MassDOT Project Selection Criteria, which was developed by the MassDOT Project Selection Advisory Council. It should be noted that, while some projects might conceivably fall under multiple categories, for clarity and consistency each project was only allocated to one specific category. Because one of the goals of this Triennial Report is to identify a course of action that will maintain the Western Turnpike in a State of Good Repair, a majority of the expenditures fall under the State of Good Repair category. However, because ongoing and planned

projects identified in MassDOT's CIP such as the ongoing AETS Conversion project, have been considered for inclusion in the SGR Action Plan, expenditures have been identified under the Modernization and Capacity categories.

7.2 Cost Development

TranSystems was tasked by MassDOT with the development of an independent assessment of future expenditure needs to maintain the Western Turnpike in a State of Good Repair. The projections presented in the following section have been developed based upon the SGR Action Plan laid out in Section 6 as well as additional input from MassDOT regarding ongoing and upcoming project initiatives. The projected future expenditures also include projects which are included in the FY2016 CIP, as well as other identified or planned construction projects from FY2017 and going forward. It should be noted that there is a difference between 2016 CIP and actuals because spending for projects in the 2016 CIP reflects actual expenditures to date and projected construction costs.

The projected costs for each asset class were developed through an extensive data collection and analysis program. Generally, the development of costs was guided by a multi-step process:

- Compile a work task list to restore/maintain a state of good repair based upon existing conditions and industry recommended practices as discussed in Section 6;
- Identify capital projects that address identified deficiencies;
- Determine the recommended frequency for each maintenance/rehabilitation work task (i.e. annually; every 5 years, 10 years; etc.);
- Calculate the cost of each work task. The cost values were developed from a series of sources including: past MassDOT projects, MassDOT Weighted Average Bid Prices, consultation with MassDOT staff, industry trends, and industry cost data;
- Allocate actual administrative and indirect costs including annual insurance costs, energy costs and space rental, annual fleet maintenance cost, annual fuel cost, annual communications cost, administrative expenses, operational services (Transcore, etc), equipment purchase, equipment lease, and annual salaries proportionally as they relate to each asset class;
- Reconcile MassDOT's ongoing and upcoming projects with work plans identified as part of the SGR Action Plan preparation to avoid duplication of projects and to ensure all major work items have been included.

Additionally, project factors were added to work tasks to account for the following items:

Mobilization – 10%
A value of ten percent was selected as an overall average value for the wide range of work tasks included in this plan. This value was added to all projects.

Traffic Control – 10%
A value of ten percent was added for projects that will require traffic lane closures.

Engineering and CE Services – 20%
A value of twenty percent was added to all projects to account for items such as program management, survey services, design, permitting, right-of-way, construction phase engineering, material testing services and construction inspection.

Contingency – 20%
A value of twenty percent was added to all projects to account for additional scope assigned during the design phase of the project.

Location – 0% to 55%
A value ranging from zero percent to fifty-five percent was added to projects to account for anticipated cost increases based on the project location (i.e. over/under/adjacent to railroad, over water, etc.).

7.3 Expenditure Plan

The summary of Projected Future Expenditures is presented in Table 7-1 below. These costs are presented as present day (2015) dollars. Table 7-2 below presents the summary of expenditures factoring a consistent 3.5% annual escalation factor. A breakdown of year by year expenditures is included in Tables 7-5 and 7-6 at the end of this report. Additional breakdown of projected expenditures is located in Appendix A-6.

Cost Category	2016	2017	2018	2019	2020	5 Year Total	10 Year Total	20 Year Total
1. Modernization	$ 42.82	$ 25.98	$ 7.55	$ 7.55	$ 7.47	**$ 91.38**	**$ 129.15**	**$ 149.95**
2. Capacity	$ -	$ -	$ -	$ -	$ -	**$ -**	**$ 204.51**	**$ 204.51**
3. State of Good Repair	$ 134.12	$ 135.80	$ 142.12	$ 135.87	$ 138.62	**$686.54**	**$1,363.68**	**$ 2,691.63**
Western Turnpike Total Cost	**$176.94**	**$161.78**	**$149.68**	**$143.42**	**$146.10**	**$777.92**	**$1,697.33**	**$ 3,046.09**

Table 7-1 Projected Expenditures (in $ millions) – Present Day (2015) by Year

Cost Category	2016	2017	2018	2019	2020	5 Year Total	10 Year Total	20 Year Total
1. Modernization	$ 44.32	$ 27.83	$ 8.38	$ 8.67	$ 8.88	**$ 98.07**	**$ 147.87**	**$ 179.21**
2. Capacity	$ -	$ -	$ -	$ -	$ -	**$ -**	**$ 269.40**	**$ 269.40**
3. State of Good Repair	$ 138.81	$ 145.48	$ 157.58	$ 155.91	$ 164.64	**$762.42**	**$1,655.20**	**$ 3,932.81**
Western Turnpike Total Cost	**$183.13**	**$173.30**	**$165.95**	**$164.58**	**$173.52**	**$860.48**	**$2,072.47**	**$ 4,381.42**

Table 7-2 Projected Expenditures (in $ millions) – 3.5% Escalation

Bridges
The Projected Future Expenditures include the Routine Maintenance costs for these bridges annually, and Scheduled Preventative Maintenance costs on a rotating 12-year basis. Each of these costs are listed under Category 3 State of Good Repair.

The cost for bridge rehabilitation and replacement are listed in the Projected Future Expenditures under Category 3 State of Good Repair. Additionally, after the bridge rehabilitation or replacement has occurred these bridges will require annual routine maintenance, and scheduled preventative maintenance every 12 years. These costs are also listed under Category 3 State of Good Repair.

The anticipated budget for these scheduled projects is listed in the Projected Future Expenditures under Category 3 State of Good Repair (in $ millions).

Cost Category	2016	2017	2018	2019	2020	5 Year Total	10 Year Total	20 Year Total
1. Modernization	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
2. Capacity	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
3. State of Good Repair	$ 35.42	$ 34.10	$ 42.95	$ 42.58	$ 45.11	$ 200.16	$ 408.02	$ 802.63
Bridges Total Cost	**$ 35.42**	**$ 34.10**	**$ 42.95**	**$ 42.58**	**$ 45.11**	**$ 200.16**	**$ 408.02**	**$ 802.63**

Maintenance Facilities

The Projected Future Expenditures include the building maintenance and site maintenance costs for these maintenance facilities annually under Category 3 State of Good Repair (in $ millions).

Cost Category	2016	2017	2018	2019	2020	5 Year Total	10 Year Total	20 Year Total
1. Modernization	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
2. Capacity	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
3. State of Good Repair	$ 12.48	$ 12.56	$ 12.01	$ 12.01	$ 12.30	$ 61.37	$ 122.20	$ 242.34
Maintenance Facilites Total Cost	**$ 12.48**	**$ 12.56**	**$ 12.01**	**$ 12.01**	**$ 12.30**	**$ 61.37**	**$ 122.20**	**$ 242.34**

Service Plazas

The Projected Future Expenditures include the building maintenance and site maintenance costs for these service plazas annually under Category 3 State of Good Repair (in $ millions).

Cost Category	2016	2017	2018	2019	2020	5 Year Total	10 Year Total	20 Year Total
1. Modernization	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
2. Capacity	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
3. State of Good Repair	$ 4.69	$ 4.69	$ 4.69	$ 4.69	$ 4.69	$ 23.43	$ 46.87	$ 93.74
Service Plazas Total Cost	**$ 4.69**	**$ 4.69**	**$ 4.69**	**$ 4.69**	**$ 4.69**	**$ 23.43**	**$ 46.87**	**$ 93.74**

Meter Stations

The Projected Future Expenditures include the building maintenance costs for this meter station annually under Category 3 State of Good Repair (in $ millions).

Cost Category	2016	2017	2018	2019	2020	5 Year Total	10 Year Total	20 Year Total
1. Modernization	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
2. Capacity	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
3. State of Good Repair	$ 0.04	$ 0.04	$ 0.04	$ 0.04	$ 0.04	$ 0.19	$ 0.39	$ 0.78
Meter Stations Total Cost	**$ 0.04**	**$ 0.04**	**$ 0.04**	**$ 0.04**	**$ 0.04**	**$ 0.19**	**$ 0.39**	**$ 0.78**

Communication Towers/Facilities

The Projected Future Expenditures include the building maintenance and site maintenance costs for all communication facilities annually under Category 3 State of Good Repair (in $ millions).

Cost Category	2016	2017	2018	2019	2020	5 Year Total	10 Year Total	20 Year Total
1. Modernization	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
2. Capacity	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
3. State of Good Repair	$ 0.80	$ 0.80	$ 0.80	$ 0.80	$ 0.80	$ 4.00	$ 8.01	$ 16.01
Communication Facilities Total Cost	**$ 0.80**	**$ 0.80**	**$ 0.80**	**$ 0.80**	**$ 0.80**	**$ 4.00**	**$ 8.01**	**$ 16.01**

Police Barracks

The Projected Future Expenditures include the building maintenance and site maintenance costs for all police stations annually under Category 3 State of Good Repair (in $ millions).

The Replacement of the Weston State Police Barracks is currently under construction. The costs for this work are also under Category 3 State of Good Repair.

Cost Category	2016	2017	2018	2019	2020	5 Year Total	10 Year Total	20 Year Total
1. Modernization	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
2. Capacity	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
3. State of Good Repair	$ 9.65	$ 8.91	$ 8.91	$ 8.91	$ 8.91	$ 45.28	$ 89.81	$ 178.87
Police Barracks Total Cost	**$ 9.65**	**$ 8.91**	**$ 8.91**	**$ 8.91**	**$ 8.91**	**$ 45.28**	**$ 89.81**	**$ 178.87**

Walls

The Projected Future Expenditures include the site maintenance costs annually under Category 3 State of Good Repair (in $ millions).

There are two metal bin walls which are recommended for rehabilitation to address deterioration. The costs for this work are also under Category 3 State of Good Repair.

Cost Category	2016	2017	2018	2019	2020	5 Year Total	10 Year Total	20 Year Total
1. Modernization	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
2. Capacity	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
3. State of Good Repair	$ 0.84	$ 0.55	$ 0.52	$ 0.53	$ 0.53	$ 2.97	$ 5.53	$ 10.70
Walls Total Cost	**$ 0.84**	**$ 0.55**	**$ 0.52**	**$ 0.53**	**$ 0.53**	**$ 2.97**	**$ 5.53**	**$ 10.70**

Sign Support Structures

The current MassDOT program includes removal and replacement of all sign support structures by 2018. The cost of this work is included under Category 3 State of Good Repair. Costs related to subsequent inventory inspections are included under Category 3 State of Good Repair (in $ millions).

Cost Category	2016	2017	2018	2019	2020	5 Year Total	10 Year Total	20 Year Total
1. Modernization	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
2. Capacity	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
3. State of Good Repair	$ 5.81	$ 8.72	$ 2.76	$ 1.96	$ 1.96	$ 21.22	$ 31.03	$ 50.65
Sign Support Structures Total Cost	**$ 5.81**	**$ 8.72**	**$ 2.76**	**$ 1.96**	**$ 1.96**	**$ 21.22**	**$ 31.03**	**$ 50.65**

Box Culverts

The Projected Future Expenditures include the structural maintenance and site maintenance costs for these box culverts annually under Category 3 State of Good Repair (in $ millions).

There are 17 box culverts which are recommended for rehabilitation to address deterioration of the concrete (headwalls, wingwalls, or barrel), settlement issues, and/or channel deterioration. The costs for this work are also listed under Category 3 State of Good Repair.

Cost Category	2016	2017	2018	2019	2020	5 Year Total	10 Year Total	20 Year Total
1. Modernization	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
2. Capacity	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
3. State of Good Repair	$ 4.67	$ 4.57	$ 4.10	$ 4.15	$ 4.15	$ 21.65	$ 42.37	$ 83.79
Box Culvert Total Cost	**$ 4.67**	**$ 4.57**	**$ 4.10**	**$ 4.15**	**$ 4.15**	**$ 21.65**	**$ 42.37**	**$ 83.79**

Roadway Pavement

The Projected Future Expenditures include the pavement maintenance and pavement replacement costs under Category 3 State of Good Repair (in $ millions).

Cost Category	2016	2017	2018	2019	2020	5 Year Total	10 Year Total	20 Year Total
1. Modernization	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
2. Capacity	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
3. State of Good Repair	$ 28.37	$ 28.37	$ 28.37	$ 28.37	$ 28.37	$ 141.86	$ 283.73	$ 567.45
Roadway Pavement Total Cost	**$ 28.37**	**$ 28.37**	**$ 28.37**	**$ 28.37**	**$ 28.37**	**$ 141.86**	**$ 283.73**	**$ 567.45**

Roadway Assets

The Projected Future Expenditures include the installation of the real time traffic monitoring system cost under Category 1 Modernization. Costs related to the roadway asset maintenance and roadway asset replacement costs under Category 3 State of Good Repair (in $ millions).

Cost Category	2016	2017	2018	2019	2020	5 Year Total	10 Year Total	20 Year Total
1. Modernization	$ 5.31	$ -	$ -	$ -	$ -	$ 5.31	$ 5.31	$ 5.31
2. Capacity	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
3. State of Good Repair	$ 12.12	$ 17.36	$ 16.72	$ 16.65	$ 16.65	$ 79.49	$ 162.71	$ 329.16
Roadway Assets Total Cost	**$ 17.43**	**$ 17.36**	**$ 16.72**	**$ 16.65**	**$ 16.65**	**$ 84.80**	**$ 168.02**	**$ 334.48**

Interchange Pavement

The Projected Future Expenditures include pavement maintenance and replacement costs under Category 3 State of Good Repair (in $ millions).

Cost Category	2016	2017	2018	2019	2020	5 Year Total	10 Year Total	20 Year Total
1. Modernization	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
2. Capacity	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
3. State of Good Repair	$ 1.37	$ 1.37	$ 6.48	$ 1.37	$ 1.37	$ 11.96	$ 18.80	$ 32.49
Interchange Pavement Total Cost	**$ 1.37**	**$ 1.37**	**$ 6.48**	**$ 1.37**	**$ 1.37**	**$ 11.96**	**$ 18.80**	**$ 32.49**

Interchange Assets

The Projected Future Expenditures include the pavement maintenance and replacement costs under Category 3 State of Good Repair (in $ millions).

Cost Category	2016	2017	2018	2019	2020	5 Year Total	10 Year Total	20 Year Total
1. Modernization	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
2. Capacity	$ -	$ -	$ -	$ -	$ -	$ -	$ 204.51	$ 204.51
3. State of Good Repair	$ 2.84	$ 2.84	$ 2.84	$ 2.84	$ 2.84	$ 14.21	$ 24.91	$ 53.33
Interchange Assets Total Cost	**$ 2.84**	**$ 2.84**	**$ 2.84**	**$ 2.84**	**$ 2.84**	**$ 14.21**	**$ 229.42**	**$ 257.84**

Pipe Culverts

The Projected Future Expenditures include the structural maintenance and site maintenance costs for these pipe culverts annually under Category 3 State of Good Repair (in $ millions).

The costs for these replacement and repair projects are listed under Category 3 State of Good Repair.

Cost Category	2016	2017	2018	2019	2020	5 Year Total	10 Year Total	20 Year Total
1. Modernization	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
2. Capacity	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
3. State of Good Repair	$ 10.15	$ 6.07	$ 6.07	$ 6.12	$ 6.05	$ 34.46	$ 70.71	$ 99.16
Pipe Culverts Total Cost	**$ 10.15**	**$ 6.07**	**$ 6.07**	**$ 6.12**	**$ 6.05**	**$ 34.46**	**$ 70.71**	**$ 99.16**

Toll Plazas

The Projected Future Expenditures include the cost for the toll plaza demolition/removal under Category 1 Modernization (in $ millions).

Additionally, a new All-Electronic Tolling System is programmed for installation under an upcoming MassDOT project. The Capital includes the cost for this new tolling system under Category 1 Modernization Projects.

Cost Category	2016	2017	2018	2019	2020	5 Year Total	10 Year Total	20 Year Total
1. Modernization	$ 37.50	$ 25.98	$ 7.55	$ 7.55	$ 7.47	$ 86.06	$ 123.84	$ 144.64
2. Capacity	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
3. State of Good Repair	$ 4.86	$ 4.86	$ 4.86	$ 4.86	$ 4.86	$ 24.30	$ 48.60	$ 130.51
Toll Plaza Total Cost	**$ 42.36**	**$ 30.84**	**$ 12.41**	**$ 12.41**	**$ 12.33**	**$ 110.36**	**$ 172.44**	**$ 275.15**

7.4 Initial Five Year Action Plan

The initial five year time period of the SGR Action Plan prepared as part of this Triennial Inspection is focused on two main goals: 1. Improve the Turnpike condition to be considered in a State of Good Repair as defined previously in this report and 2. Implement a defined maintenance plan that is sufficient to keep assets in a State of Good Repair. To accomplish these goals, it is estimated that $778M (in 2015 dollars) will be needed over the next five years (2016-2020) as shown in Tables 7-3 and 7-4 and Figure 7-1.

Cost Category	2016	2017	2018	2019	2020	5 Year Total
1. Modernization	$ 42.82	$ 25.98	$ 7.55	$ 7.55	$ 7.47	**$ 91.38**
2. Capacity	$ -	$ -	$ -	$ -	$ -	**$ -**
3. State of Good Repair	$ 134.12	$ 135.80	$ 142.12	$ 135.87	$ 138.62	**$686.54**
Western Turnpike Total Cost	**$176.94**	**$161.78**	**$149.68**	**$143.42**	**$146.10**	**$777.92**

Table 7-3 - Projected expenditures over initial five years (in $ millions) in 2015 dollars

Cost Category	2016	2017	2018	2019	2020	5 Year Total
1. Modernization	$ 44.32	$ 27.83	$ 8.38	$ 8.67	$ 8.88	**$ 98.07**
2. Capacity	$ -	$ -	$ -	$ -	$ -	**$ -**
3. State of Good Repair	$ 138.81	$ 145.48	$ 157.58	$ 155.91	$ 164.64	**$762.42**
Western Turnpike Total Cost	**$183.13**	**$173.30**	**$165.95**	**$164.58**	**$173.52**	**$860.48**

Table 7-4 - Projected expenditures over initial five years (in $ millions) escalated at 3.5%/yr

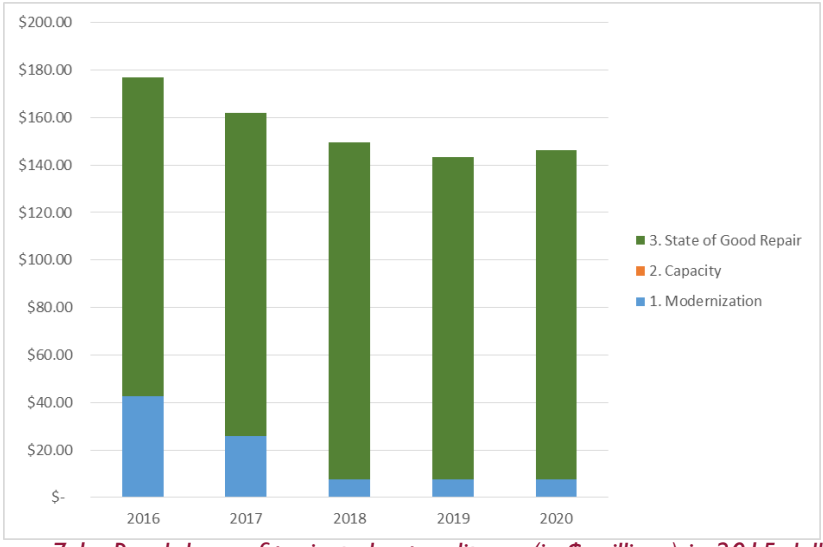

Figure 7-1 - Breakdown of projected expenditures (in $ millions) in 2015 dollars

Initial Five Year Expenditure by Asset Class

As depicted in Figure 7-2, 26% and 20% of overall expenditures are allocated to the Turnpike bridges and pavement, respectively, while 14% of expenditures are allocated to Toll Plazas. The relatively high percentage of allocation to the Toll Plaza asset class is primarily driven by the ongoing AETS conversion project.

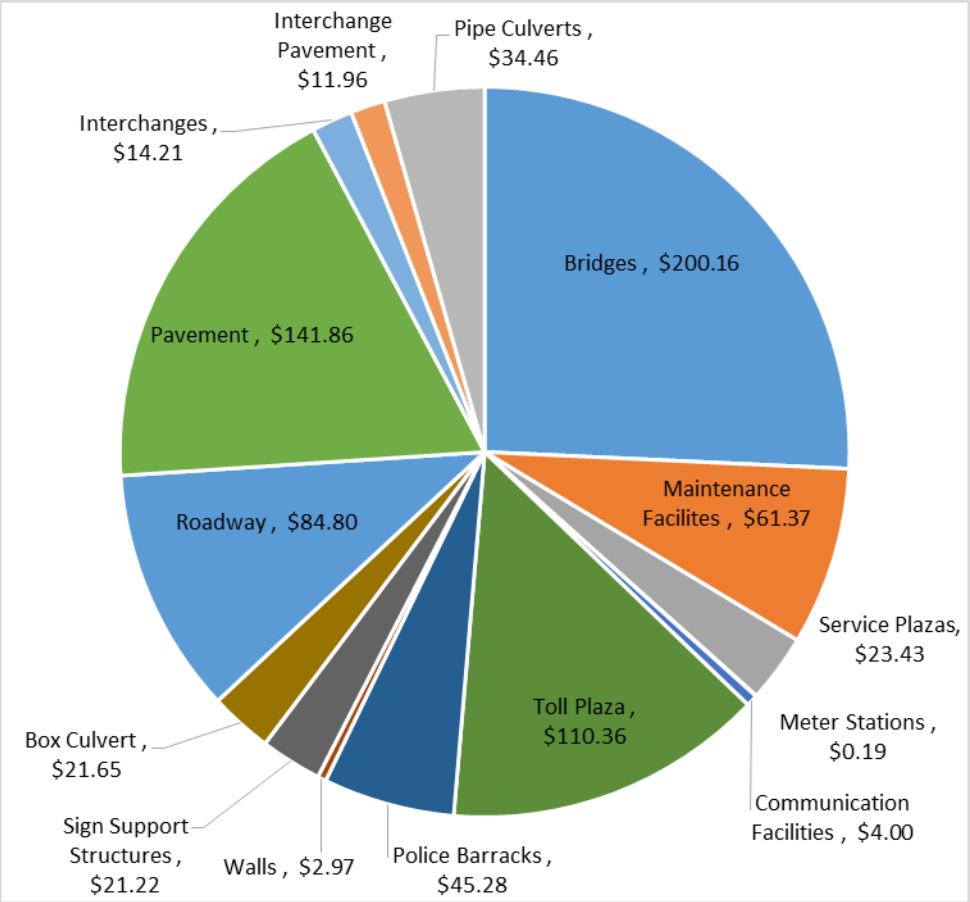

Figure 7-2 - Initial Five Year Expenditures (in $ millions) by Asset Class

The following are actions recommended for specific asset classes. These action items are in conjunction with the conduction of a routine and comprehensive maintenance program as described previously.

Bridges

A review of existing conditions reveals eight bridges that are recommended for replacement or significant rehabilitation in order to be considered in a State of Good Repair at the end of the Initial Five Year Period. These bridges are:

Municipality	BIN	Facility Carried	Facility Intersected	Estimated Replacement/Rehab Cost ($M)
Framingham	4PJ	I-90 WB	MDC Res 3	$3.6
Framingham	4PH	I-90 EB	MDC Res 3	$3.6
Palmer	4MB	Flynt St	I-90	$2.0
Millbury	4LP	Int. 11 Ramps	I-90	$4.3
West Stockbridge	4HA	I-90 EB	Williams River	$3.7
Auburn	4KP	Int. 10 Ramps	I-90	$5.2
Auburn	4KJ	I-90 EB	Southbridge St.	$6.6
Auburn	4KK	I-90 WB	Southbridge St.	$6.8

The bridges carrying I-90 Eastbound and Westbound over the MDC Reservoir 2 (BIN 4PJ and 4PH) are currently being designed. All other bridges identified are not yet being designed. It is recommended that design of these bridges commence expeditiously to facilitate construction within the initial five year window.

Police Barracks
The replacement of the Weston State Police Barracks is currently under construction. Costs associated with this replacement are included in the Initial Five Year Plan.

Walls
A section of the metal bin retaining wall at MM 32.1 is failing. Major repairs to this section of the wall should be initiated as soon as possible. Additionally, a second metal bin retaining wall at MM 35.4 is also showing signs of distress and should be considered for rehabilitation.

Sign Support Structures
All sign support structures are programmed to be replaced within the Initial Five Year Plan period. These costs are reflected in the Initial Five Year Plan.

Box Culvert
Based on observed conditions, nine box culverts have been identified as in need of major concrete repairs. These repairs should be completed within the initial five year period for the Western Turnpike to be considered in a State of Good Repair at the end of that period. These culverts are:

Municipality	MM	No. of Cells	Cell Depth (ft)	Cell Width (ft)
West Stockbridge	0.90	3	7	16
Lee	13.7	1	9	27
Becket	16.0	1	6	10
Becket	19.0	1	8	16
Otis	21.4	1	5.5	8
Sturbridge	78.3	1	10	20
Charlton	79.9	1	10	18
Charlton	82.3	1	10	18
Auburn	90.7	2	8	8

Roadway
MassDOT is in the process of initiating a Real Time Traffic Monitoring System (RTTMS). Costs for implementation of this system are included in the initial five year action plan.

Pipe Culverts
Based upon observed conditions, it is anticipated that approximately 109 pipe culverts will be in need of replacement or significant rehab during the 20 year planning horizon of this Report. It is recommended that 40 culverts be addressed within the initial five year period to correspond with the defined State of Good Repair at the end of the initial five year period.

Toll Plazas

MassDOT is currently in the process of converting the Turnpike (Western Turnpike and MHS) to an All Electronic Toll System (AETS). As part of this project, the existing toll plazas on the Turnpike will be removed. Much of the construction work associated with this project will be conducted within the initial five year period.

7.5 Expenditure Summary

The following tables present a summary of projected expenditures for a 20 year planning period in present day (2015) costs (Table 7-5) and future costs escalated at 3.5%/year (Table 7-6).

Cost Category	2016	2017	2018	2019	2020	5 Year Total	2021	2022	2023	2024	2025	10 Year Total
1. Modernization	$ 42.82	$ 25.98	$ 7.55	$ 7.55	$ 7.47	**$ 91.38**	$ 7.55	$ 7.55	$ 7.55	$ 7.55	$ 7.55	**$ 129.15**
2. Capacity	$ -	$ -	$ -	$ -	$ -	**$ -**	$ -	$ 68.17	$ 68.17	$ 68.17	$ -	**$ 204.51**
3. State of Good Repair	$ 134.12	$ 135.80	$ 142.12	$ 135.87	$ 138.62	**$686.54**	$ 137.77	$ 136.33	$ 130.37	$ 132.46	$ 140.20	**$ 1,363.68**
Western Turnpike Total Cost	**$176.94**	**$161.78**	**$149.68**	**$143.42**	**$146.10**	**$777.92**	**$ 145.33**	**$ 212.05**	**$206.10**	**$208.18**	**$ 147.76**	**$ 1,697.33**

Cost Category	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	20 Year Total
1. Modernization	$ 7.55	$ 7.55	$ 5.69	$ -	$ -	$ -	$ -	$ -	$ -	$ -	**$ 149.95**
2. Capacity	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	**$ 204.51**
3. State of Good Repair	$ 131.90	$ 133.56	$ 127.55	$ 125.22	$ 133.75	$ 135.65	$ 136.24	$ 132.34	$ 138.08	$ 133.67	**$2,691.63**
Western Turnpike Total Cost	**$139.46**	**$141.12**	**$133.24**	**$125.22**	**$133.75**	**$135.65**	**$ 136.24**	**$ 132.34**	**$138.08**	**$133.67**	**$3,046.09**

Table 7-5 Projected 20 Year Expenditures (in $ millions) – Present Day (2015) Costs

Cost Category	2016	2017	2018	2019	2020	5 Year Total	2021	2022	2023	2024	2025	10 Year Total
1. Modernization	$ 44.32	$ 27.83	$ 8.38	$ 8.67	$ 8.88	**$ 98.07**	$ 9.29	$ 9.61	$ 9.95	$ 10.30	$ 10.66	**$ 147.87**
2. Capacity	$ -	$ -	$ -	$ -	$ -	**$ -**	$ -	$ 86.73	$ 89.77	$ 92.91	$ -	**$ 269.40**
3. State of Good Repair	$ 138.81	$ 145.48	$ 157.58	$ 155.91	$ 164.64	**$762.42**	$ 169.36	$ 173.45	$ 171.68	$ 180.53	$ 197.77	**$ 1,655.20**
Western Turnpike Total Cost	**$183.13**	**$173.30**	**$165.95**	**$164.58**	**$173.52**	**$860.48**	**$ 178.64**	**$ 269.79**	**$271.39**	**$283.73**	**$ 208.43**	**$ 2,072.47**

Cost Category	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	20 Year Total
1. Modernization	$ 11.03	$ 11.42	$ 8.90	$ -	$ -	$ -	$ -	$ -	$ -	$ -	**$ 179.21**
2. Capacity	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	**$ 269.40**
3. State of Good Repair	$ 192.58	$ 201.82	$ 199.48	$ 202.69	$ 224.07	$ 235.22	$ 244.51	$ 245.82	$ 265.45	$ 265.97	**$3,932.81**
Western Turnpike Total Cost	**$203.61**	**$213.24**	**$208.38**	**$202.69**	**$224.07**	**$235.22**	**$ 244.51**	**$ 245.82**	**$265.45**	**$265.97**	**$4,381.42**

Table 7-6 Projected 20 Year Expenditures (in $ millions) – Escalated Costs