TRANSPORTATION ASSET MANAGEMENT PLAN

August 2019

District Department of Transportation

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Table of Contents

List of Tables

List of Figures

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Government of the District of Columbia

Department of Transportation

Office of the Director

August 30, 2019

Mr. Chris Lawson
Division Administrator
District of Columbia Division
Federal Highway Administration
1200 New Jersey Avenue, SE
East Building, Room E61-312
Washington, DC 20590

RE: Request for Certification of Final Transportation Asset Management Plan (TAMP)

Dear Mr. Lawson:

This letter serves as a formal request to FHWA for an annual consistency determination, which is an evaluation whether the District Department of Transportation (DDOT) has developed and implemented a TAMP that is consistent with the requirements established by 23 U.S.C. 119 and 23 CFR part 515.

Attached here for your review are the most recent State DOT approved TAMP and supporting documents to demonstrate implementation of the TAMP as required by 23 CFR 515.13(b).

Should you have any questions, please contact Aaron Horton, Associate Director of Maintenance, at Aaron.Horton@dc.gov or (202) 671-4679.

Sincerely,

Jeff Marootian
Director

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Executive Summary

TRANSPORTATION ASSET MANAGEMENT IS A FEDERAL REQUIREMENT

Transportation Asset Management is defined by United States Code (23 U.S. Code § 101) as a strategic and systematic process of operating, maintaining, and improving physical assets, with a focus on both engineering and economic analysis based upon quality information to identify a structured sequence of maintenance, preservation, repair, rehabilitation, and replacement actions that will achieve and sustain a desired state of good repair over the lifecycle of the assets at minimum practicable cost.

FHWA Minimum Process Requirements - 23 CFR 515

- Summary Listing and Condition Description of National Highway System (NHS) pavements and bridges.
- Asset Management Objectives
- Performance Gap Analysis
- Lifecycle Planning Analysis
- Risk Analysis and Management
- Ten-year Financial Planning
- Investment Strategies

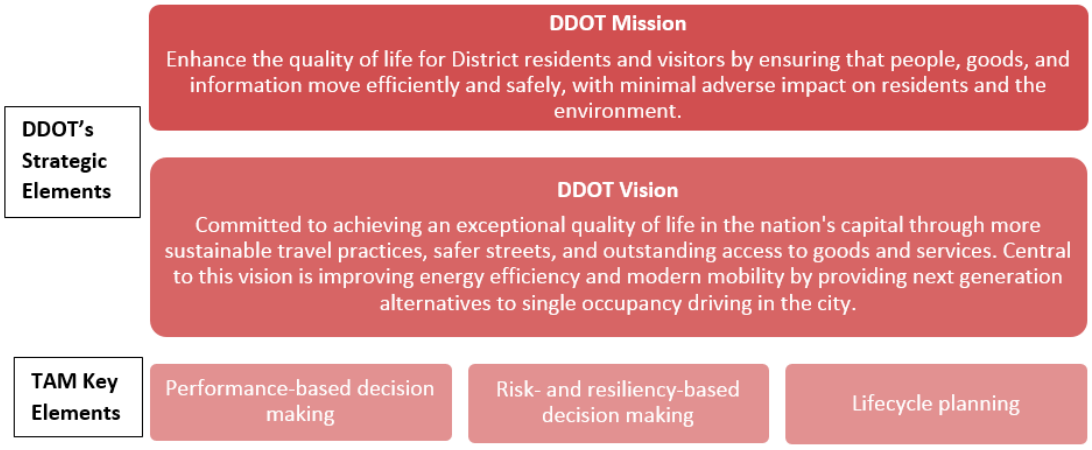
FHWA Minimum Requirements for Asset Inclusion in the TAMP

- NHS Pavements
- NHS Bridges

DDOT TAMP Scope

- NHS Pavements
- NHS Bridges
- Non-NHS Pavement and Bridges
- Pedestrian Bridges
- Vehicular Tunnels

ASSET MANAGEMENT AND DDOT'S STRATEGIC APPROACH

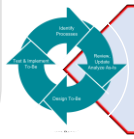


ASSET MANAGEMENT OBJECTIVES

The fundamental principles underlying DDOT's asset management objectives include making transparent and accountable decisions, managing risks, and minimizing lifecycle cost while achieving DDOT's established performance targets. Achieving the performance targets enables DDOT to make progress towards national performance goals, and to deliver a transportation system in a state of good repair.

1. Enhance performance-based decision making.

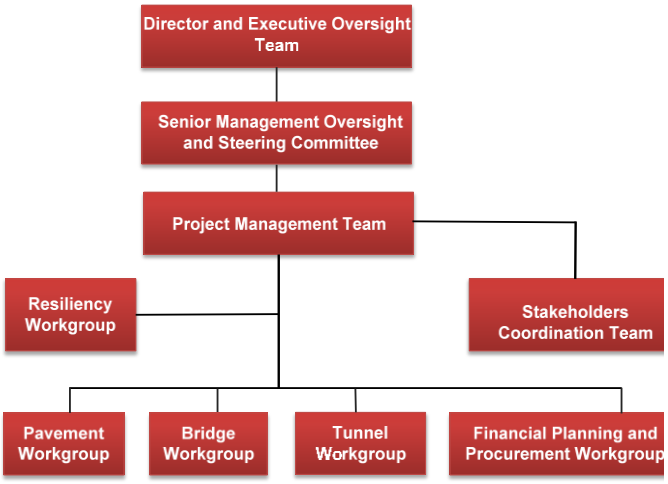
2. Incorporate risk/resiliency planning into investment decision making.



3. Incorporate lifecycle planning scenarios into investment prioritization.

DEVELOPING AND MANAGING THE TAMP

The District Department of Transportation (DDOT) has developed a comprehensive TAM Governance Document as a standalone resource for staff involved in the TAM process. The Governance Document describes the teams' membership, roles, and responsibilities as they pertain to carrying out TAM activities and developing the TAMP. This structure is meant to be functional with workgroups formed and disbanded as TAM maturity evolves. From this point forward, these groups are focused on the development of the final TAMP document.

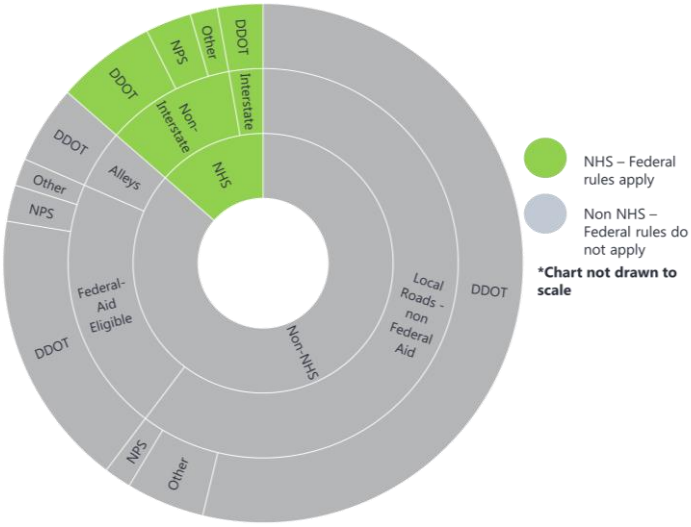


Team Responsibilities:

- Signs the TAMP.
- Provides strategic direction.
- Provides regular guidance.
- Updates the TAMP.
- Provides guidance on technical analysis for pavements, bridges, tunnels, financial, and risk management.

DESCRIPTION OF ASSET INVENTORY

The District's asset inventory is categorized into Interstate and non-Interstate NHS routes that combine to make up the NHS, which are subject to the federal TAMP requirements, and the non-NHS system, which is not required by the federal rules to be included in the TAMP. Ownership and maintenance responsibility of assets in each category is shared among DDOT, the National Park Service (NPS), the Architect of the Capitol (AOC), and other federal and local agencies. The system consists of 1,150.1 centerline miles of pavements, 265 bridges, 17 tunnels, and other ancillary assets that are pertinent to the safe and efficient operation of the system.



Pavement Categories		DDOT		NPS		Others*	
		Miles	%	Miles	%	Miles	%
NHS	Interstates	11.8	100%	0.0	0%	0.0	0%
	Non-Interstates	109.3	89%	11.8	10%	1.2	1%
	Subtotal NHS	**121.1**		**11.8**		**1.2**	
	Total NHS	**134.1**					
Non-NHS	Federal-Aid Roads	305.2	96%	9.7	3%	4.4	1%
	Local Roads	592.0	85.0%	18.7	2.7%	86.0	12.3%
	Subtotal Non-NHS	**897.2**		**28.4**		**90.4**	
	Total Non-NHS	**1016**					
System (NHS and Non-NHS) Subtotal		**1,018.3**		**40.2**		**91.6**	
System (NHS and Non-NHS) Total		**1,150.1**					

* includes other federal and local agencies.

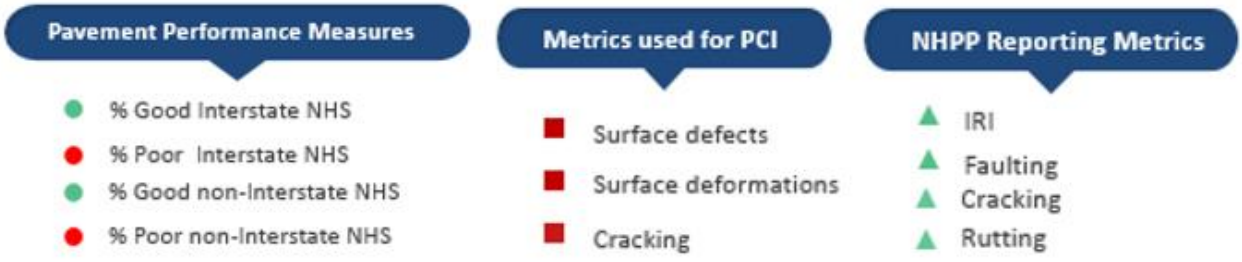
Bridge Categories		Number of Bridges	Bridge Deck Area, (sq. ft.)
NHS	DDOT	132	4,531,202
	NPS	12	351,510
	Subtotal	**144**	**4,882,712**
Non-NHS	DDOT	76	1,147,829
	NPS	21	173,716
	DDOT Pedestrian Bridges	24	93, 093
	Subtotal of Non-NHS	**121**	**1,414,638**
Total Bridge Inventory		**265**	**6,297,350**

PERFORMANCE MEASURES AND ASSET CONDITIONS

To respond to Federal rule 23 CFR 490, DDOT is expected to use the performance measures specified in Subpart C and D in assessing pavement and bridge conditions for the NHS.

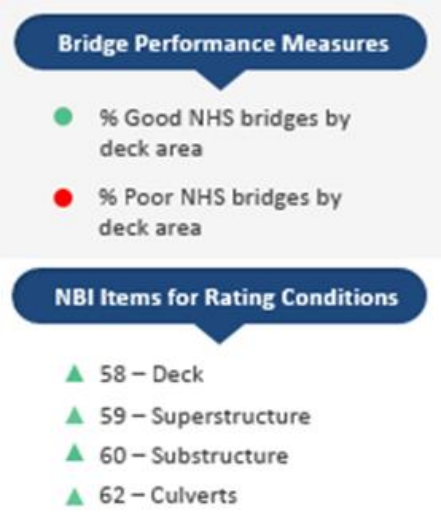
Pavement Performance Measures

The four performance measures for pavements include the percentage of Interstate and Non-Interstate NHS pavements in "Good" and "Poor" conditions. DDOT currently uses three measures (%Good, %Fair, and %Poor) based on Pavement Condition Index (PCI) to track pavement performance and to drive investment decisions. The PCI uses metrics such as surface defects, surface deformation, and cracking percent. DDOT will be reporting performance using the national highway performance program (NHPP) metrics in future TAMP.

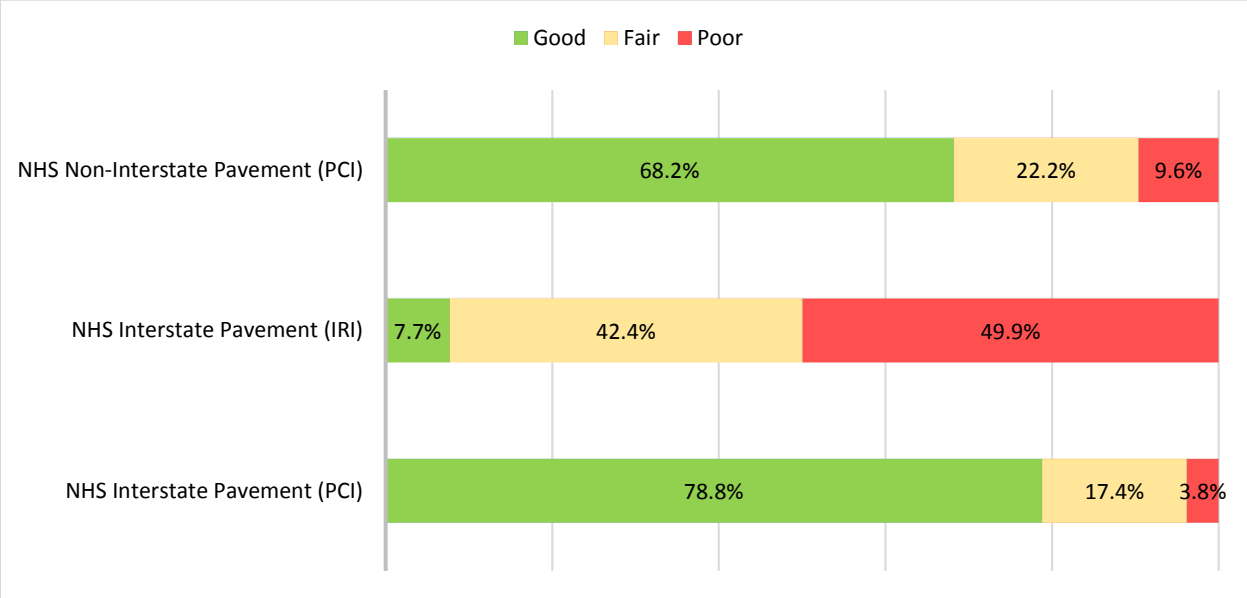


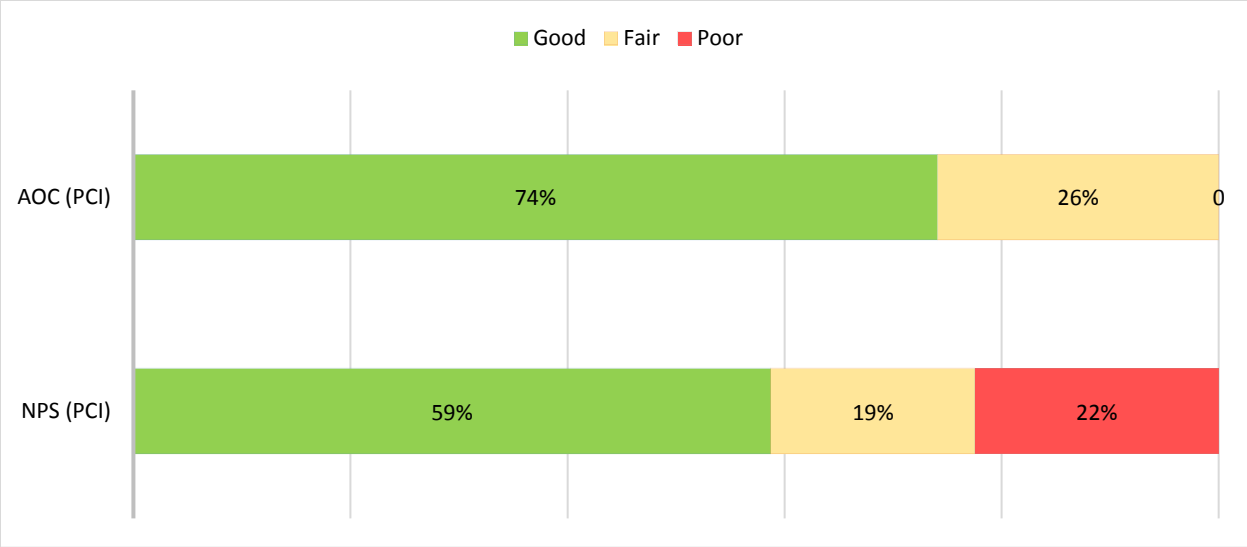
Bridge Performance Measures

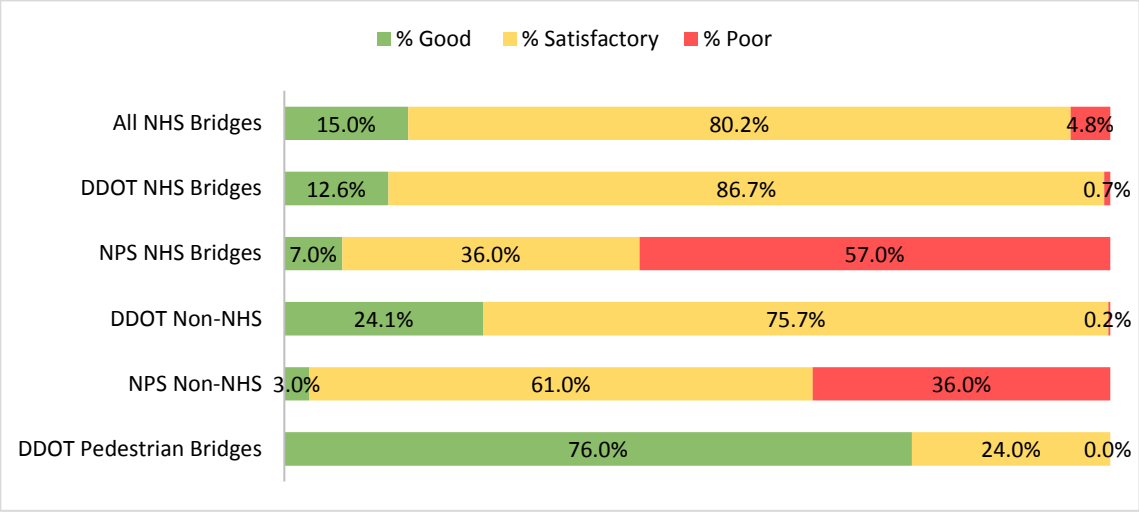
The two performance measures for bridges include the percentage of NHS bridges classified to be in "Good" condition and the percentage of NHS bridges classified to be in "Poor" condition. These measures are based on deck area of bridges, and they apply to bridges carrying the NHS, including bridges connecting on- and off-ramps to the NHS.



NHS BASELINE PERFORMANCE





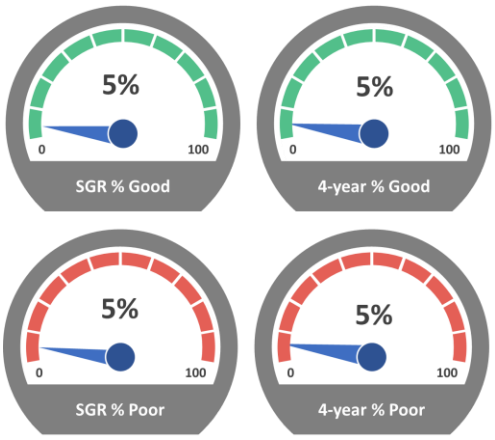


STATE OF GOOD REPAIR AND PERFORMANCE TARGETS

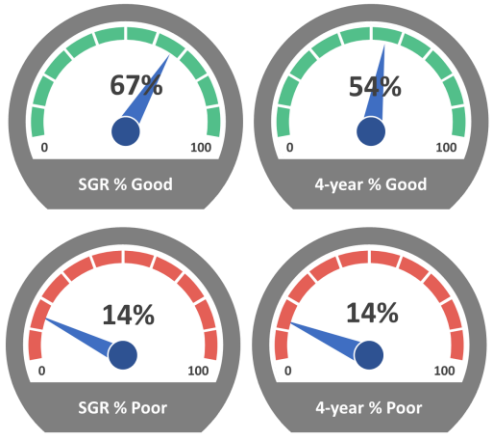
DDOT establishes the state of good repair (SGR) for assets looking at various constraints, including legislative mandates, current condition, and anticipated level of investment.

DDOT defines SGR as the state of achieving or exceeding the federal minimum performance requirements stipulated for Interstate pavement and NHS bridges. For non-Interstate NHS pavements, DDOT's long-term goal is to maintain the existing conditions (i.e., 10 years and beyond) if no additional funding becomes available. Similar definition is adopted for NHS bridges. DDOT intends to maintain the deck area of NHS bridges classified as poor at 10% or below, while improving the percentage good of NHS deck area in the District. These definitions ensure that DDOT meets legislative mandates, while managing customer expectations.

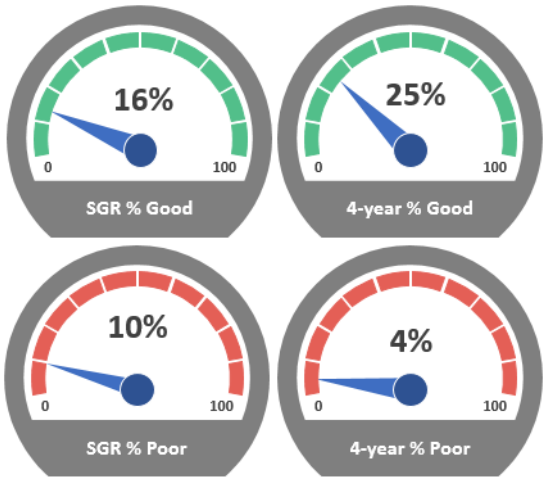
Interstate NHS Pavement (IRI)



Non-Interstate NHS Pavement (PCI)



NHS Bridges



FINANCIAL PLANNING

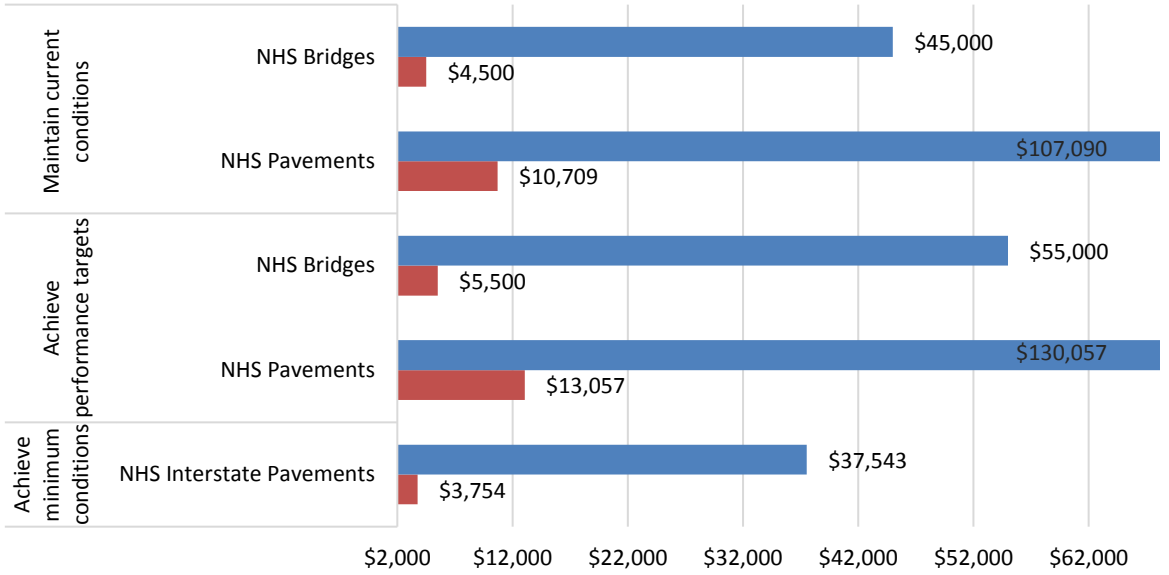
Sources of Funds

Funding for DDOT's investment programs for Asset Management comes from two primary sources: The Federal Highway Administration and the local GO Bonds and Revenues. Other external sources include NPS and AOC funding, which are not administered by DDOT but can have a noticeable impact on system performance.

Uses of Funds

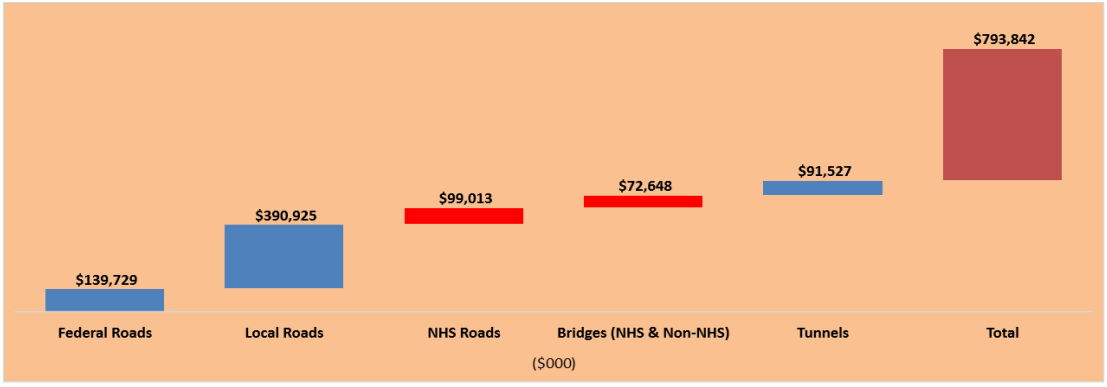
DDOT has two expenditure categories that impact the performance of pavement, bridges, and tunnels directly: Preservation and Maintenance Investments and Capital Improvement Investments. DDOT also manages other expenditure categories that have indirect performance effects on roadway, bridge, and tunnel conditions and network operation.

TEN-YEAR ESTIMATED COST PROFILES FOR SPECIFIC GOALS AND ASSET CLASS

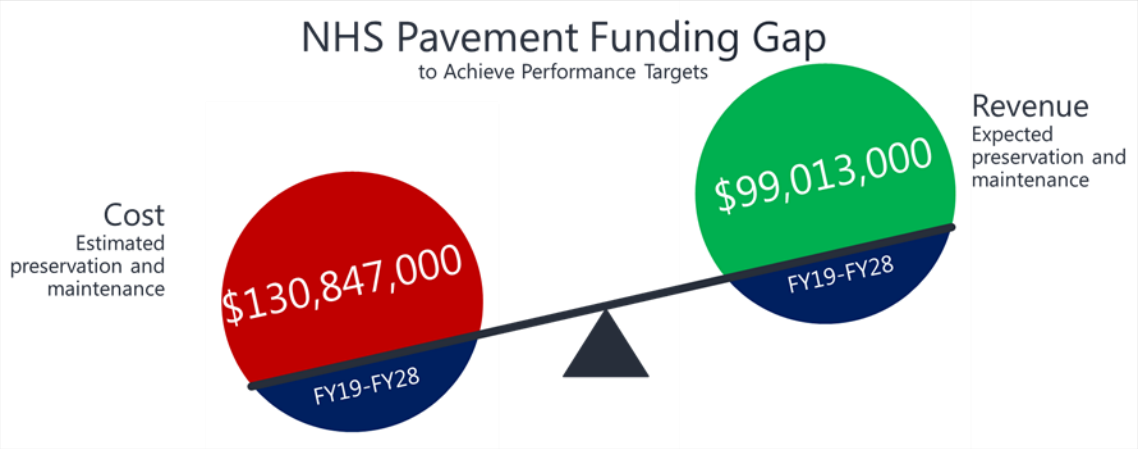


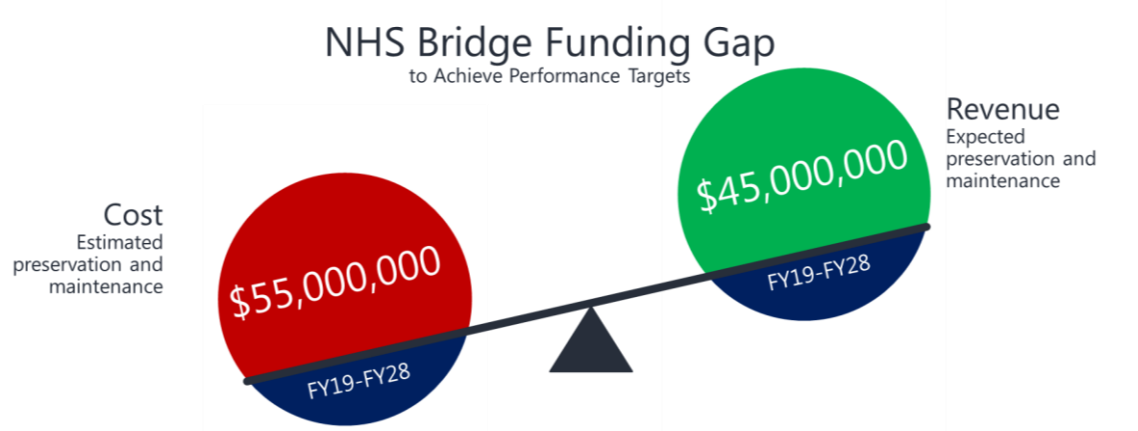
	Achieve minimum conditions	Achieve performance targets		Maintain current conditions	
	NHS Interstate Pavements	NHS Pavements	NHS Bridges	NHS Pavements	NHS Bridges
Estimated 10-Year Cost for Preservation and Maintenance ($000)	$37,543	$130,573	$55,000	$107,090	$45,000
Estimated Annual Average Cost ($000)	$3,754	$13,057	$5,500	$10,709	$4,500

TEN-YEAR PROJECTED REVENUE FOR PRESERVATION AND MAINTENANCE



TEN-YEAR ESTIMATED FUNDING GAPS

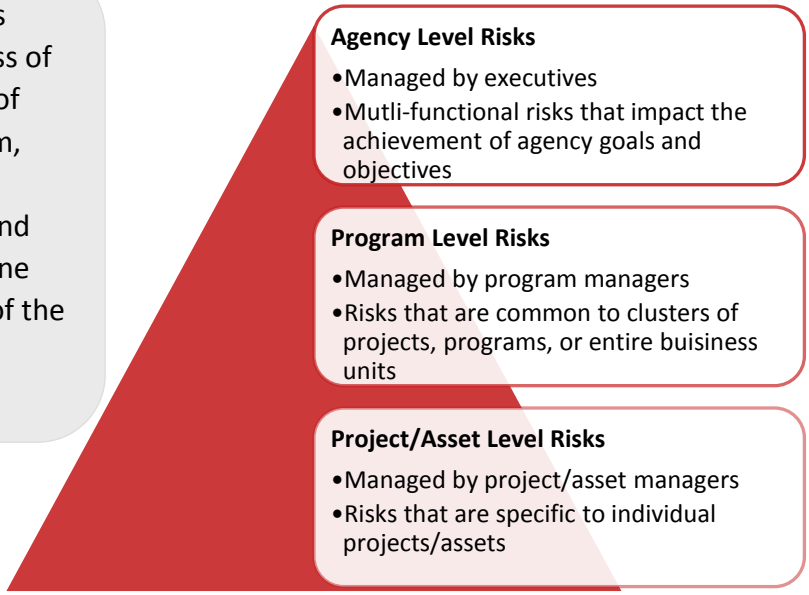




DDOT is proactively working internally, discussing the investments needed to achieve targets and maintain the NHS pavement and bridges at or above the federal minimum conditions set under the National Performance Management Measures. This will ensure the obligation plan, the TIP and STIP reflect the funding needs and enable DDOT close the financial gap and implement the desired investment strategies in Chapter 7, for SGR. For example, DDOT has identified FY19 August redistribution funds to close the funding gap in 2020 and is currently working on obligating the funds.

RISK MANAGEMENT LEVELS TREATED IN THE TAMP

Risk management is defined as "a process of identifying sources of risk, evaluating them, and integrating mitigation actions and strategies into routine business functions of the agency" to address them.



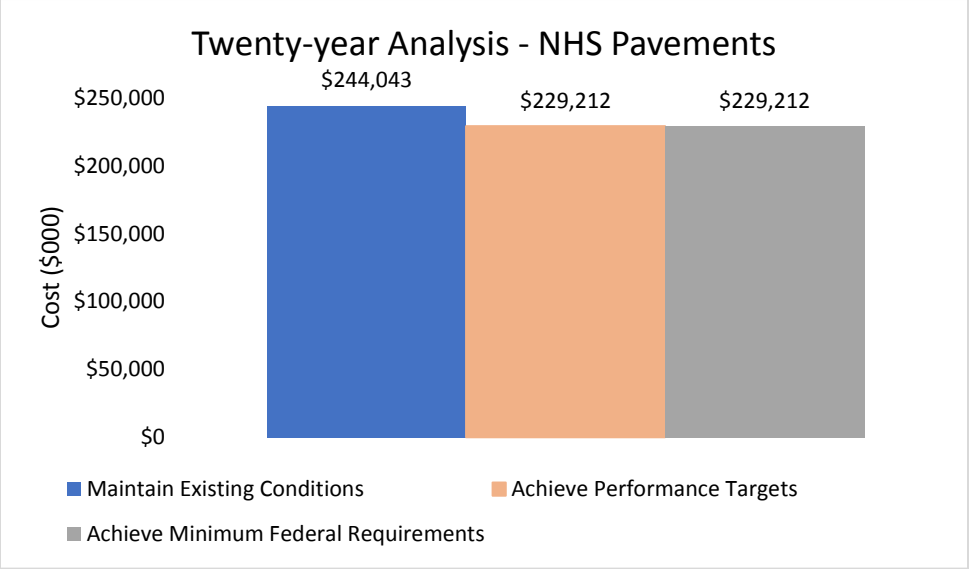
TOP-FIVE IDENTIFIED RISKS

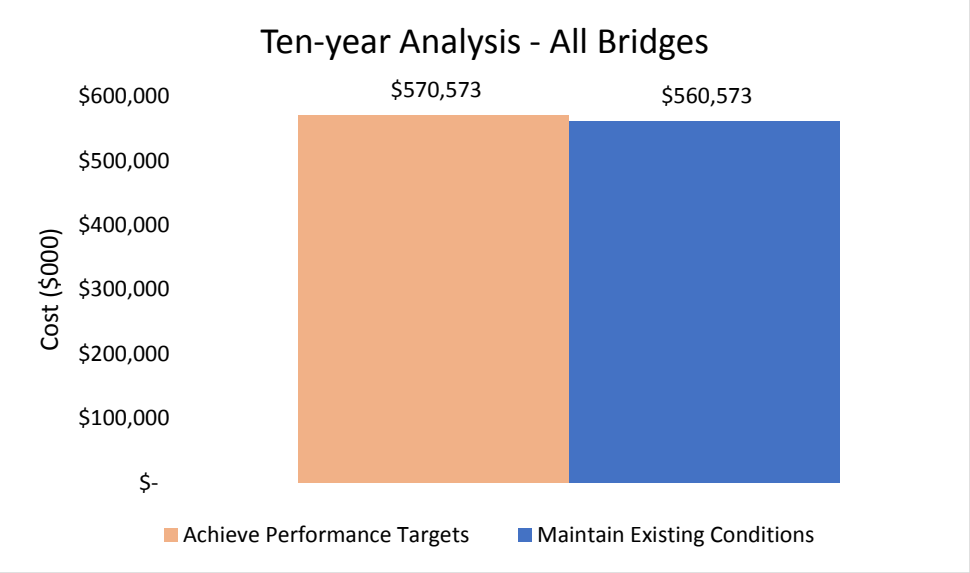
Risk scores	Risk events	Mitigation actions
20	Inability to procure qualified contractors in a reasonable amount of time to support program delivery.	▪ Communicate the impact of project delays to stakeholders. ▪ Review existing standard operating procedure, procurement timelines, identify improvement areas, and implement actions to expedite the procurement process.
20	Inability to meet performance goals due to a potential drop in performance of large, critical bridges.	▪ Implement a bridge management system capable of analyzing bridge performance and budget. ▪ Prioritize bridge preservation and investments based on performance, criticality, and risk.
19	Local politics impact local funding appropriation.	▪ Use performance measures to communicate and inform decision makers. ▪ Communicate the impact of resource reallocation on the overall performance of the network.
18	Program delivery is impacted by funding high-profile and politically-motivated projects.	▪ Use performance measures to inform decision makers ▪ Communicate the impact of resource reallocation on the overall performance of the network.
18	Loss of performance or damage to assets due to the failure of utility assets or buried pipes.	▪ Establish a working understanding with utility agencies. ▪ Require performance-based repairs from utility agencies. ▪ Improve repair and performance enforcements.

LIFECYCLE PLANNING

Lifecycle Planning is defined as "a process to estimate the cost of managing an asset class, or asset sub-group, over its whole life with consideration for minimizing cost while preserving or improving the condition."

DDOT estimated different scenarios depending on the maturity of pavement and bridge systems and data availability to evaluate the needs and to develop investment strategies.

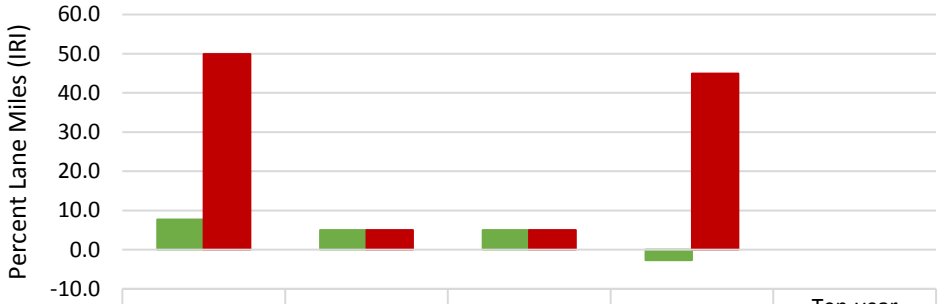




PERFORMANCE GAP ANALYSIS

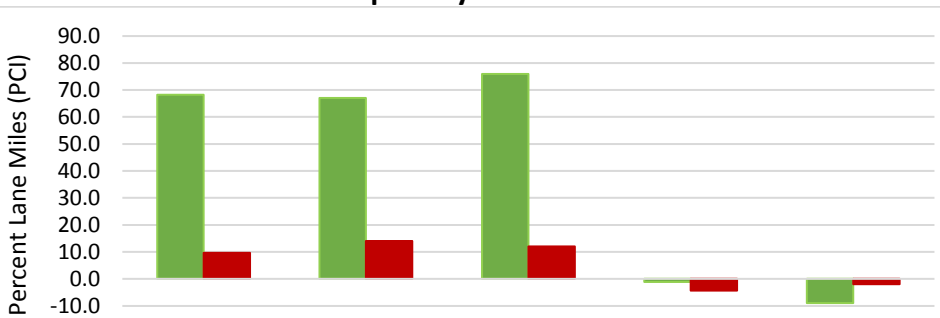
The figures below show the outcome of the gap analysis for Interstate and non-Interstate NHS pavements and NHS bridges owned by DDOT. The performance gap is the percentage difference between the established SGR and the baseline condition. A negative gap implies that system performance is declining from the baseline and positive gaps indicate improvement in performance.

Performance Gap Analysis – Interstate Pavement



	Current Performance (2018)	State of Good Repair	Ten-year Projected Performance	Current Performance Gap	Ten-year Projected Performance Gap
% Good	7.7	5.0	5.0	-2.7	0.0
% Poor	49.9	5.0	5.0	44.9	0.0

Performance Gap Analysis – Non-Interstate Pavement



	Current Performance (2018)	State of Good Repair	Ten-year Projected Performance	Current Performance Gap	Ten-year Projected Performance Gap
% Good	68.2	67.0	76.0	-1.2	-9.0
% Poor	9.6	14.0	12.0	-4.4	-2.0

Performance Gap Analysis – DDOT-owned NHS Bridges

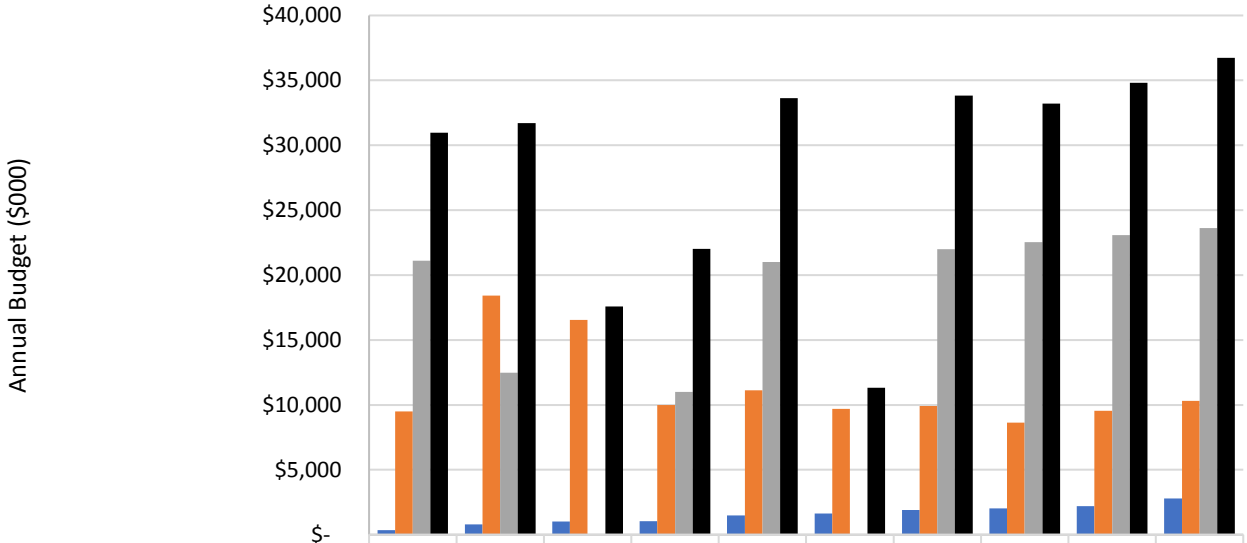
	Current Performance (2018)	State of Good Repair	Ten-year Projected Performance	Currrent Performance Gap	Ten-year Projected Performance Gap
% Good	15.0	16.0	63.0	1.0	-47.0
% Poor	5.0	10.0	2.0	-5.0	-8.0

INVESTMENT STRATEGIES

Investment strategy is defined as "a set of strategies that result from evaluation of various levels of funding to achieve State DOT targets for asset condition and system performance effectiveness at a minimum practicable cost while managing risks." DDOT has adopted a set of strategic rules to guide the development of investments that seek to achieve a state of good repair while making progress towards the achievement of performance targets and national goals.

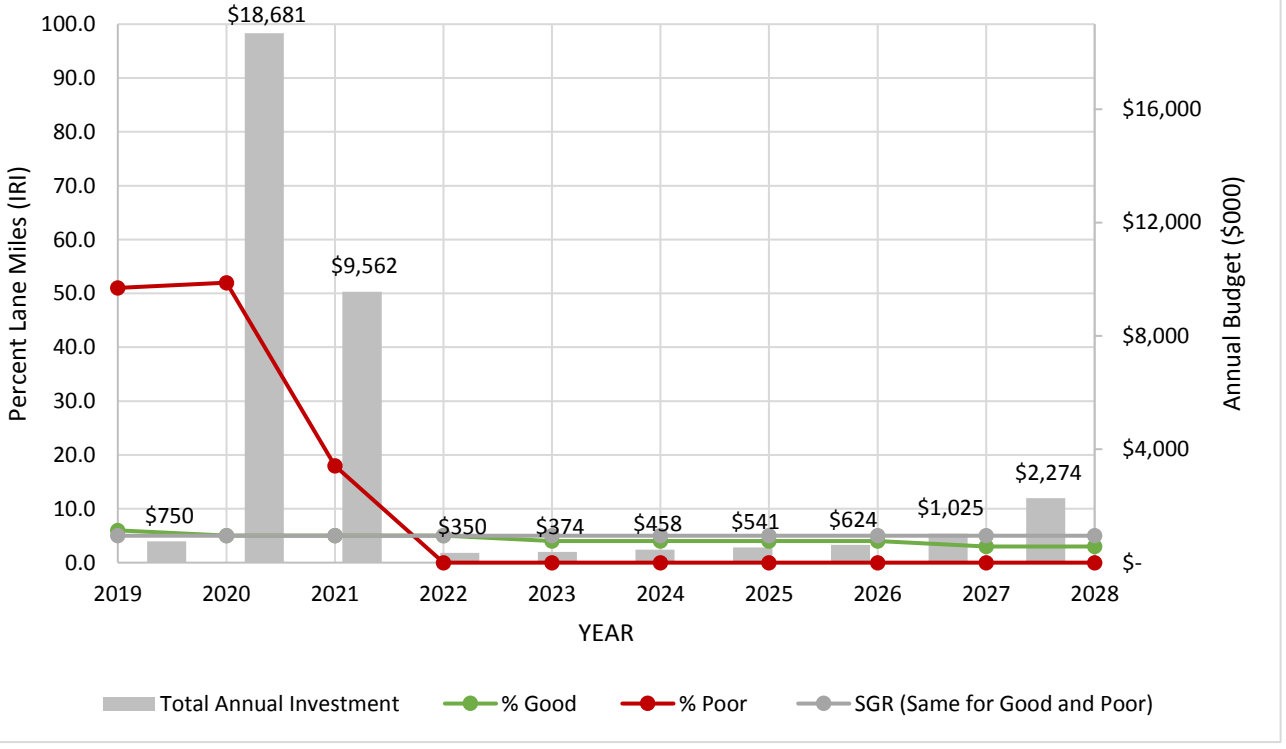
The investment strategies are preservation and performance focused, risk oriented, and financially constrained. These strategies were developed using information gathered from the risk analysis process, asset management gap analysis workshops, lifecycle planning, and DDOT's financial planning. The following figures show the projected performance and cost for each strategy for DDOT-owned assets.

Annual Investment Trend – NHS Pavement

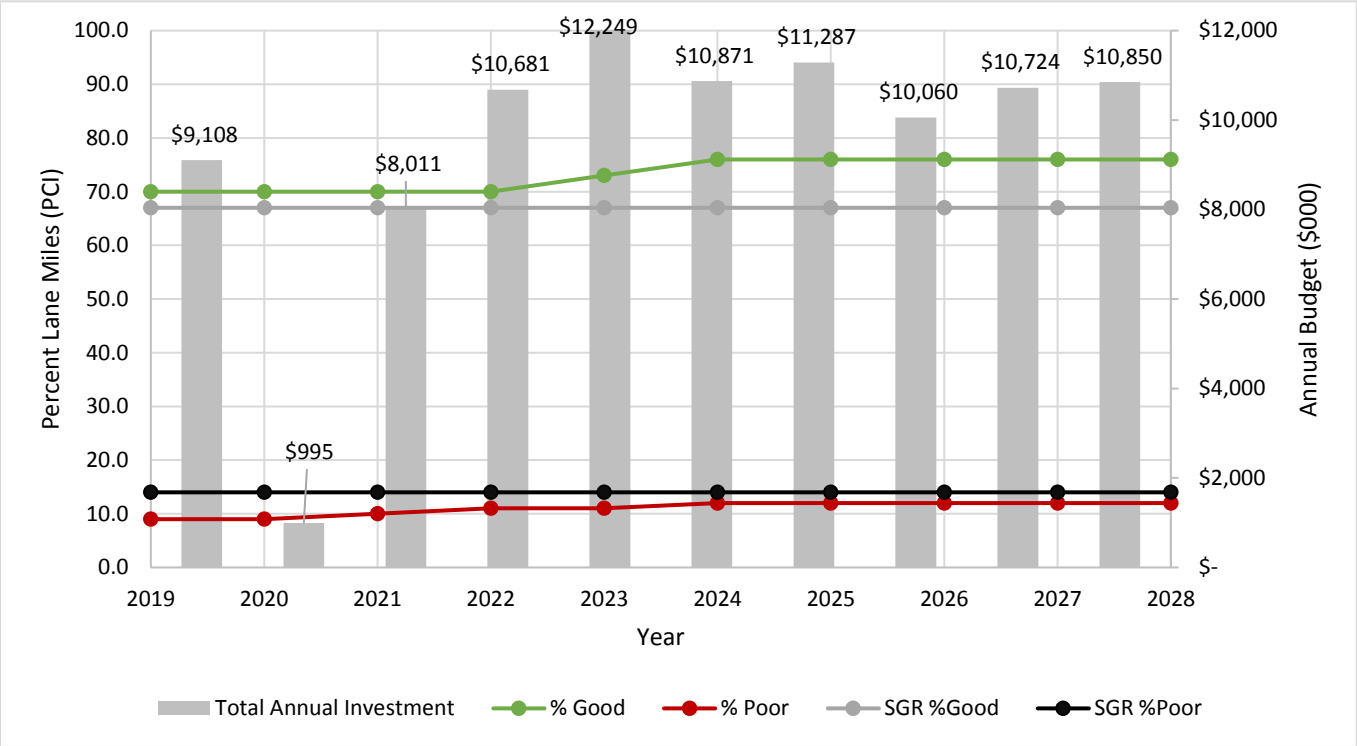


	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
Preservation	$358	$807	$1,015	$1,043	$1,487	$1,644	$1,913	$2,039	$2,206	$2,802
Minor Rehabilitation	$9,500	$18,428	$16,558	$9,988	$11,136	$9,686	$9,915	$8,644	$9,543	$10,323
Capital Improvement Investment	$21,100	$12,473	$-	$11,000	$21,000	$-	$22,000	$22,528	$23,069	$23,622
Total Annual Investment	$30,958	$31,708	$17,573	$22,031	$33,623	$11,329	$33,828	$33,212	$34,818	$36,747

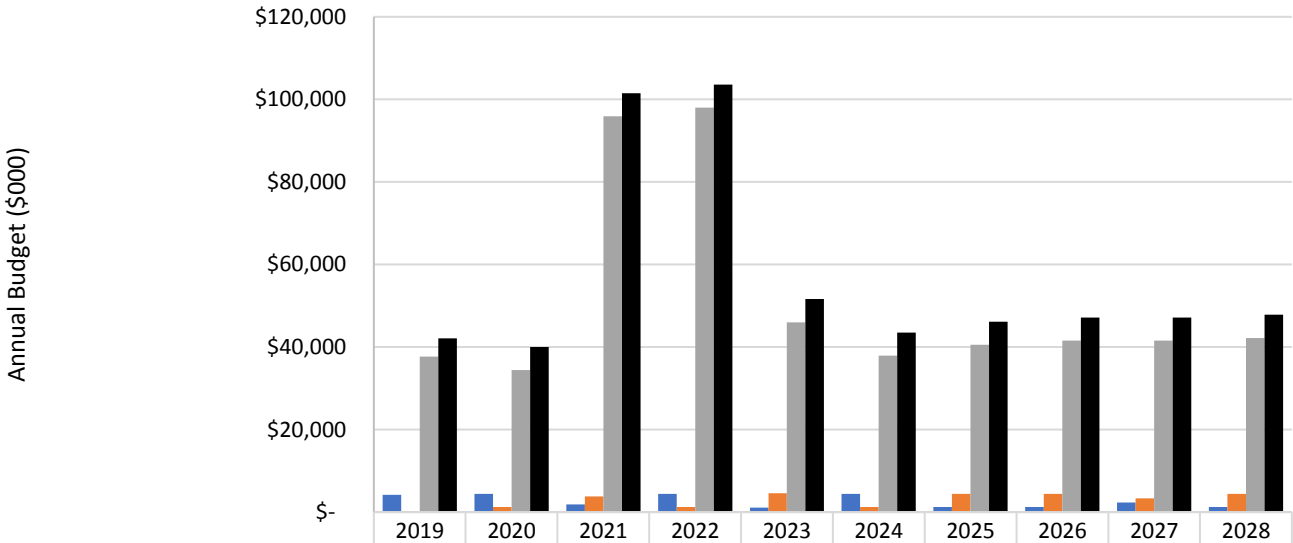
Projected Performance and Funding – Interstate Pavement



Projected Performance – Non-Interstate Pavement

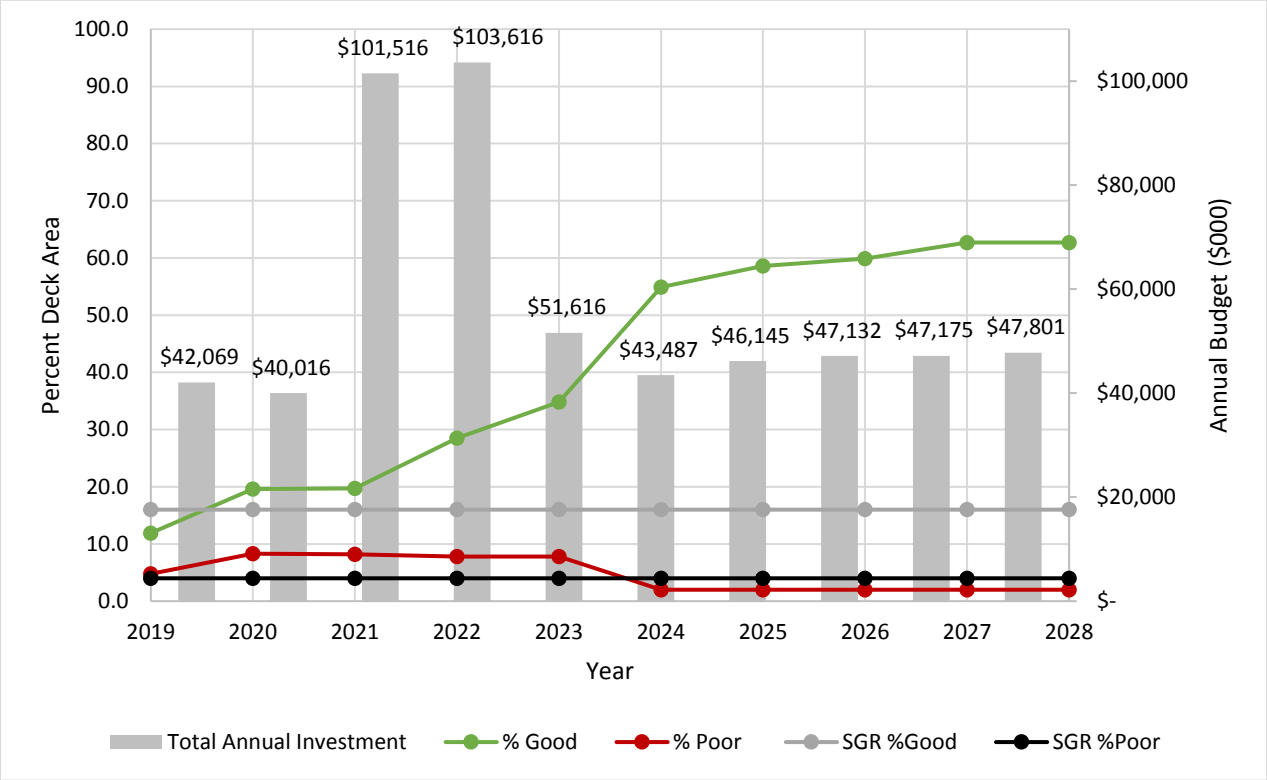


Annual Investment Trend – DDOT-owned Bridges



	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
Light Preservation (NHS Bridges)	$4,160	$4,404	$1,850	$4,416	$1,058	$4,377	$1,200	$1,200	$2,294	$1,200
Heavy Preservation (NHS Bridges)	$256	$1,212	$3,766	$1,200	$4,558	$1,239	$4,416	$4,416	$3,321	$4,416
Capital Improvement Investment	$37,653	$34,400	$95,900	$98,000	$46,000	$37,871	$40,529	$41,516	$41,560	$42,185
Total Annual Investment	$42,069	$40,016	$101,516	$103,616	$51,616	$43,487	$46,145	$47,132	$47,175	$47,801

Projected Performance – DDOT-owned NHS Bridges



Chapter 1 Introduction

1.1 Overview

In 2012, Congress passed the Moving Ahead for Progress in the 21st Century (MAP-21) Act. One of the provisions in MAP-21 requires all State Departments of Transportation (DOTs) to develop a risk-based Transportation Asset Management Plan (TAMP) for their National Highway System (NHS) pavement and bridge assets. The MAP-21 provisions were reinforced through the passage of the Fixing America's Surface Transportation (FAST) Act in 2015. Following these mandates, DDOT has developed this risk-based TAMP using sound business and engineering principles, in collaboration with all stakeholders of NHS assets within the District. DDOT's engagement activities with the key external stakeholders are detailed in Chapter 2 of this document.

Transportation Asset Management (TAM) is defined as "*A strategic and systematic process of operating, maintaining, and improving physical assets, with a focus on both engineering and economic analysis based upon quality information to identify a structured sequence of maintenance, preservation, repair, rehabilitation, and replacement actions that will achieve and sustain a desired state of good repair (SGR) over the lifecycle of the assets at minimum practicable cost*[1]."

This chapter describes how TAM business processes align with DDOT's strategic direction and other planning processes. Specifically, this chapter outlines the following:

- **DDOT's strategic approach**: This section describes DDOT's vision, mission, and goals and how asset management principles support DDOT's strategic direction.
- **TAMP relationship with other business plans:** This section describes how DDOT's TAMP interacts with other DDOT planning documents.
- **Scope and organization of the TAMP:** This section outlines the types of assets and networks covered in this TAMP as well as the organization of the TAMP.

1.2 DDOT's Strategic Approach

DDOT's vision, organizational mission, and core values are key elements integrated into the business processes of the Department. These elements guide the Department's approach to achieve strategic goals and are entrenched in operational and investment decision making processes that pertain to asset management decisions. Asset management enables DDOT to reinforce the Department's core values in evaluating alternatives in maintenance and capital investments and supporting the achievement of the Department's mission and vision. The key asset management processes do not exist in a vacuum, but they bring together, reinforce, and support the Department's core values, mission, and vision.

[1] (23 U.S.C. 101(a)(2), MAP-21 § 1103).

Figure 1-1 shows DDOT's strategic direction (agency mission and vision) and TAM key elements.

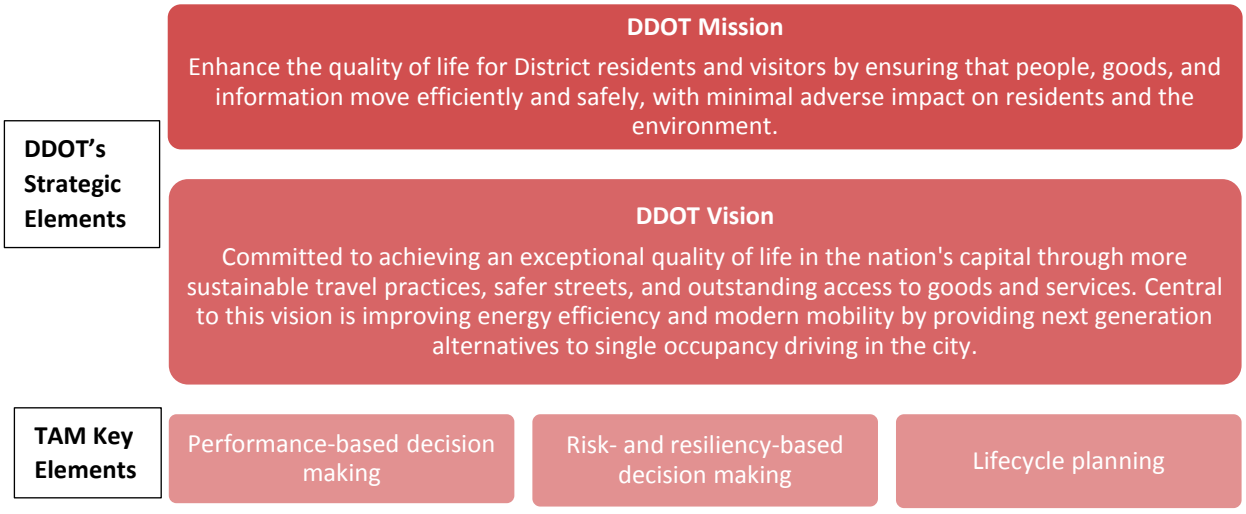


Figure 1-1. DDOT's Strategic Direction and TAM Key Elements.

1.3 TAMP Relationship with Other Plans and Business Practices

Traditionally, DDOT produces multiple comprehensive planning documents to support strategic decision making and business operations. Examples of these plans with direct relation to the TAMP include MoveDC, the 25-year Statewide Multimodal Long-Range Transportation Plan, the Statewide Transportation Improvement Program (STIP), and the District's 6-year Capital Improvement Program (CIP). DDOT's TAMP is central to the Department's planning, programming, and budgeting processes. It is used as a supporting tool to improve the Department's planning processes, which leads to better asset preservation and system performance by linking DDOT's long-range goals with the Department's daily operational activities.

23 CFR 515.9(h) of the asset management final rules requires that DDOT integrate its asset management plan into the Department's planning processes that lead to the STIP. Figure 1-2 shows how the DDOT TAMP plays a central role in DDOT's planning efforts to achieve state and national goals for infrastructure conditions[2], which are maintaining the highway infrastructure asset system in SGR and system performance.

[2] 23 USC 150(b)

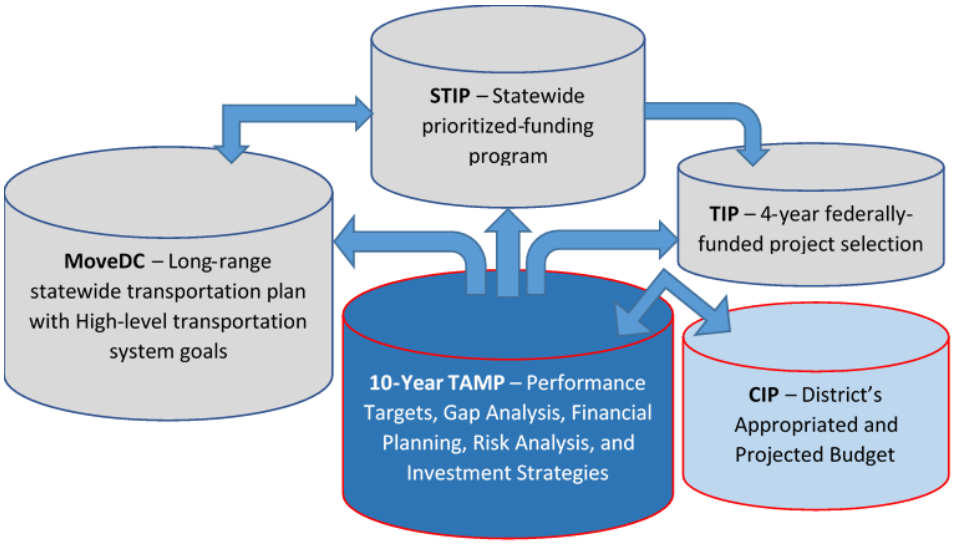


Figure 1-2. Links between DDOT TAMP, MoveDC, TIP, STIP, and CIP.

1.4 Scope and Organization of TAMP

The federal rules require DDOT to include pavement and bridge assets on the NHS, irrespective of ownership of the asset. Furthermore, the rules recommend that State DOTs may include other assets in the right-of-way (ROW) beyond pavement and bridges and beyond the extent of the NHS. DDOT's current TAMP includes the two required asset classes on the NHS. DDOT's long-term goal is to develop a more comprehensive TAMP including all other assets. As a start, DDOT has included additional information on tunnels. However, this information is not to be considered as part of the TAMP review process.

Figure 1-3 provides an overview of highway assets included in this TAMP, and Figure 1-4 shows the map of NHS network in the District of Columbia included in the TAMP. The assets in the second box is not to be consisdered for the TAMP review process.

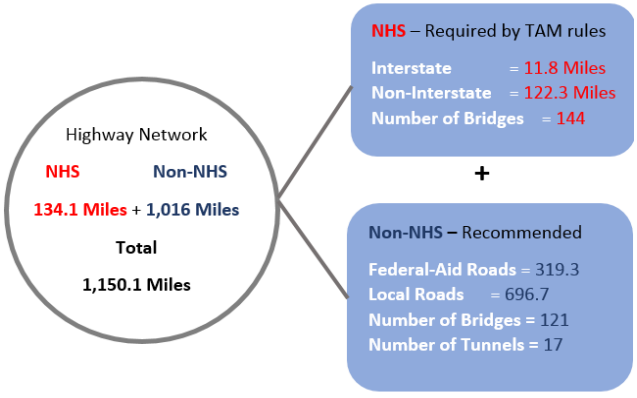


Figure 1-3. Overview of Highway Assets Included in TAMP.

The results in this TAMP include an extensive analysis of NHS pavements and bridges to respond to the federal requirements. DDOT made additional efforts to generate similar results for tunnels and non-NHS pavements (i.e., local and federal roads) based on the availability of data and the capabilities of existing management systems to support the analysis. As such, this TAMP serves as a framework to later include other asset classes such as guardrails, culverts, underground utilities, sidewalks, alleys,

and streetlights in the future, as part of DDOT's long-term vision for applying similar asset management principles.

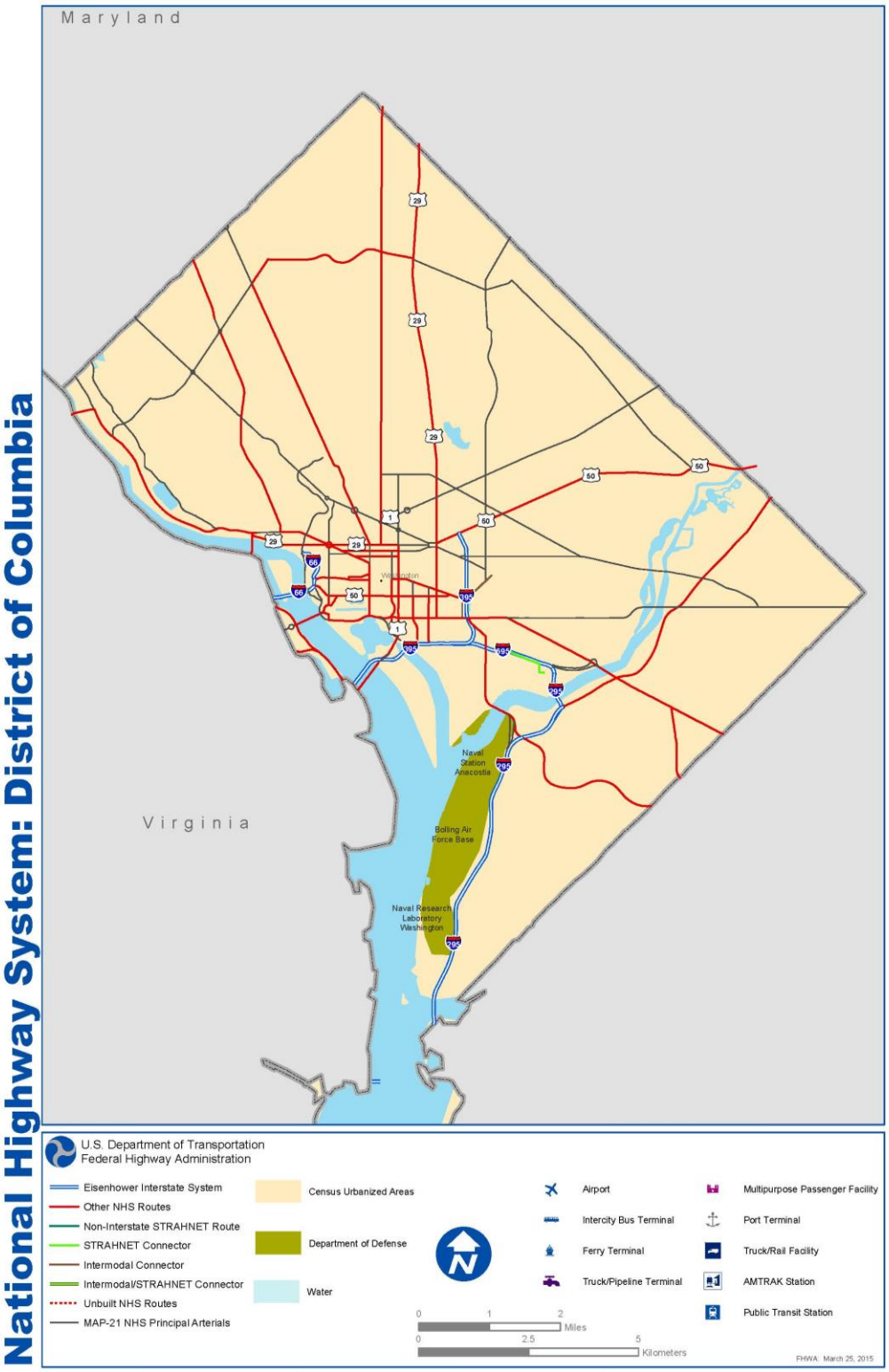


Figure 1-4. NHS Extent and Classification in the District of Columbia.

Organization of TAMP

The remainder of the TAMP is organized as follows:

02

Chapter 2

Presents an overview of TAM practices at DDOT. Particularly, the chapter presents DDOT's TAM objectives and Organizational Structure and how it relates to the business structure that governs the asset management practices.

03

Chapter 3

Reviews the state of DDOT's highway transportation system. Particularly, the chapter reviews the demand for transportation, asset inventory and condition trends, and performance measures.

04

Chapter 4

Provides information about the sources and uses of funds related to DDOT's highway assets covered in this TAMP.

05

Chapter 5

Describes the comprehensive risk management processes and results from the analysis, including a summary of the Part 667 analysis.

06

Chapter 6

Describes DDOT's approach and results from the lifecycle planning for assets.

07

Chapter 7

Outlines DDOT's investment strategies development approach and results to achieve short- and long-term performance goals.

08

Chapter 8

Outlines the existing strengths and improvement recommendations needed to improve the practice of asset management in the Agency.

Chapter 2 Transportation Asset Management at DDOT

2.1 Overview

This chapter provides a synopsis of how DDOT carries out TAM. TAM as a business practice requires a well-defined method that establishes existing practice and institutes objectives to serve as a direction for the Department. Management-level involvement and effective collaboration with key stakeholders are among the several components of DDOT's TAM framework.

Specifically, this chapter provides information on:

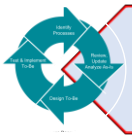
- DDOT's TAM objectives.
- DDOT's organizational structure.
- The governance of TAM practices.
- The participation of external stakeholders in the TAM process.
- Role of the TAMP in Asset Management practice.
- Asset Management policy development process.
- TAMP management.
- TAM improvement process.

2.2 Asset Management Objectives

The fundamental principles underlying DDOT's asset management objectives include making transparent and accountable decisions, managing risks, and minimizing lifecycle cost while achieving DDOT's established performance targets. Achieving the performance targets enables DDOT to make progress towards national performance goals and to deliver a transportation system in a state of good repair. DDOT establishes the state of good repair (SGR) for assets looking at various constraints, including legislative mandates, current condition, and anticipated level of investment. The Department relies on the analytical capabilities of existing asset management systems, supplemented by expert knowledge, to define the long-term needs and expected performance of assets.

1. Enhance performance-based decision making.

2. Incorporate risk/resiliency planning into investment decision making.



3. Incorporate lifecycle planning scenarios into investment prioritization.

DDOT defines SGR as the state of achieving or exceeding the federal minimum performance requirements established for Interstate pavement and NHS bridges. For non-Interstate NHS pavements, DDOT's long-term goal is to maintain the existing conditions (i.e., 10 years and beyond). Similar definition is adopted for NHS bridges. DDOT intends to maintain the bridge deck area of NHS bridges classified as poor at 10% or below, while improving the percentage good of NHS deck area in the District. These definitions ensure that DDOT meets legislative mandates, while managing customer expectations.

2.3 DDOT's Organizational Structure

Figure 2-1 shows DDOT's organizational structure[3]. The Director oversees the Department with support from the four Chief Officers heading the four administrations (i.e., Project Delivery, Operations, Administrative, and Performance Management) and the Chief of Staff. The Operations Administration includes the Maintenance Division, within which Asset Management resides. However, Asset Management transcends the Operations Administration and the Maintenance Division. Each administration has a unique TAM role to ensure the Department achieves TAM objectives. As such, representatives from key divisions are represented in the TAM governance process.

2.4 TAM Governance and TAMP Management

Overall TAM coordination resides in the Operations Administration under the guidance of the Chief Operations Officer. To encourage a culture of coordinated, integrated, and informed process, DDOT has adopted an all-inclusive governance approach to administer the TAM process and manage the contents of the TAMP. This approach includes key stakeholders from different administrations and divisions. Figure 2-2 shows the governance team that supports the propagation of TAM practices throughout the Department. The governance team also supports the development, implementation, and management of the TAMP.

DDOT makes continuous improvements to existing functional structures, technical processes, and stakeholder engagement practices as the TAM practice matures and additional information becomes available. Anticipated improvements to meet the final TAMP requirements and beyond are documented in a later chapter of this TAMP. Key improvement themes include instituting

[3] DDOT, Updated July 2019

agency-wide TAM, applying integrated data management systems, and supporting integrated decision making to enhance a performance-based resource allocation approach.

The TAM governance team is functional rather than organizational and consists of the following components:

- Director and the Executive Oversight Team
- Senior Management Oversight and Steering Committee
- Project Management Team
- TAM Focus Area Workgroups (i.e., Pavement, Bridge, Tunnel, Financial and Procurement, Resiliency, and Stakeholders Coordination)

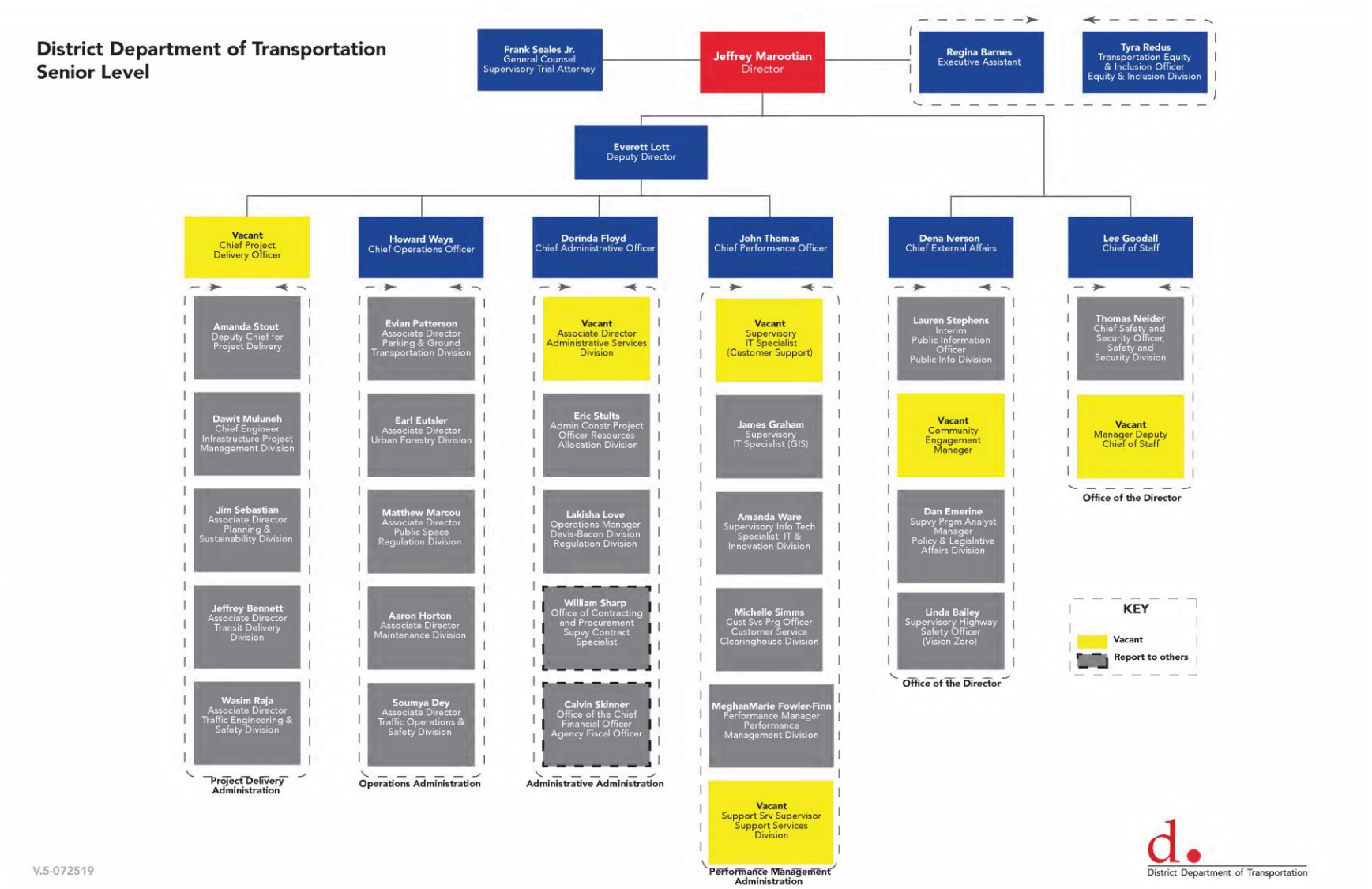


Figure 2-1. DDOT Organizational Structure.

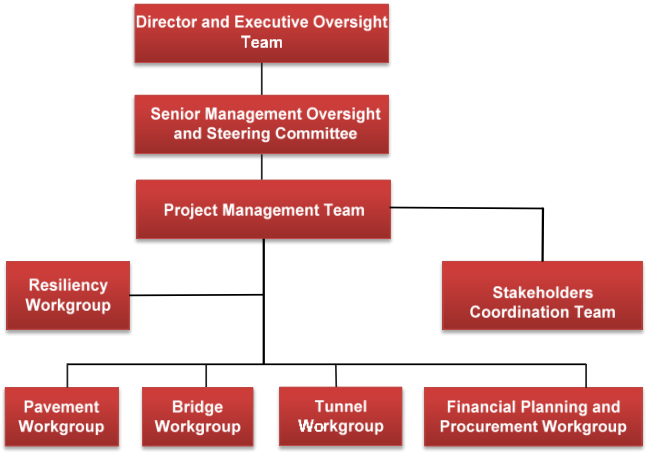


Figure 2-2. TAM Governance Structure.

The following sections describe the roles each functional component is expected to play to accomplish TAM objectives. DDOT has developed a comprehensive TAM Governance Document (Appendix A) as a standalone resource for staff involved in the TAM process. The Governance Document describes the teams' membership, roles, and responsibilities as they pertain to carrying out TAM activities and developing the TAMP. The membership includes Division Chiefs, Key Associate Directors, and representatives from multiple divisions within the current DDOT's organizational structure. This structure is meant to be living and functional with workgroups formed and disbanded as TAM maturity evolves. From this point forward, these groups are focused on the development of the final TAMP document.

The teams ensure that information in the TAMP is current and the processes used in generating the information are consistent with federal requirements.

Director and Executive Oversight Team

This team serves as the executive champions of TAM, providing strategic direction to the TAMP development process and making key decisions concerning the contents of the TAMP.

Senior Management Oversight and Steering Committee

This team acts as the advisory body to DDOT's TAM program, providing regular guidance to the Project Management Team on direction and technical matters.

Project Management Team

This team ensures that the TAMP project deliverables are on schedule and the TAMP stays current. The team is responsible for the delivery of the contents of the workgroups to produce an easy-to-follow TAMP product.

Asset Management Workgroups

Pavement Workgroup – Provides guidance on the technical analysis and contents related to pavement management for the TAMP. The key roles of this workgroup are to provide data, run analysis, and review sections of the TAMP.

Bridge Workgroup – Provides guidance on the technical analysis and contents related to bridge management for the TAMP. The key roles of the workgroup are to provide data, run analysis, and review sections of the TAMP.

Tunnel Workgroup – Provides guidance on the technical analysis and contents related to tunnel management for the TAMP. The key roles of the workgroup are to provide data, run analysis, and review sections of the TAMP.

Financial Planning and Procurement Workgroup – Provides guidance and supports the development of the Financial Plan and Investment Strategies. This workgroup also undertakes procurement planning activities to ensure smooth execution of TAMP projects.

Stakeholders Coordination Team – This team supports the coordination of all engagement and communication activities with key external stakeholders.

2.5 Engagement with External Stakeholders

DDOT owns and maintains most of the NHS transportation assets network within the District. A small portion of the roadways is managed by the National Park Service (NPS), a federal entity. Decisions on critical roads within the District consider inputs from key external stakeholders who own or manage portions of the transportation network. This process involves formal coordination and collaboration efforts among stakeholders to gather and share meaningful data and information to drive decisions and manage performance.

The key external stakeholders of the District's roadway network are the:

- Federal Highway Administration (FHWA) District of Columbia Division Office;
- FHWA (Eastern Federal Lands Highway Division - EFLHD);
- National Park Service;
- Metropolitan Washington Council of Governments (MWCOG); and
- The Architect of the Capitol (AOC).

To ensure that DDOT has the best available data to develop the TAMP, and to build a better relationship with stakeholders to promote a seamless, well-performing transportation system, DDOT engaged the external stakeholders to discuss the roles and needs for developing the TAMP.

In the past two years, DDOT has held several engagement activities through workshops and teleconferences with the external stakeholders. Follow-up communications to discuss and present the TAMP processes and results have continued and are expected to go on to help

improve decision making and resource allocations. For example, DDOT collaborated with MWCOG in setting performance targets such that the Department's performance targets align with regional goals and help to make progress towards achieving national performance goals.

Data Challenges

DDOT maintains a majority of asset inventory included in the TAMP. However, the fraction of assets maintained by key stakeholders such as the NPS and AOC may have differential impact on some of the analyses. Hence, access to stakeholders' quality and complete data on asset conditions, performance, and financial data is very critical. DDOT made several efforts to gather the necessary data from NPS and AOC. However, a few challenges have hindered DDOT's progress in acquiring complete data. For example, forecasted financial information is not readily available. Secondly, NPS uses different pavement metrics than DDOT, which were challenging to include in an overall network analysis. Also, information related to project planning was not readily available to enable DDOT to conduct performance analysis in order to project future asset performance. The percentage of AOC NHS inventory (less than 1%) is not significant enough to influence the analyses.

DDOT relied on the best available data to conduct the analyses, excluding pavement performance and financial data from NPS and AOC. To address these challenges, DDOT will continually meet with the stakeholders to update available information. To achieve the best value out of this process, DDOT has developed a memorandum of understanding (MOU) to capture the roles and responsibilities of the key stakeholders and the meeting requirements to support the process. DDOT will also develop a stakeholder communication plan building on the TAM governance structure developed as part of the TAM process.

2.6 The Role of the TAMP in Asset Management

TAM as defined is a collection of business and technical processes to make efficient use of available resources. The TAMP plays a central role in documenting these processes and results to serve as one source of information for stakeholders. DDOT's TAMP is a tactical, living document containing information about asset inventory, condition and performance, long-term investment strategies to address performance requirements and targets, and the business process to support risk management in a cost-efficient manner.

The TAMP supports DDOT's business practice by establishing performance targets and developing enhanced processes and programs to enable DDOT to manage customers' expectations within prevailing financial constraints. The TAMP serves as a single source of information for all internal and external stakeholders responsible for the management of the NHS and beyond, serving as a communication tool between technical and non-technical personnel.

Chapter 3 State of the System

3.1 Overview

Transportation asset management thrives on reliable and complete inventory and condition data. DDOT manages its assets by maintaining a comprehensive knowledge of the assets the Department owns as well as assets that contribute to the safe operation of the entire District's highway transportation system, including those owned or maintained by other entities. Understanding the inventory and condition of existing assets is critical to effective asset management and efficient resource utilization.

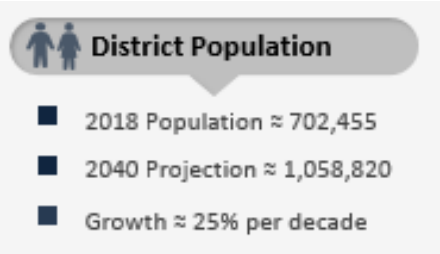
This chapter offers information on:

- **Infrastructure demand:** This section describes the past, present, and future demand for transportation infrastructure in the District.
- **Asset inventory:** This section contains the pavement, bridge, and tunnel asset inventory.
- **Asset condition:** This section describes pavement, bridge, and tunnel asset performance measures and condition trends.

3.2 Demand for Transportation Infrastructure

The economic vitality and recreational activities across the District depend on the safe and efficient movement of people, goods, and services within and beyond the District's jurisdiction. The location of the District makes the characteristics of the transportation system unique in demand and operations. For example, during the workweek, the daytime population of the District can reach one million with people originating from neighboring suburbs[4].

The 2018 estimated population for the District was 702,455[5]. This estimate represents a population growth of about 16.7 percent in the last eight years. The District is among the places in the United States expected to experience the fastest population growth in the next 20 years. Specifically, the population of the District is projected to grow by 25 percent each decade for the next two decades. The population in the District is expected to reach 1,058,820 by the year 2040[6]. Total employment



[4] District of Columbia Department of Transportation – FY2016 Highway Safety Plan
[5] US Census Bureau
[6] Metropolitan Washington Council of Governments (MWCOG) and http://statchatva.org/2016/05/11/national-population-projections/

growth was about 3.5 percent between 2014 and 2015. These growth numbers are indicative of the future challenges and demand on existing transportation systems.

Figure 3-1 shows a decade trend of vehicle miles traveled (VMT) in the District[7]. The trend indicates a steady decline in VMT between 2008 and 2014 of 2.2 percent during that period. The figure shows that in 2017, the VMT on the District's system stood at 3.7 billion, indicating a steady growth similar to the national trend in VMT since 2013. Since 2008, per capita VMT has fallen substantially due to multimodal transportation investments and economic conditions; however, the increase in aggregate VMT coupled with expected population and job growth in the District will put additional demand on the highway transportation infrastructure. The Department also deals with broader transportation demand challenges related to transit, bicycle infrastructure, and others. This TAMP deals mainly with highway (pavement and bridge) infrastructure demand, and they are accounted for in management systems when conducting analysis.

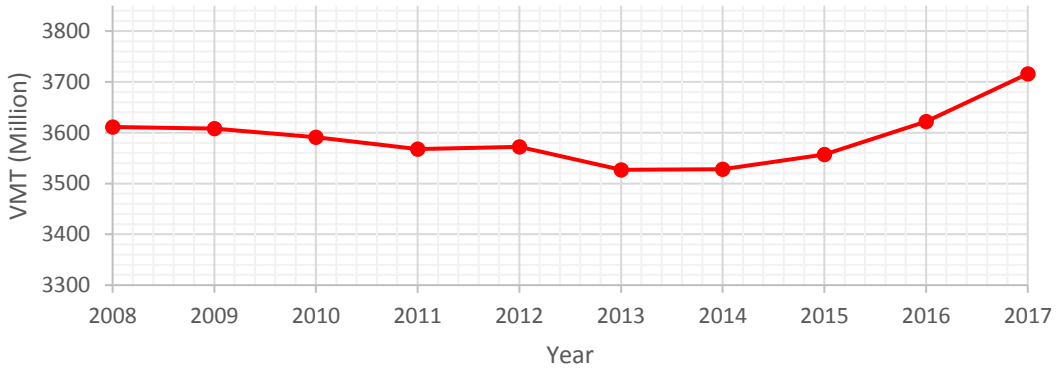
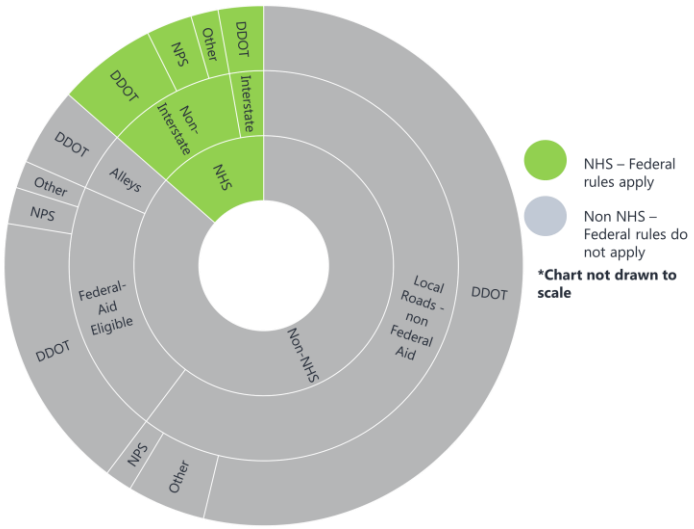


Figure 3-1. VMT in the District of Columbia.

3.3 Asset Inventory and Conditions

The District's highway transportation system consists of 1,150.1 centerline miles of pavements, 265 bridges, 17 tunnels, and other ancillary assets that are pertinent to the safe and efficient operation of the system. Effectively tracking and maintaining these assets



[7] FHWA Policy and Governmental Affairs Office of Highway Policy Information - Table VM-2

are essential to the achievement of the system's purpose. The scope of this TAMP covers pavement, bridge, and tunnel assets on the entire network, including NHS and non-NHS, irrespective of ownership of the asset.

The Department's asset inventory is categorized into Interstate and non-Interstate NHS making up the NHS, which is subject to federal requirements, and the non-NHS system, which is not required by the federal rules to be included in the TAMP. Ownership and maintenance responsibility of assets in each functional category is shared among DDOT, NPS, the AOC, and other federal and local agencies. These multijurisdictional ownership and maintenance responsibilities can offer opportunities for the key stakeholders to effectively and efficiently manage the assets through strategic, interorganizational collaboration. Specifically, the TAMP can improve communication among the key stakeholders, help eliminate duplicate efforts by leveraging individual capabilities, and support risk management.

On the other hand, the multiple ownership and maintenance of the transportation system can present challenges that can impact the development of the TAMP and achievement of network performance targets. For example, multiple ownership means multiple datasets that could present gaps in inventory and condition analysis. In addition, each entity is autonomous and may have different priorities, which may not align with DDOT's priorities for the TAMP and can influence the way resources are allocated to achieve national performance goals.

3.4 Pavement

Pavement Asset Register

DDOT owns 1,018.3 out of the 1,150.1 miles of pavement, representing approximately 90 percent of the entire pavement inventory in the District of Columbia. The inventory contains three pavement surface types. Asphalt (AC) and Composite pavements make up over 95 percent of the inventory with Portland Concrete Cement (PCC) pavements making up less than five percent. The pavement inventory is not expected to experience a significant increase in the next decade.

As indicated, DDOT is responsible for the maintenance of the entire Interstate system. Maintenance responsibility for the Non-Interstate NHS pavements is shared between DDOT, NPS, and other federal and local agencies. The non-NHS inventory (897.2 centerline miles) represents a significant portion of the entire District's network, making it critical for DDOT to manage them strategically. Approximately 300 centerline miles of the non-NHS pavements are eligible for Federal-aid, bringing the Federal-aid eligible highways on the District's network to 426.3 centerline miles, including the NHS.

Table 3-1 shows that NHS pavement is 134 centerline miles (583 lane-miles[8]), representing 11.7 percent of the entire system. DDOT maintains 90 percent of the NHS.

[8] Highway Statistics Table HM-48

The Interstate system is 11.8 centerline-miles (73 lane-miles[5]), representing about 13 percent of the total NHS lane-miles and two percent of the entire network. Although the Interstate system constitutes only one percent of the network, it carries about 13 percent of the VMT annually.

Table 3-1. Pavement Inventory and Ownership.

Pavement Categories		DDOT		NPS		Others*	
		Miles	%	Miles	%	Miles	%
NHS	Interstates	11.8	100%	0.0	0%	0.0	0%
	Non-Interstates	109.3	89%	11.8	10%	1.2	1%
	Subtotal NHS	**121.1**		**11.8**		**1.2**	
	Total NHS	**134.1**					
Non-NHS	Federal-Aid Roads	305.2	96%	9.7	3%	4.4	1%
	Local Roads	592.0	85.0%	18.7	2.7%	86.0	12.3%
	Subtotal Non-NHS	**897.2**		**28.4**		**90.4**	
	Total Non-NHS	**1016**					
System (NHS and Non-NHS) Subtotal		**1,018.3**		**40.2**		**91.6**	
System (NHS and Non-NHS) Total		**1,150.1**					

* includes other federal and local agencies including AOC, WMATA and Military Reservations.

Pavement Data Collection and Management System

DDOT's pavement data collection practices are in accordance with the National Highway Performance Program (NHPP) (23 USC 119) and Federal rule 23 CFR Part 490 (Subpart C) reporting requirements. DDOT gathers data annually for the entire highway system including federal and local roads, irrespective of ownership and maintenance responsibility, using state-of-the-art imaging technology to gather pavement condition data. The data collected includes pavement distresses mandated under the NHPP: International Roughness Index (IRI), cracking, rutting, and faulting. However, the effective date for reporting data elements beyond IRI for Non-Interstate NHS is not until 2021. DDOT will continue to gather these data elements to inform decision making in future TAMPs.

The District continues to improve on data quality, since variability in pavement rating has a significant impact on the quality of condition data. DDOT has a pavement management system (PMS) in place to evaluate the impact of budget on network-level performance. The system allows DDOT to rate roadway condition using Pavement Condition Index (PCI), analyze pavement distress, recommend appropriate pavement treatment types, plan projects, and prioritize work. DDOT continues to assess and prioritize enhancement developments to improve data quality programs and the performance predictions capabilities of existing management systems to address 23 CFR 515.17 requirements and to support resource allocation.

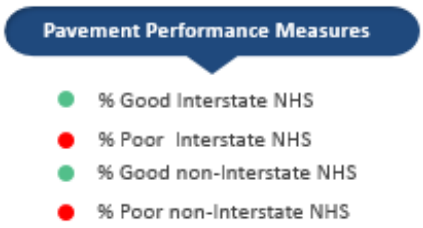
Table 3-2 contains the minimum requirements stipulated by 23 CFR 515.17, current capabilities of DDOT pavement management system, and needed enhancements. DDOT envisions these enhancements to be completed in the next two years.

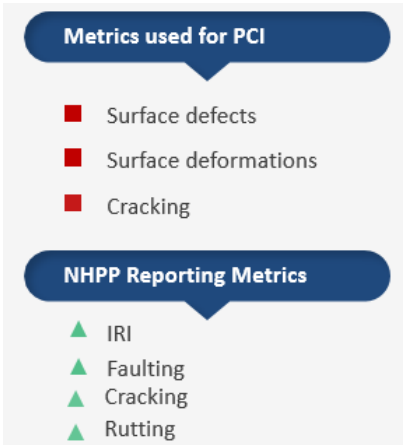
Table 3-2. Pavement Management System Requirements and Needed Enhancements.

23 CFR 515.17 Requirements	MicroPAVER Capabilities	Needed Enhancement
Collect, process, store, and update inventory and condition data for all NHS pavement assets.	🟢	Integrate pavement management system with maintenance and financial systems.
Forecast deterioration for all NHS pavement assets.	🟡	Develop and implement deterioration models using FHWA metrics.
Determine the benefit-cost over the life cycle of assets to evaluate alternative actions, for managing the condition of NHS pavements.	🔴	Acquire new management modules capable of addressing this requirement.
Identify short- and long-term budget needs for managing the condition of all NHS pavement assets.	🟡	Incorporate FHWA performance metrics in estimating and identifying budget needs.
Determine the strategies for identifying potential NHS pavement projects that maximize overall program benefits with the financial constraints.	🟡	Improve analytical capabilities of system to maximize benefits, considering FHWA metrics and financial constraints.
Recommend programs and implementation schedules to manage the condition of NHS pavement assets within policy and budget constraints.	🟡	Incorporate FHWA performance metrics in recommending programs to manage NHS pavement assets.
Capabilities Key: Fully meets the requirement 🟢 Partially meets the requirement 🟡 Does not meet the requirement 🔴		

Pavement Performance Measures and Targets

Subpart C of the Federal rule 23 CFR 490 specifies four pavement performance measures, including the percentage of Interstate and Non-Interstate NHS pavements in “Good” and “Poor” conditions. These measures are to be based on the combination of IRI, rutting, cracking percent, and faulting (for concrete pavements). Subpart C of the Federal rule 23 CFR 490 specifies four pavement performance measures, including the percentage of Interstate and Non-Interstate NHS pavements in “Good” and “Poor” conditions. These measures are to be based on the combination of IRI, rutting, cracking percent, and faulting (for concrete pavements).





Prior to the TAM rules, DDOT used PCI to assess and rate pavement conditions, as well as to drive network budgeting, planning, and project prioritization decisions. The Department continues to use PCI to support decision making while conducting the required analyses to respond to the federal measures. PCI uses metrics such as surface defects, surface deformations, and cracking percent to rate the pavement condition. Like the NHPP performance measures, PCI combines several condition metrics. However, PCI uses a mathematical formula and a weighting system to compute a composite value (between 0 and 100) indicating the condition of the pavement. The NHPP rating system combines all the metrics based on established thresholds to assess the pavement condition. The pavement condition metric thresholds used under the NHPP requirements are presented in Appendix B.

As IRI is not a good representation of roadway conditions in an urban environment, and as recommended by FHWA, DDOT estimated PCI to rate NHS pavements with speed limit below 40mph. In future data collection efforts, DDOT will gather Present Serviceability Rating (PSR) in the field to improve reporting capabilities. For this TAMP, DDOT will report performance using IRI and PCI to draw linkages between the performance metrics DDOT uses (PCI) and the federal metrics (IRI), to understand their effect on overall network-level performance outcome.

On the other hand, NPS uses different performance metrics, namely Pavement Condition Rating (PCR), to assess pavement conditions. PCR is similar to PCI in terms of scaling. It takes on the values of zero to 100, with a score of 100 ranked as perfect condition. This added complication makes it challenging to establish overall NHS asset conditions when stakeholders rely on different business processes in making investment decisions.

Table 3-3 shows the crosswalk between ratings required by Federal rule 23 CFR Part 490 Subpart C, and DDOT measures.

Table 3-3. DDOT Pavement Ratings Crosswalk Table.

Pavement Performance Category	IRI (inches/mile)	PCI (0-100 value)	PSR (0.0-5.0 value)	Performance Measures
Good	< 95	PCI ≥ 71	PSR ≥ 4.0	Percentage of lane-miles in "Good" condition
Poor	>170	PCI ≤ 55	PSR ≤ 2.0	Percentage of lane-miles in "Poor" condition

Pavement Baseline Conditions

Figure 3-2 shows the baseline (2018) conditions for DDOT-owned pavement categories based on three performance metrics. Figure 3-3 shows similar illustration with NPS- and AOC-owned NHS pavements. As expected, the metrics are different, resulting in dissimilar outcome in terms of percentage good and poor pavements. The figure shows that the pavements perform poorly when overall performance is based solely on IRI whereas performance is improved when PCI is used. Reporting with different metrics is challenging, requiring owners and asset managers to explain the differences in outcome.

Interstate Pavement Minimum Condition Requirement:

% Poor Interstate Lane-miles ≤ 5%

Interstate NHS Pavement Existing Condition (PCI):

% Good = 78.8

% Poor = 3.8

Interstate NHS Pavement Existing Condition (IRI):

% Good = 7.7

% Poor = 49.9

The Federal rules 23 CFR 490.315 and 23 CFR 490.317 require all State DOTs to meet a minimum condition requirement for Interstate pavements. That is, the total lane miles of Interstate pavements in poor condition cannot exceed 5%. If DDOT fails to achieve this minimum condition for the most recent year, the Department will be required to obligate NHPP funds or transfer funds from the Surface Transportation Program (STP) to NHPP to address Interstate pavement condition. It is important to mention that this minimum threshold is based on a combination of all the federal metrics—IRI, Faulting, percent cracking, and rutting. The existing conditions show that DDOT achieves and exceeds this minimum condition when PCI is used but is in default if the assessment is based on IRI. Beginning January 2021 and in accordance with FHWA requirements, DDOT will be reporting network performance using the combined metrics promulgated by the rules. DDOT expects to achieve this minimum condition using the combined federal metrics.

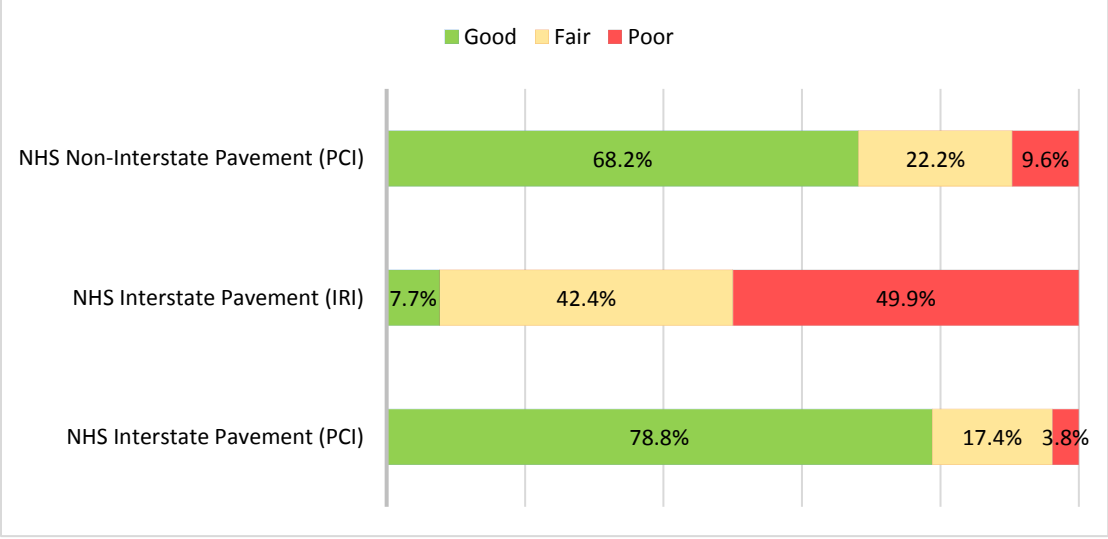


Figure 3-2. DDOT NHS Pavement Baseline (2018) Conditions.

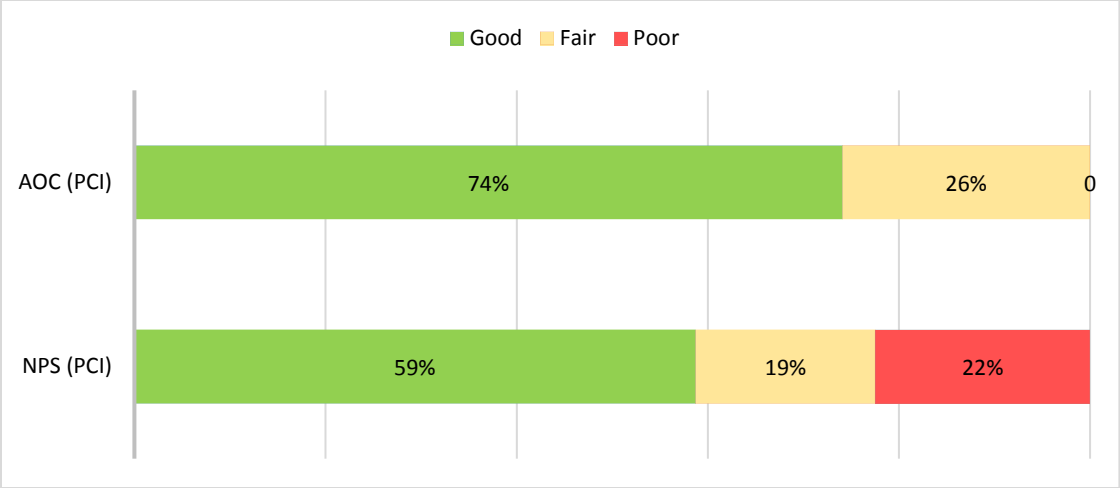


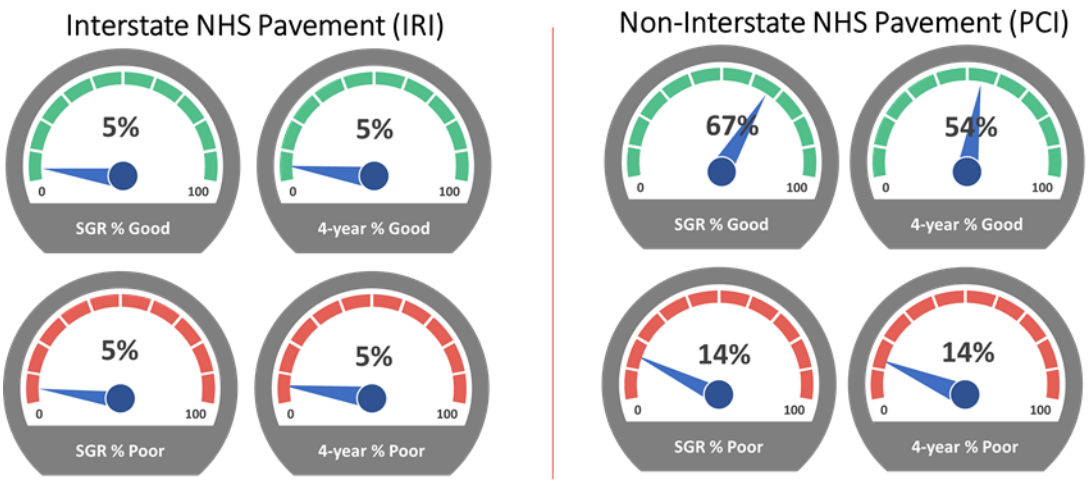
Figure 3-3. NPS and AOC NHS Pavement Baseline (2018) Conditions.

Pavement Performance Targets

DDOT is required to establish and report performance targets for the NHS pavements while meeting a minimum condition requirement for Interstate pavements. Pavement performance targets include 2- and 4-year targets to guide investment decisions and to enable DDOT to make progress towards achieving the national goals. Throughout the TAMP development process, DDOT coordinated with and engaged key external stakeholders of the NHS, such as NPS, AOC, and MWCOG, to establish asset performance targets. The initial performance targets were established in May 2018 and reported to FHWA in October 2018. These targets are based on IRI and PCI for Interstate NHS and non-Interstate NHS pavements, respectively.

The infographics below show DDOT pavement performance targets. As indicated, the targets suggest a decline in network performance. DDOT acknowledges that a declining system may not always be the best strategy. However, to address the risk of losing performance on the Interstate due to financial constraints and managing customer expectations, DDOT makes difficult decisions, including accepting reasonable decline on low-risk roadways. Thus, establishing these targets. The 4-year target shows increase in Poor non-interstate NHS from approximately 10% to 14% because DDOT focuses resources towards NHS Interstates to meet the minimum federal requirements. Other risk factors that may contribute to this decline include high cost of implementing preservation on urban arterials (i.e., all of the non-Interstates NHS), the poor rating of roadways sections because of utility work and development projects in the city, and uncertainty in the PSR values.

The asset workgroups, in consultation with key stakeholders, will continue to review and revise these targets as more performance information become available.



DDOT also ensures that the rest of the non-NHS roadway network (i.e., the non-NHS federal-aid and local roads) is in good condition, to minimize performance decline and the risk of system failure, since most travel in the District occurs on these road classes. The non-NHS federal-aid and local roads are not subject to federal requirements; however, the application of good practice asset management can enable DDOT optimize available resources and performance. Figure 3-4 shows the baseline conditions of these pavement categories.

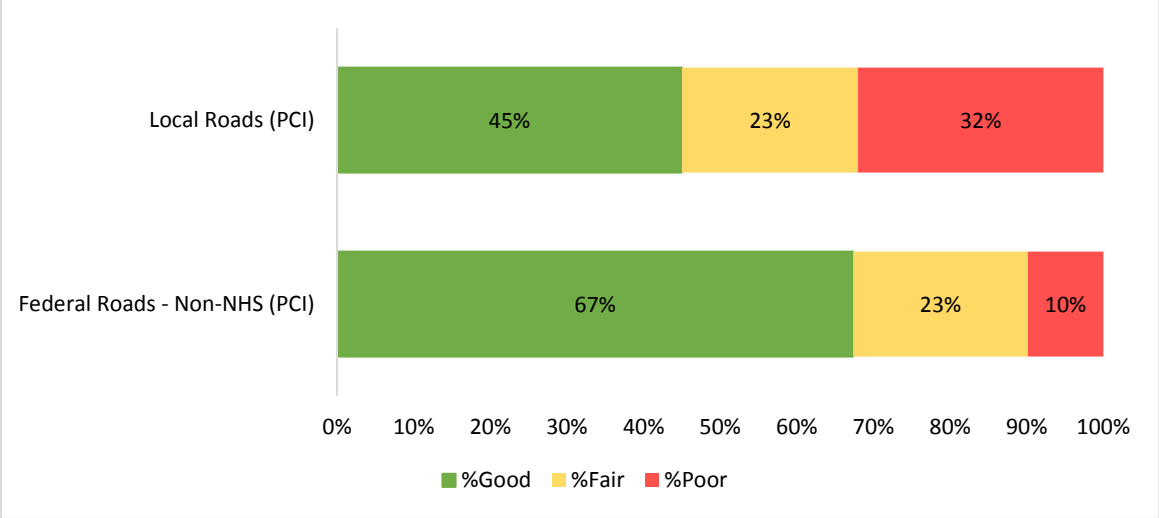


Figure 3-4. DDOT Non-NHS Pavement Baseline (2018) Conditions.

3.5 Bridges

Bridge Asset Register

DDOT's bridge inventory includes all DDOT-owned bridges as well as non-DDOT bridges that pass over the District's roadways. The non-DDOT bridges included in the bridge inventory consist of NPS and railroad bridges. DDOT keeps limited information on non-DDOT bridges as part of the inventory. DDOT is only responsible for maintaining the

bridges DDOT owns. Out of the 265 bridges on the District of Columbia network, DDOT is responsible for 208 highway bridges and 24 pedestrian bridges.

DDOT maintains over 90 percent deck area, including NHS and non-NHS bridges of this inventory (approximately 6 million sq. ft.), while NPS manages less than 10 percent of the inventory. The total NHS (including Interstate and non-Interstate) bridge deck area is about 4.8 million square feet, representing 76 percent of the entire bridge inventory. Table 3-4 contains the bridge inventory by classification and maintenance responsibility.

Table 3-4. Inventory of Bridge Deck Area by Maintenance Responsibility.

Bridge Categories		Number of Bridges	Bridge Deck Area, (sq. ft.)
NHS	DDOT	132	4,531,202
	NPS	12	351,510
	Subtotal	**144**	**4,882,712**
Non-NHS	DDOT	76	1,147,829
	NPS	21	173,716
	DDOT Pedestrian Bridges	24	93, 093
	Subtotal of Non-NHS	**121**	**1,414,638**
Total Bridge Inventory		**265**	**6,297,350**

Figure 3-5 shows a decade trend of bridge inventory, including pedestrian bridges (in deck area). The District's NHS bridge inventory has grown between 2012 and 2015 even though the inventory of DDOT-maintained bridges has been steady in the past decade. The growth in NHS bridge inventory since 2012 is a result of the reclassification of the NHS and DDOT's efforts to upgrade existing NHS bridges. DDOT expects the bridge deck area in the District's inventory to grow slightly in the next few years as major bridge projects are completed. An example of such major bridge projects is the replacement of the Frederick Douglass Memorial Bridge by the year 2022, which will increase the bridge's deck area.

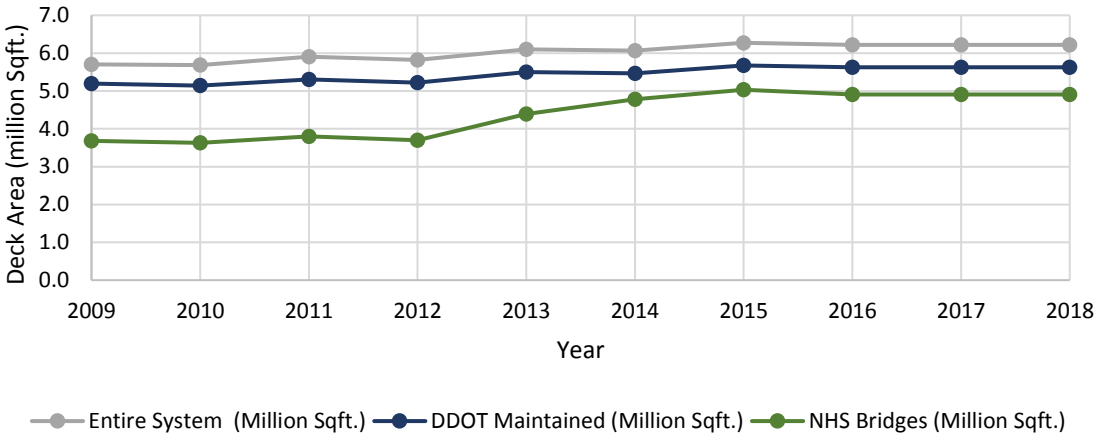


Figure 3-5. Bridge Deck Area Inventory Trend.

Bridge Data Collection and Management System

DDOT has in place a Bridge Management System (BMS) to inventory all highway and pedestrian bridges on the District's network, including federal and local bridges. In addition, the District gathers limited information, such as vertical and horizontal clearances, on railroads and NPS bridges that cross over the District's roadways. DDOT gathers bridge condition data on a biennial schedule based on element-level condition assessment. The inspection cycle becomes more frequent for bridges identified to have critical issues, such as bridges classified as poor. Poor bridges are bridges with any component (deck, superstructure, substructure, and culvert) with an NBI condition rating less than or equal to four. NBI condition rating scale goes from zero to nine, with nine being the excellent condition and zero representing failed condition. The inspection frequency depends on the criticality of the identified issue and is based on the specified recommendations made by DDOT engineers. DDOT inspects bridges using the specifications of the National Bridge Inspection Standards (NBIS).

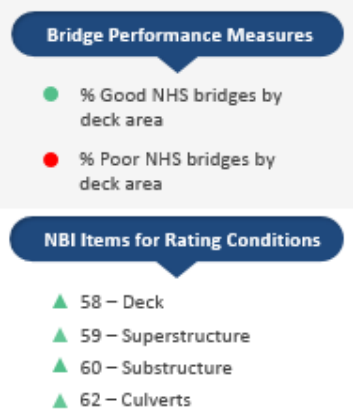
DDOT is working to enhance existing management systems in order to improve the modeling capabilities so they can leverage the element-level condition data and maintenance information stored in the system. The enhancement actions planned in the next two years is indicated in the Table 3-5 below and will improve efficiency in decision making and support effective lifecycle planning.

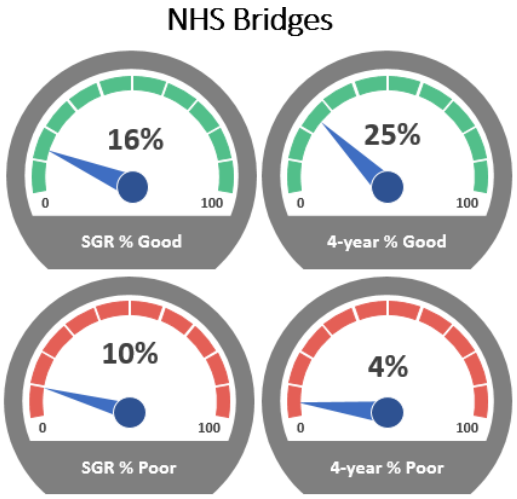
Table 3-5. Bridge Management System Requirements and Needed Enhancements.

23 CFR 515.17 Requirements	MicroPAVER Capabilities	Needed Enhancement
Collect, process, store, and update inventory and condition data for all NHS pavement assets.	●	Integrate pavement management system with maintenance and financial systems.
Forecast deterioration for all NHS pavement assets.	●	Develop and implement deterioration models using FHWA metrics.
Determine the benefit-cost over the life cycle of assets to evaluate alternative actions, for managing the condition of NHS pavements.	●	Acquire new management modules to improve the analytical capabilities.
Identify short- and long-term budget needs for managing the condition of all NHS pavement assets.	●	Incorporate FHWA performance metrics in estimating and identifying budget needs.
Determine the strategies for identifying potential NHS pavement projects that maximize overall program benefits with the financial constraints.	●	Improve analytical capabilities of system to maximize benefits, considering FHWA metrics and financial constraints.
Recommend programs and implementation schedules to manage the condition of NHS pavement assets within policy and budget constraints.	●	Incorporate FHWA performance metrics in recommending programs to manage NHS pavement assets.
Capabilities Key: Fully meets the requirement ● Partially meets the requirement ● Does not meet the requirement		

Bridge Performance Measures and Targets

The Federal rules promulgate two performance measures for State DOTs to use to assess bridge condition. The measures include the percentage of NHS bridges classified to be in "Good" condition and the percentage of NHS bridges classified to be in "Poor" condition. These measures are based on deck area of bridge inventory, and they apply to bridges carrying the NHS, including bridges connecting on- and off-ramps to the NHS. The bridge's condition ratings are based on four NBI items—deck, superstructure, substructure, and culverts.





On the other hand, NPS uses different performance metrics—namely the Bridge Health Index (BHI)—in assessing the condition of their bridges. BHI values range between 0% and 100% and are based on bridge structural condition, erosion around bridge piers and abutments, and the rate

of deterioration[9]. This added complication makes it challenging to establish overall NHS asset conditions and common performance targets to guide investment decisions.

DDOT is required to establish and report performance targets for its Interstate and Non-Interstate NHS bridges. The performance targets include 2- and 4-year targets to guide investment decisions. In May 2018, DDOT engaged the key stakeholders of the NHS to establish these targets. DDOT will continue to collaborate with MWCOG and the NPS to refine or adjust the targets as more performance data become available through reporting.

Bridge Baseline Conditions

DDOT's bridge performance assessment aligns with the federal requirements. Specifically, DDOT uses both bridge component and bridge element condition data to establish bridge condition. Based on these metrics, the percent of deck area on DDOT-owned NHS bridges classified as poor is less than one percent (i.e., 0.7%) of the total NHS inventory maintained by DDOT. However, with the inclusion of non-DDOT NHS bridges, the deck area of poor NHS bridges increases to 4.8%. The differences in these outcomes indicate that most of the poor NHS bridge deck area is contained in external stakeholders' bridge inventory.

In addition to the performance target requirement, DDOT is expected to meet a minimum condition requirement for NHS bridges; that is the percentage deck area of poor NHS bridges cannot exceed 10% of the total NHS bridge deck area. If this minimum requirement is not met for three consecutive years, DDOT will be required to obligate and set aside NHPP funds for eligible projects on bridges on the NHS to address the deficiency.

Figures 3-6 shows the baseline (2018) condition of NHS and non-NHS DDOT-maintained and NPS-maintained bridges. DDOT and NPS continue to make strategic investments in bridges to maintain or see additional decline in the number of Poor bridges. As mentioned earlier, there are several on-going major bridge projects that when completed will reduce the deck area of bridges classified as poor condition. This is indicated in the established performance targets. One such investment is the rehabilitation of the Arlington Memorial Bridge. The rehabilitation of this NPS-maintained bridge will have significant impact on the achievement of bridge performance target in the District. This project is expected to be completed in 2020. Upon its completion, this project will add an additional two

[9] National Capital Region Long Range Transportation Plan 2018

hundred thousand square feet of bridge deck area classified as "Good" to the NHS bridge inventory[10].

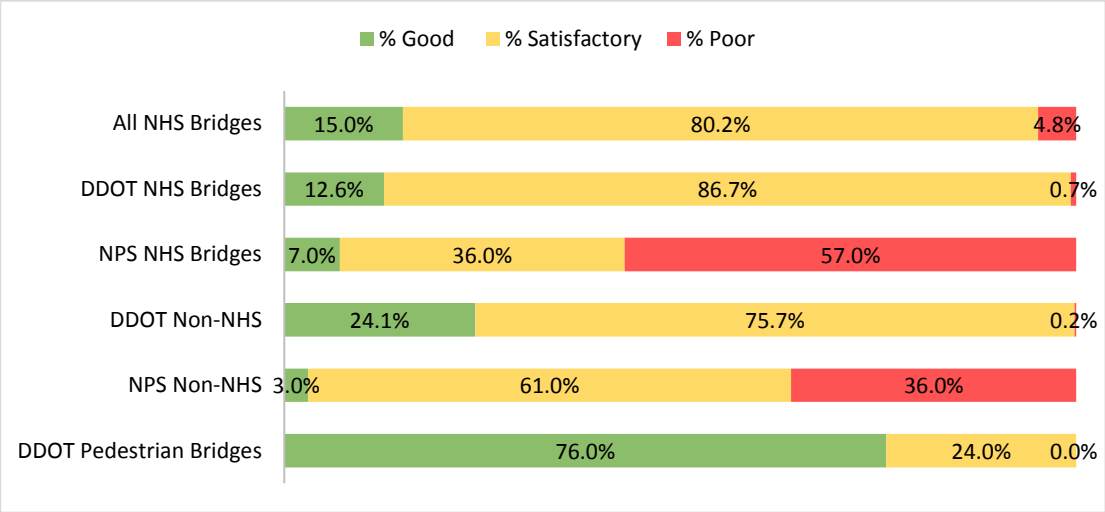


Figure 3-6. Baseline (2018) Condition for Bridges on the District's Network.

3.6 Tunnels*

Tunnel Asset Register

The National Tunnel Inspection Standards (NTIS) defines a tunnel as: "an enclosed roadway for motor vehicle traffic with vehicle access limited to portals, regardless of type of structure or method of construction, that requires, based on the owner's determination, special design considerations to include lighting, ventilation, fire protection systems, and emergency egress capacity. The term "tunnel" does not include bridges or culverts inspected under the National Bridge Inspection Standards (NBIS) (23 CFR 650 Subpart C - NBIS)." DDOT owns and maintains 15 of the 17 vehicular tunnels on the District's transportation network that are subject to the federal requirements stipulated in 23 CFR 650 Subpart E of the federal rules. NPS is responsible for the remaining two tunnels. The federal rules require tunnel owners to establish a highway tunnel inspection program, maintain a tunnel inventory, and report to FHWA inspection results and critical findings, which include structural or safety-related deficiencies that require immediate follow-up inspection or action. Although not a requirement for the TAMP, DDOT finds tunnels to be critical to the operation of the District's network, hence their inclusion in the TAMP.

*It should be noted that this is a starting point for tunnels and should not be considered for this TAMP

[10] https://flh.fhwa.dot.gov/projects/dc/amb/

Tunnel Data Collection and Management System

DDOT is one of the first DOTs to institute a formal Tunnel Management System (TMS) in the United States[11]. Under an FHWA pilot project, DDOT implemented a TMS in 2003 to help the District manage its tunnels. Currently, DDOT gathers and maintains tunnel data on DDOT-owned tunnels within the District's transportation network through a biennial inspection schedule. The inspection procedures enable DDOT to make informed management decisions, avoid costly repairs in the long term, and successfully operate the transportation system.

DDOT's inspection standards meet or exceed those stipulated in the NTIS regulation 23 CFR 650 Subpart E and are in accordance with the Tunnel Operations, Maintenance, Inspection, and Evaluation (TOMIE) Manual and the Standards for National Tunnel Inspection (SNTI). DDOT uses these standards to gather comprehensive data on operating systems for tunnels regarding structural, civil, and functional integrity. The functional systems DDOT inspects include mechanical systems, electrical systems, lighting systems, fire life safety and security systems, and signs and protective systems. DDOT manages and documents all tunnel maintenance activities using a system called SABER Tunnel Maintenance Management System (TMMS) and collects NTIS information using AASHTO's BrM.

Tunnel Performance Measures and Targets

Since 2005, DDOT has used a data-driven, performance-based contracting method to preserve and improve upon the maintenance of tunnel assets. This practice is consistent with the performance-based approach required by the Federal rules for tunnels (23 CFR 650 Subpart E). The performance-based contract includes the development of a quarterly report of asset conditions detailing the condition score of the features inspected for each tunnel facility. DDOT classifies tunnel assets into 18 categories, including tunnels, tunnel support spaces, tunnel air plenums, ventilation shafts, etc. Each asset category is grouped under one of the following systems: structural, mechanical, lighting, or electrical.

The performance of each asset category is tracked with one or more elements. The elements are physical/structural, cleanliness, and operational, for which deficiencies would require an intervention for the safe operation of a tunnel. For example, given an asset category, tunnel drainage system, DDOT tracks performance with the piping and inlets element using defined performance measures. DDOT uses 81 performance measures in evaluating asset conditions for all 18 asset classes defined for tunnels.

Each performance measure is assessed at five levels ranging from Level 5 (excellent condition) to Level 1 (unsatisfactory condition) for deficiencies (for a sample list of tunnel asset categories, tracking elements, and performance measures, see Appendix C).

[11]https://www.fhwa.dot.gov/publications/focus/05may/01.cfm

Deficiencies found during inspection are corrected within a day to 60 days, depending on the criticality level. On a quarterly cycle, DDOT evaluates the performance of the tunnel contract holder to ensure that critical performance measures and performance targets are met. DDOT uses these quarterly reports to produce an annual report, which documents DDOT's progress to achieve performance standards and adherence to established performance targets.

Tunnel Baseline Conditions

As noted in the previous paragraphs, DDOT currently uses five condition states in evaluating tunnel performance. However, the SNTI defines four condition states to use in tracking tunnel conditions. DDOT will transition into this reporting format once the major ongoing initiatives are completed.

SNTI Tunnel Condition State Definitions

- **Condition State (CS) 1**: Good condition - no notable distress
- **Condition State (CS) 2**: Fair condition - isolated breakdowns or deterioration
- **Condition State (CS) 3**: Poor condition - widespread deterioration or breakdowns without reducing load capacity
- **Condition State (CS) 4**: Severe condition - warrants structural review to determine the effect on strength or serviceability of the element or tunnel, OR a structural review has been completed and the defects impact strength and serviceability of the element or tunnel

Figure 3-7 shows the baseline conditions for tunnels using two NBI components, superstructure and substructure, in evaluating the overall condition of tunnels.

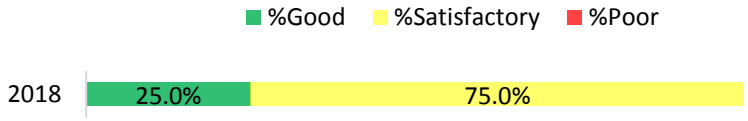


Figure 3-7. NBI Condition Rating of DDOT Tunnels.

Chapter 4 Financial Planning

4.1 Overview

This chapter provides information about the sources and uses of funds related to DDOT's highway assets covered in this TAMP. Specifically, this chapter describes the following:

- **Sources of funds**: This section describes DDOT's **funding process** and the respective **funding sources** for asset management programs.
- **Uses of funds:** This section describes how DDOT **uses funds** in maintaining, preserving, and operating asset categories on the District's network.
- **Estimated cost and projected revenue levels:** This section describes the **estimated cost** to achieve DDOT's and national TAM goals and the **projected funding** expected to be available for the duration of the TAMP.
- **Asset valuation:** This section contains the process DDOT uses to estimate highway **asset value**.

4.2 Sources of Funds

Funding Process

The District's Statewide Transportation Improvement Program (STIP) describes the process through which stakeholders develop and fund surface transportation projects in the District. The four transportation agencies within the District responsible for developing the STIP and regional Transportation Improvement Program (TIP) projects include DDOT, EFLHD, the Washington Metropolitan Area Transit Authority (WMATA), and the National Capital Region Transportation Planning Board (TPB). Each agency uses specific internal procedures to determine which projects receive funding for the duration of the STIP through a network-level analysis. DDOT updates the STIP regularly to reflect new federally funded projects. The information in the STIP and TIP provides good background information for the financial analysis and lifecycle planning process for the TAMP.

DDOT holds an annual call for projects from all divisions within the Department, including the Maintenance Division and the Infrastructure Project Management Division (IPMD), to identify existing and new projects that require funding. The Maintenance Division is made up of four branches, one of which is the Asset Management Division (AMD), which is responsible for the SGR of transportation infrastructure. The AMD identifies asset maintenance and preservation needs that support the achievement of program, District, and national goals to be included in the District's STIP for funding.

If a project requires major rehabilitation work, it is escalated for further planning, coordination, and approval. These projects serve as the basis to include in the regional

TIP and the District STIP, fiscally constrained documents. These documents identify federally funded projects as well as projects funded with local capital or private funds that are regionally significant.

The District of Columbia develops a 6-year Capital Improvements Program (CIP) for all fixed assets owned by all local agencies in the District, including highway assets. The CIP is a capital budget developed and updated annually by the Mayor, with approval by the City Council and ultimate approval by the United States Congress. The CIP includes transportation projects that use local funds. The proposed CIP for FY2019–FY2024 includes $44.6 million expenditures in FY2019 for local streets rehabilitation and other bridge improvement projects.

Funding Sources

Funding for DDOT's investment programs for Asset Management comes from two primary sources: The Federal Highway Administration and the local GO Bonds and Revenues. Other external sources include NPS and AOC funding, which are not administered by DDOT but can have a noticeable impact on system performance.

Like all State DOTs, DDOT receives its share of the Federal Highway Trust Fund (HTF) based on annual Federal appropriations. DDOT's CIP funding is appropriated annually. The Mayor's Office develops and submits the budget based on the City's needs and the City Council holds public hearings to either approve or amend the Mayor's annual budget.

Figure 4-1 shows the total DDOT revenue and contribution of each funding source for FY2018. The figure shows that the HTF (local match to FHWA) and FHWA formula allocation represent about 45 percent of the revenue sources. The remaining 55 percent comes from local sources including bonds.

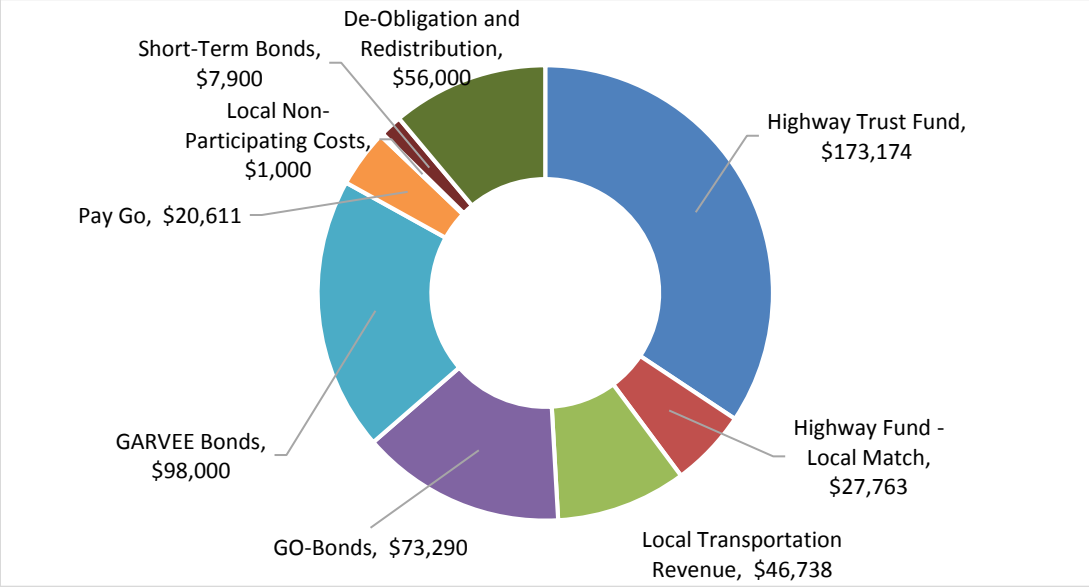


Figure 4-1. Total Federal and Local Revenue by Sources for FY2018.

The following subsections describe DDOT's highway funding categories and their key sources:

Highway Trust Fund

The HTF has two primary sources. The most significant portion of the HTF comes from federal grants. The remaining part comes from the District's HTF to match the federal grant. The HTF is funded through federal and local taxes on fuels, taxes on truck users, and interest on invested balances. This fund is primarily used for projects that qualify for federal aid funding.

In addition, the District receives an allotment of funding, "August Redistribution," which is a non-static amount that must be obligated before the end of the 4th quarter of the fiscal year (FY).

Through active portfolio management, the District is able to leverage obligation limitation budget from projects that have been withdrawn, de-obligated, or closed but have unspent balances that can be used to fund new projects during the FY.

Outside of the traditional formula obligation limitation, the District also receives "other" funding. These funding sources include but are not limited to small scale annual grants DDOT applies to FHWA in the areas of Disadvantaged Business Enterprise (DBE), On the Job Training (OJT), and process innovation, directed obligation pass throughs in which the District is merely obligating funds to transfer directly to other agencies at FHWA's mandate. In past years there has also been substantial earmarked funding for Frederick Douglass Memorial Bridge, Metropolitan Branch Trail, and the US General Services Administration-funded I-295/Malcolm X Interchange project.

Local Fund

Local funds available for use to construct, maintain, and operate highway assets come from a variety of sources and are primarily used to fund local projects including but not limited to pavements, bridges, and tunnels. The principal sources of this fund include consistent and one-time sources. The District budget book contains a comprehensive description of the primary sources of the local fund.

Other Funds

NPS, EFL, and AOC have jurisdiction of some NHS routes in the District of Columbia with their own dedicated funding sources. DDOT does not have management and administrative control over these assets and funding. However, use of funds and maintenance of the assets by those agencies can impact the overall performance of the NHS network. An example is the rehabilitation of the George Washington Memorial Parkway Bridge (Arlington Memorial Bridge). EFL has identified $150 million in the FY

2018 – 2021 TIP to maintain this asset[12]. When completed, this project is expected to improve NHS bridge performance significantly in the District. NPS must competitively apply for funding through the Federal Lands Transportation Program or other similar programs. This rest of the analysis included in the financial planning chapter reflects only DDOT dedicated funding sources and uses.

4.3 Uses of Funds

Primarily, DDOT has two expenditure categories that impact the performance of pavement, bridges, and tunnels directly: Preservation and Maintenance Investments and Capital Improvement Investments. DDOT also manages other expenditure categories that have indirect performance effects on roadway, bridge, and tunnel conditions and network operation. They include programs such as education and safety for the safe operation of the system, bicycle/pedestrian programs to improve mobility, streetscape/public space programs to improve modal choice and quality of public spaces, and planning/programming/fiscal/administrative programs to support planning studies and others.

Preservation and Maintenance Program

DDOT pursues a variety of work types on pavements, bridges, and tunnels to preserve asset condition and to extend their useful life. These investments enable DDOT to make progress towards achieving performance targets and attaining SGR. Work types within this investment category for pavements include maintenance (pothole filling), preservation (slurry seal, overlay, joint replacement, and sealing), localized reconstruction, and surface rehabilitation that is not included in Capital Infrastructure investments. Examples of work types for bridges within this investment category for maintenance, preservation, and reconstruction include deck overlay, deck washing, deck seal, beam painting, deck patching, etc. Table 4-1 contains DDOT's actual 6-year historical investments in preservation and maintenance programs.

Table 4-1. Summary of Historical Investments in Preservation and Maintenance Program.

Asset Class	Preservation and Maintenance Investments ($000)					
	FY13	FY14	FY15	FY16	FY17	FY18
	39,008	**39,150**	**51,737**	**53,086**	**64,258**	**70,420**
NHS Roads	3,624	8,125	5,101	9,853	17,709	12,993
Bridges*	8,418	8,269	7,088	2,450	3,648	8,343
Tunnels	4,263	3,625	7,569	4,468	4,962	5,102
Federal Roads - Non-NHS**	14,743	16,623	20,880	16,920	3,899	9,468
Local Roads	7,959	2,508	11,099	19,394	34,040	32,917

*Includes NHS and Non-NHS Highway bridges. ***DDOT-maintained non-NHS roadways eligible for Federal-aid.*

[12] FY2018-FY2021 Transportation Improvement Program, FHWA, EFLHD

Capital Improvement Investments

Capital improvement investments include mega/special multimodal projects (projects spanning more than one FY) such as the Frederick Douglass Memorial Bridge, 11th Street SE, and Key Bridge projects. These multimodal investments target highway and non-highway assets such as bicycle lanes and pedestrian facilities. Capital projects can impact asset performance when major rehabilitation and reconstructions of bridges eliminate poor bridges. Also, some capital projects could add to DDOT's inventory base by increasing the number of lane miles or square footage of a bridge deck area after completion of the project. Any addition to an asset is included in the asset management database and is considered in future lifecycle costs of the expanded asset.

Table 4-2 contains DDOT's actual 6-year historical CIP investments in roads and bridges specifically.

Table 4-2. Summary of Historical Capital Improvement Investments.

Asset Class	CIP Investments ($000)					
	FY13	FY14	FY15	FY16	FY17	FY18
	373,324	373,828	373,323	375,320	373,324	373,323
NHS Roads	9,735	-	6,644	10,365	17,331	10,147
Bridges*	83,268	37,545	99,529	-	105,285	136,813
Federal Roads - Non-NHS**	38,140	32,825	4,245	18,254	11,451	15,209
Other*** (including Multimodal expansion)	242,181	303,458	262,905	346,701	239,257	211,154

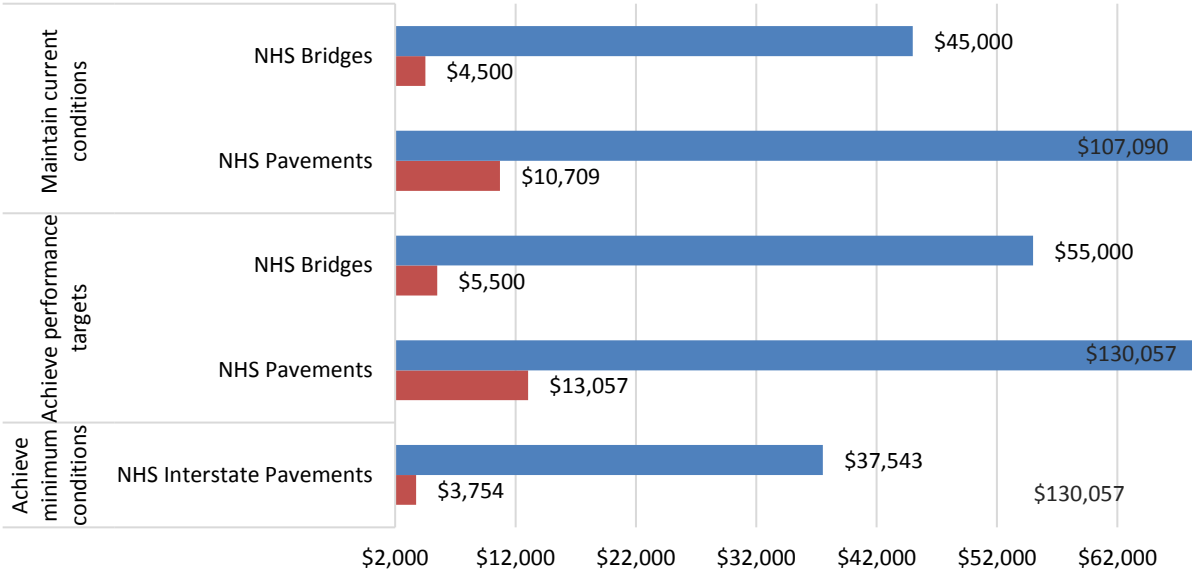
*Includes NHS and Non-NHS Highway bridges. ***DDOT-maintained non-NHS roadways eligible for Federal-aid.*
****Includes other CIP, including multimodal projects (bike, streetcar, streetscape and other) and Local Capital.*

4.4 Estimated Cost and Funding Levels

Estimated Cost

To understand the long-term needs of the transportation system, DDOT estimated the cost associated with the funding scenarios that were established as part of the LCP process. The underlying policies and scenarios governing the LCP process are expected to minimize the long-term costs of owning assets and managing inherent risks. The results of the lifecycle cost analyses provide pertinent information for DDOT in estimating the funding needs for the duration of the TAMP. The process was accomplished through the use of the Department's performance modeling tools, such as Paver for pavements, American Association of State Highway and Transportation Officials (AASHTO) BrM, and proprietary coding methods for bridges, as well as inputs from experts. DDOT will continue to refine and enhance the analytical capabilities of existing systems to improve decision making efficiency.

Figure 4-2 shows the 10-year estimated preservation and maintenance cost profiles for each stated goal and asset category or subgroup. These costs do not include capital improvement (major rehabilitation of bridges and pavement). For NHS bridges, DDOT estimates the annual average need for preservation and maintenance to be approximately $4.5 million to maintain the current conditions until the year 2028. Similarly, annual average need for preservation and maintenance is estimated as $5.5 million to achieve and exceed the 4-year bridge performance targets. Since the existing bridge conditions are below the federal minimum requirements, it is expected that similar investment to maintain existing condition will enable DDOT to stay in compliance with the rule.



	Achieve minimum conditions	Achieve performance targets		Maintain current conditions	
	NHS Interstate Pavements	NHS Pavements	NHS Bridges	NHS Pavements	NHS Bridges
Estimated 10-Year Cost for Preservation and Maintenance ($000)	$37,543	$130,573	$55,000	$107,090	$45,000
Estimated Annual Average Cost ($000)	$3,754	$13,057	$5,500	$10,709	$4,500

Figure 4-2. Estimated Preservation and Maintenance Cost Profiles by DDOT Goals and Asset Categories.

Projected Funding Levels

DDOT estimated the expected funding for TAM investments by gathering and analyzing historical funding trends for each of the asset categories or subgroups: NHS roads and bridges, local and federal roads eligible for federal aid, and tunnels.

DDOT anticipates receiving approximately $790 million for the preservation and maintenance of road, bridge, and tunnel assets for the duration of the TAMP. About $170 million of this amount is expected to be available for the preservation and maintenance of NHS roads and NHS and non-NHS bridges, and approximately $91 million for tunnels. A significant portion of the projected funds is expected to fund non-NHS local roads. These revenue estimates and the results from the risk analysis process form the basis for the reasonable amount of investment strategies and work types DDOT can implement for the duration of the TAMP. These projections take into consideration the potential risk factors, such as risk of legislation changes, that may impact future funding levels.

TEN-YEAR PROJECTED REVENUE ($000)*

NHS Pavements - $99,013

Bridges - $72,648**

*For Preservation and maintenance, excludes CIP. **Includes NHS and Non-NHS bridges.

Figure 4-3 shows a summary of the 10-year expected revenue for each asset category.

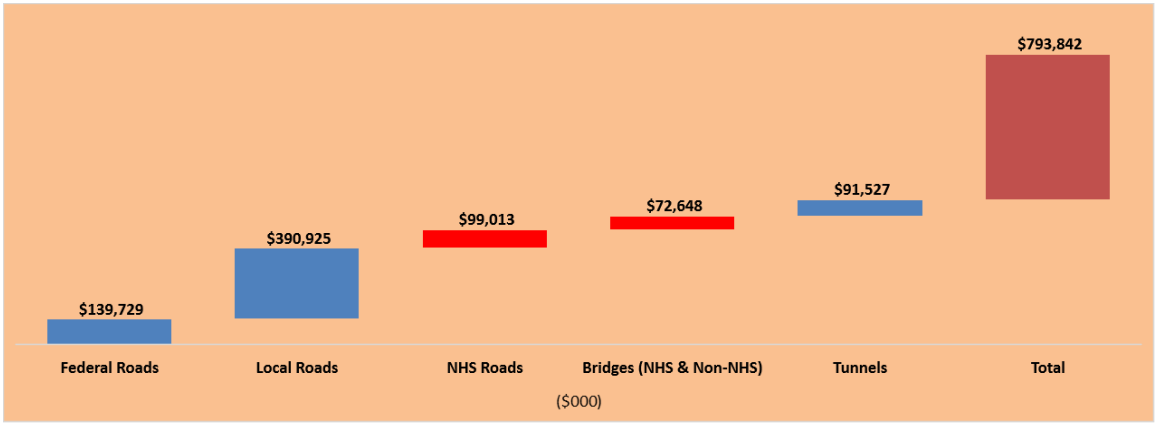


Figure 4-3. Ten-Year Summary of Projected Revenue for Preservation and Maintenance Programs.

The revenue estimation results are based on historical trends, quantitative models, and existing information from the CIP and supplemented with expert opinion. The process commenced with a review of historical funding trends and the development of assumptions that align with sound financial practices. DDOT held a one-day workshop to discuss the approach, develop assumptions, and to review the expected results. The workshop involved key stakeholders, such as experts from the bridge, pavement, and finance divisions.

Table 4-3 contains the projected funding levels for preservation and maintenance programs in each FY for the duration of the TAMP. The table shows that about $86 million is expected to be available for preservation and maintenance investments in FY2019. This amount includes $44.6 million revenue for local streets rehabilitation[13] during FY2019.

[13] District FY2019-FY2024 Capital Improvement Plan

This expected funding will enable DDOT to reduce the percent of poor pavements by a significant amount during this period.

Similarly, DDOT anticipates receiving about $10.5 million in revenue during FY2019 for NHS roads. This revenue stream is expected to remain steady until it reaches approximately $11 million by the end of FY2028. For bridges (including NHS and non-NHS), DDOT expects to receive $6 million in FY2019. About 80% of this revenue is expected to go towards funding for preservation and maintenance of NHS-only bridges. Chapter 7 – Investment Strategies contains the funding allocation strategies and the predicted performance of NHS assets for each of the anticipated funding levels.

Table 4-3. Projected FY Funding for Preservation and Maintenance Program.

Asset Class	Projected Preservation and Maintenance Investment ($000)									
	FY19	**FY20**	**FY21**	**FY22**	**FY23**	**FY24**	**FY25**	**FY26**	**FY27**	**FY28**
	86,236	**69,974**	**79,710**	**85,294**	**70,808**	**67,835**	**80,550**	**82,483**	**84,463**	**86,489**
NHS Roads	10,555	10,000	10,000	10,000	10,000	6,000	10,240	10,486	10,737	10,995
Bridges*	7,354	3,231	12,075	9,365	6,575	4,100	7,223	7,396	7,574	7,755
Tunnel	12,647	10,625	10,930	18,625	5,575	8,175	6,017	6,162	6,310	6,461
Federal Roads - Non-NHS**	11,080	11,080	11,080	11,080	11,080	11,080	17,666	18,090	18,524	18,969
Local Roads	44,600	35,038	35,625	36,224	37,578	38,480	39,404	40,349	41,318	42,309

*Includes NHS and Non-NHS Highway bridges. ***DDOT-maintained non-NHS roadways eligible for Federal-aid.*

The District's capital budget for FY2019 was estimated to be $1.668 billion for improvements in high profile projects[14]. This estimated budget includes $627.3 million for DDOT to perform major capital improvement projects, such as improvement in the South Capitol Street corridor and replacement of the 68-year old Frederick Douglass Memorial Bridge as well as some key local rehabilitation projects to improve street conditions[14]. It is important to note that the majority of these capital projects are not driven by asset condition only, but mostly through capacity or corridor improvements. Table 4-4 contains the projected revenue expected to be available for capital investments in the asset categories listed, for the duration of the TAMP.

[14] District FY2019-FY2024 Capital Improvement Plan.

Table 4-4. Projected FY Funding for Capital Investment.

Asset Class	Projected CIP Investments ($000)									
	FY19	FY20	FY21	FY22	FY23	FY24	FY25	FY26	FY27	FY28
	218,733	199,777	254,580	150,021	248,021	159,860	229,482	231,388	230,984	234,081
NHS Roads	21,100	12,473	0	11,000	21,000	0	22,000	22,528	23,069	23,622
Bridges*	37,653	34,400	95,900	98,000	46,000	37,871	40,529	41,516	41,560	42,185
Federal Roads – Non-NHS**	43,829	32,050	34,000	0.0	38,000	38,000	30,814	31,554	32,311	33,086
Other (including Multimodal Expansion)	124,778	133,327	124,680	139,021	125,943	83,989	119,144	123,922	122,317	121,913

*Includes NHS and Non-NHS Highway bridges. **DDOT-maintained non-NHS roadways eligible for Federal-aid.

Estimate Funding Gaps or Surplus

DDOT estimates that additional preservation and maintenance funding will be required in the future to enable the Department to achieve the NHS pavement and bridge SGR and long-term performance targets. Figure 4-4 shows the estimated preservation and maintenance cost and forecasted revenue for NHS pavements for the duration of the TAMP. Total additional funds of approximately $32 million are required in pavement preservation and maintenance for the duration of the TAMP to achieve and sustain SGR. An average annual budget of $13 million is required compared to the current annual budget of about $10 million. DDOT anticipates that an initial investment of $19 million in FY2020 will enable the Department to make significant progress towards the short-term performance targets and long-term SGR.

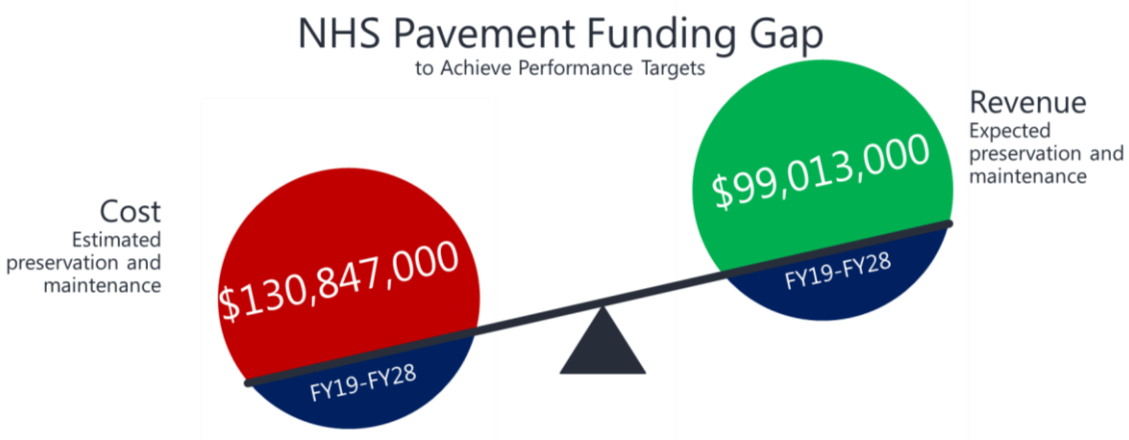
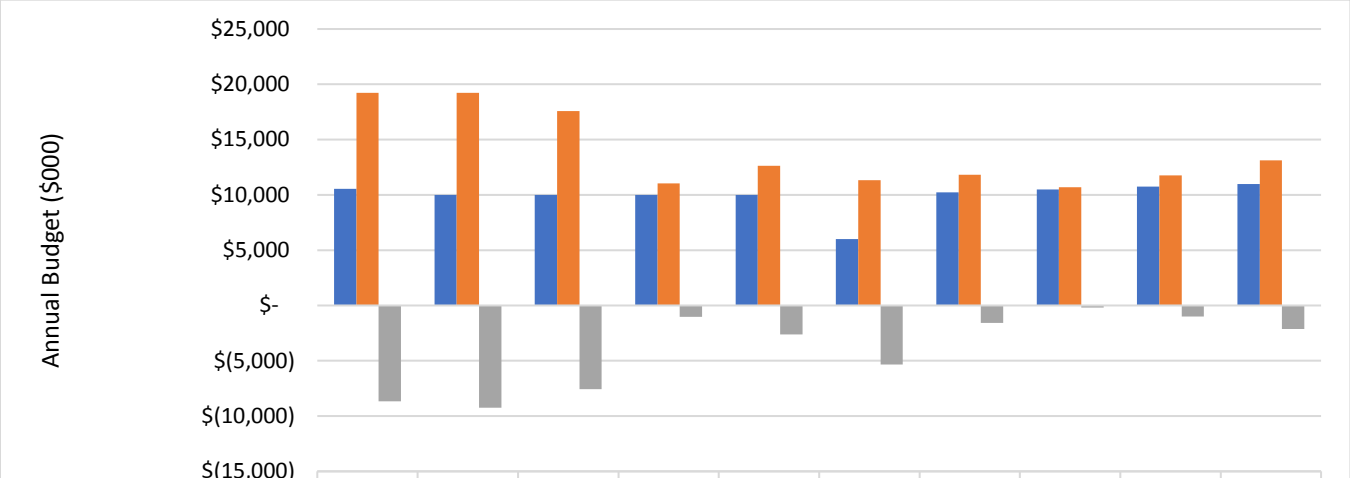


Figure 4-4. NHS Pavements Preservation and Maintenance Funding Gap.

Figure 4-5 depicts the funding gap that may exist if DDOT's current budget does not increase substantially. In the figure, the difference between the projected annual budget and estimated needs to meet DDOT's SGR and performance targets represent the funding

gap for each year. The funding gap is largest in year 2020 but shrinks in the further years. However, the funding gap depicted can become worse if the funding needed was not met each year. Failure to meet the funding needs of the target-achieving budget in one year could result in untreated assets and, therefore, increased expenditure needed in future years. DDOT can only maintain the current performance if the current investment levels are applied over the duration of the TAMP.

DDOT is proactively working internally, discussing the investments needed to achieve targets and maintain the NHS pavement and bridges at or above the federal minimum conditions set under the National Performance Management Measures. This will ensure the obligation plan, the TIP and STIP reflect the funding needs and enable DDOT close the financial gap and implement the desired investment strategies in Chapter 7, for SGR. For example, DDOT has identified FY19 August redistribution funds to close the funding gap in 2020 and is currently working on obligating the funds.



	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
Current Budget	$10,555	$10,000	$10,000	$10,000	$10,000	$6,000	$10,240	$10,486	$10,737	$10,995
Target Achieving Budget	$19,235	$19,235	$17,573	$11,031	$12,623	$11,329	$11,828	$10,684	$11,749	$13,125
Funding Gap	$(8,680)	$(9,235)	$(7,573)	$(1,031)	$(2,623)	$(5,329)	$(1,588)	$(198)	$(1,012)	$(2,130)

Figure 4-5. Target Achieving Annual Funding Gap – NHS Pavement.

Figure 4-6 shows the estimated preservation and maintenance cost and forecasted revenue for NHS bridges for the duration of the TAMP. The figure shows that the estimated cost outpaces the forecasted revenue for NHS bridges resulting in a funding gap of approximately $10 million for the bridge preservation and maintenance program. DDOT anticipates that because of the several capital investment programs and projects in the pipeline, the Department will be able to meet the targets with an additional annual funding of approximately $1.0 million.

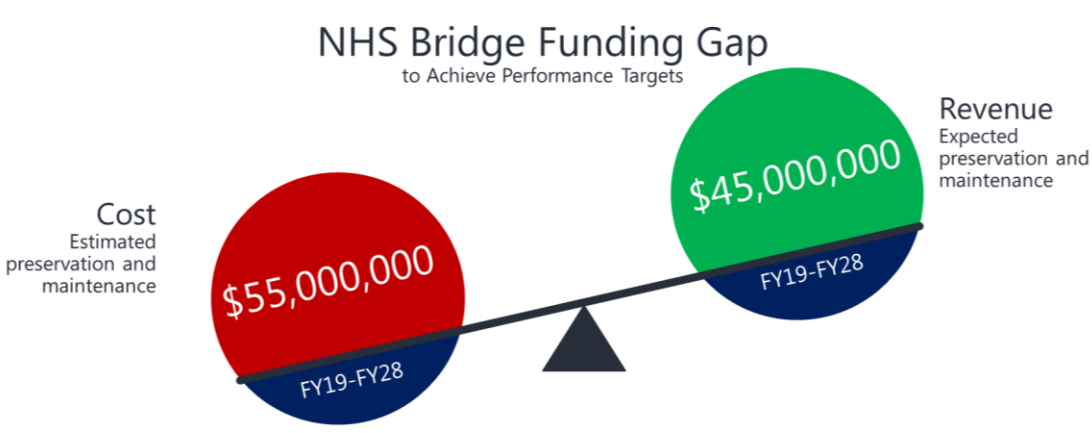


Figure 4-6. NHS Bridge Preservation and Maintenance Funding Gap.

Similarly, to the process in place to bridge the financial gap for pavements, DDOT will be using the August redistribution and de-obligation to close the funding gap. In fact, DDOT is actively working with the State Regional Planning Division and Resource Management to discuss the results of the TAMP and amend the obligation plan to enable DDOT to close the financial gap and implement the desired investment strategies in Chapter 7.

Assumptions and Potential Risks

DDOT made several assumptions in estimating the expected revenue levels and cost of work needed to address the national and asset management goals for the duration of the TAMP. These assumptions introduce a degree of uncertainty and risk into the decision-making process. Typical sources of risks include the following:

- Uncertainty in the modeling capabilities of asset management systems.
- Uncertainty in projected funds due to over-reliance on historical funding trends which may not be available in the future.
- Uncertainty in unforeseen emergency events that can impact asset and system performance.
- Cost increase and changes in funding levels due to changing market, demographics, or economic trends.
- The four-year targets are assumed to be the same as the 10-year targets for NHS pavements. The level of financial uncertainty between the fourth and tenth year could impact DDOT's ability to achieve these targets after year four.

The risk management chapter deals with the approach to mitigate these risks and assigns owners to manage the risks effectively.

4.5 Asset Valuation

There are several methods to value assets in asset management. DDOT uses the replacement cost approach to value transportation assets. The replacement cost refers to the monetary value

needed to replace an asset now to serve the same purpose. The replacement value approach does not consider asset deterioration or existing condition. The approach estimates the cost to build as new irrespective of the current condition, using the unit cost of replacement. This approach usually yields a higher asset value than the actual value of an asset based on the existing state. In this TAMP, DDOT did not include the value of tunnels due to lack of enough information to estimate the value. The Department is working to develop processes to enable this estimation in the future.

The estimated replacement value for pavement and bridge assets on the District's network is approximately $33.7 billion. This value includes an estimated replacement cost of about $30 billion for NHS pavements and bridges. Figure 4-7 shows a breakdown of the replacement costs for each asset group/subgroups[15]. DDOT's strategic investments seek to maintain and improve upon the value of assets. Through the LCP processes (scenario analysis), DDOT has identified annual strategies and needed funding levels to enable the Department to maintain or add value to the existing asset inventory.

DDOT estimates tunnel asset value to vary from one tunnel to another. That is, there is no established unit cost available to use to estimate the value of tunnels on the District highway network. In future TAMP, DDOT will develop strategies and processes to establish the unit cost and value of all tunnels in the District.

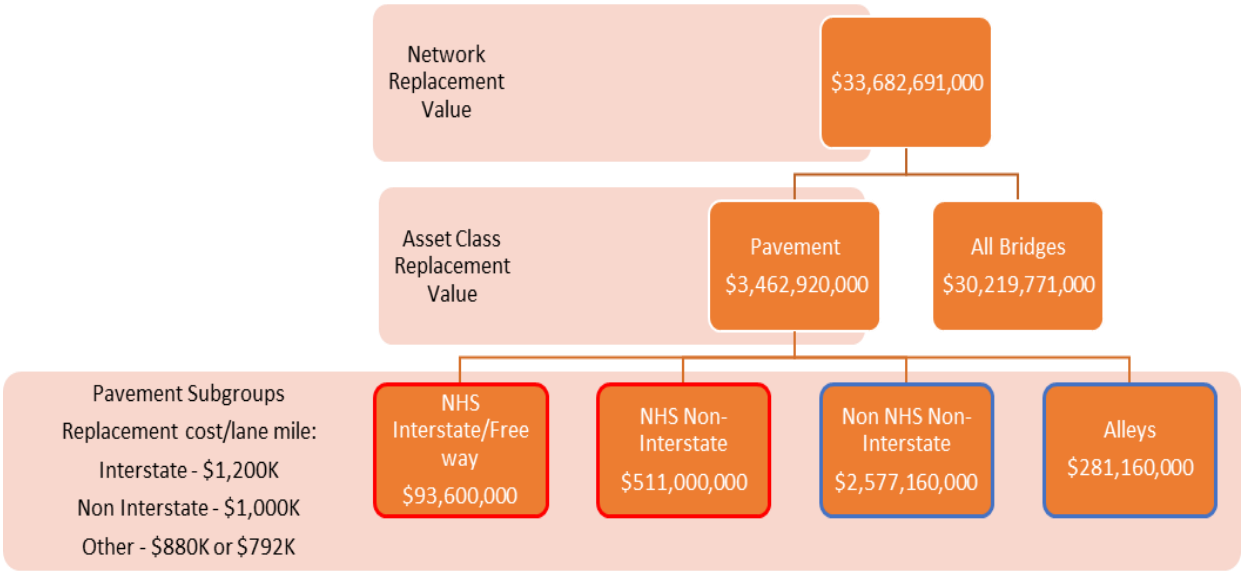


Figure 4-7. Replacement Costs for Highway Assets.

[15] DDOT Action Agenda 2010

Chapter 5 Risk Management Analysis

5.1 Overview

This chapter describes DDOT's risk management process. Specifically, this chapter offers information on the following:

- **Fundamentals of risk management:** This section provides the definitions for the essential elements of risk management.
- **Risk management framework and process:** This section describes the underlying risk framework and specific actions that guide the risk management analysis process and the risk register resulting from the analysis. The contents include the procedures DDOT used in assessing the likelihood of occurrence and impact and consequences of each risk.
- **Implementation of the results in the TAMP:** This section describes the strategies DDOT has adopted to implement the risk results into the TAMP and to influence decision making.
- **Emergency evaluation and alternative analysis:** This section describes the process and results of the 23 CFR 667 evaluation of NHS pavements and bridges repeatedly damaged by emergency events.

5.2 Fundamental of Risk Management

For consistency in applying the principles of risk management, DDOT adopts the following generally accepted practice definitions:

Risk is described as a potential event that can be expressed in terms of consequence, impact, or severity of the impact and its related likelihood of occurrence. The most widely used definition of risk in TAM is the International Organization for Standardization (ISO) 31000 definition[16], which defines risk as the "effect of uncertainty on objectives." The FHWA definition of risk mirrors this international standard and defines risk as the positive or negative effects of uncertainty or variability upon agency objectives.

Risk	"….. a potential event that can be expressed in terms of consequence, impact, or severity of the impact and its related likelihood of occurrence."

Uncertainty is the lack of complete knowledge about the variables influencing the outcomes of the decision process present in all investment decision making.

Probability of occurrence is the frequency or likelihood with which a given risk event may occur in a specified timeframe.

[16] ISO, 2009

Consequence is the extent to which a given risk event can impact the Department's objectives if the risk event occurs.

Risk management involves identifying, assessing, analyzing, and treating a risky situation(s). Specifically, AASHTO defines risk management as a process of identifying sources of risk, evaluating them, and integrating mitigation actions and strategies into routine business functions of the agency to address them. DDOT's risk management program supports the Department's mission, asset management goals, and policies as well as complying with federal and local mandates.

Risk Management	"…. a process of identifying sources of risk, evaluating them, and integrating mitigation actions and strategies into routine business functions of the agency."

Risks exist and are managed at different levels of an organization, including the categories identified by FHWA[17]. The agency-level risks are the highest level of risk management, impacting a broader scope of the organization. Executives effectively manage these types of threats. The lowest level of risks occurs at the project/asset level. Their impact is very narrow, affecting individual assets or projects. Asset or project managers effectively manage these. Figure 5-1 shows the three primary levels of risks and the expected responsibility assignment.

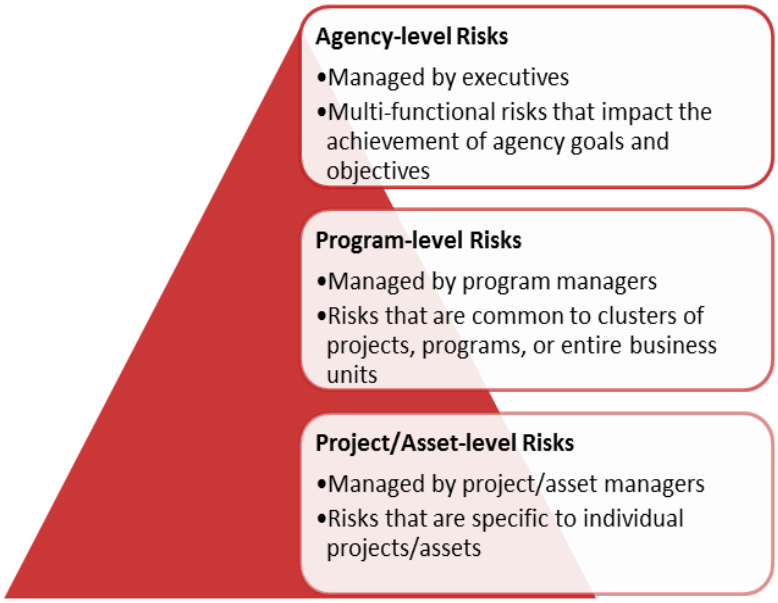


Figure 5-1. Risk Management Levels.

The risk register is a comprehensive, decision-support tool documenting and tracking all the identified risk events, their likelihood of occurrence and consequences and impacts on business processes if they occur, the associated mitigation strategies and actions to alleviate the impact

[17] FHWA, Transportation Risk Management: International Practices for Program Development and Project Delivery

on objectives, and the business functions or owners expected to manage the given risk. The risk register is a living document that is updated regularly to reflect existing conditions.

Mitigation strategies are the high-level strategies applied to a given risk depending on the risk appetite of the organization. They may include transferring, treating, terminating, tolerating, or taking advantage of the risk. Part of developing risk management strategies is to establish specific mitigation actions or treatments to support implementation.

5.3 Risk Management Framework and Processes

DDOT uses generally accepted practices in developing the risk management plan. The Department adopts a risk management framework that incorporates international standards in risk management. Figure 5-2 is a modified risk framework with the listed processes DDOT used in analyzing risk, developing the risk register, and planning for mitigation and monitoring. The paragraphs that follow describe the steps listed in the framework.

Figure 5-2. Risk Management Framework.

Establishing Context

The principal goal of this step was for DDOT to develop the objectives of the risk management process, ensuring that the objectives aligned with organizational and TAM goals and objectives. This step prepared the resiliency workgroup[18] for the risk workshop as well as clarified the processes involved in risk management. The outcome was an understanding of the scope and context of the TAMP risk management process.

Identifying Risks

The objective of this activity was to identify a list of events DDOT considers as potential threats or opportunities to hinder or enable, respectively, the achievement of the

[18] This is the group that was formed to evaluate risks to the Department. The membership of this group is defined in Chapter 2.

Department's asset management goals. The process commenced with an initial list of risk events developed through a literature search and information gathered through interviews with key stakeholders in the Department. DDOT held a one-day workshop to discuss the events and their impacts. During the workshop, the resiliency workgroup addressed concerns and agreed on the risk events.

DDOT used an electronic polling system to achieve consensus. For each risk event, the workshop participants were asked to choose from four possible options, including:

- Do not agree with the risk event;
- Neutral to the event;
- Agree that the event is a potential risk to DDOT; or
- Do not know if the risk event should be included in the list.

The participants came to a consensus on 36 potential risk events. The outcome of this process was a tabulated list of threats, their impact on organizational goals, pavement, bridge, and tunnel conditions, performance goals, and the management level they fall within.

Analyzing Risks

The objective of this activity was the estimation of the likelihood and consequences for each identified risk event to determine the magnitude of the resulting risk. During this step, DDOT ranked the identified risks in terms of their likelihood of occurrence and their consequences if they occur. DDOT relied on historical information and expert knowledge in assigning the likelihood and consequence values.

The workshop facilitators engaged the resiliency workgroup through a consensus-building process (again using an electronic polling system and through thorough discussion) to assign the likelihood and consequence ratings. The participants analyzed each risk event with multiple consequence dimensions including **safety**, **mobility**, **asset damage**, and **financial**.

Risk Likelihood

The risk likelihood rating indicates the frequency with which the risk event may occur. For this exercise, DDOT used a rating scale of one to five, with one representing very low likelihood and five representing very high likelihood. Table 5-1 contains the risk likelihood ratings and their descriptions.

Table 5-1. Risk Likelihood Rating and Description.

Risk Element	Index/Code	Rating	Description/Action
Likelihood	1	Very Low	One or no occurrence in ten years.
	2	Low	Between two and five occurrences in ten years.
	3	Medium	Between six and nine occurrences in ten years.
	4	High	One occurrence every year.
	5	Very High	Beyond ten occurrences in ten years.

Risk Consequence

The risk consequence measures the impact of the risk on DDOT's goals if the event occurs. The consequence ratings were assessed using the following consequence criteria:

- **Safety**: chance of severe injury or fatal crashes;
- **Mobility**: chance of inability to effectively move between locations (congestion, roadway capacity, connectivity);
- **Asset Damage**: chance of damage requiring immediate maintenance or replacement/repair; and
- **Financial**: chance of increasing agency costs or other industry costs (bid prices, materials costs, or asset value depreciation).

Each impact criterion was assigned a consequence rating using Table 5-2 as a guide.

Table 5-2. Consequence Rating.

Index/Code	Mobility	Safety	Asset Damage	Finance
1	Situation affects a small (neighborhood or town) number of travelers for a short time (hours).	No injury(ies) (property damage only).	No direct asset damage; Deferred maintenance accumulates over 1 year.	Lowers transportation network value by < 1% or costs <$1M per year.
2	Situation affects a small number of travelers for a moderate time (days-months).	Possible injury(ies).	Direct asset damage requires minor repair; Deferred maintenance accumulates over 2 years.	Lowers transportation network value by 1-2% or $1M<= Costs <=$10M per year.
3	Situation affects a small number of travelers for a long time.	Non-incapacitating injury(ies).	Direct asset damage requires routine repair; Deferred maintenance accumulates over 5 years.	Lowers transportation network value by 2-3% or $10M< Costs < =$25M per year.
4	Situation affects a large (multiple towns or metropolitan region) number of travelers for a short time	Incapacitating injury(ies).	Direct asset damage necessitates closure or major repair; Deferred maintenance accumulates over 10 years.	Lowers transportation network value by 3-4% or $25M<Costs <=$50M per year.
5	Situation affects a large number of travelers for a moderate time.	Fatality(ies).	Asset is unfit for service or destroyed; Deferred maintenance accumulates over more than 10 years.	Lowers transportation network value by > 4% or costs > $50M per year.

Evaluating Risk

To evaluate the risks, DDOT used the raw ratings from the risk analysis process for likelihood and the four consequence categories to generate a composite risk score for risk event. The Risk Event Scores were used in conjunction with the risk matrix (Table 5-3) to evaluate the risks and identify higher- and lower-priority risks.

Risk events with very low likelihoods and negligible consequences are assigned a risk score of one and considered to be lower-priority risks. Similarly, risk events with very high likelihoods of occurrence and catastrophic consequences are assigned a risk score of 25 and considered to be higher-priority risks. In addition to the risk scores, DDOT considers other decision variables, such as cost and benefits, in prioritizing the risks for mitigation.

Table 5-3. Sample Risk Matrix.

Likelihood		*Consequence (Index/Descriptor)*				
		1	2	3	4	5
Index	*Descriptor*	**Negligible**	**Minor**	**Major**	**Critical**	**Catastrophic**
1	**Very Low**	**1**	**2**	**3**	**4**	**5**
2	**Low**	**2**	**4**	**6**	**8**	**10**
3	**Medium**	**3**	**6**	**9**	**12**	**15**
4	**High**	**4**	**8**	**12**	**16**	**20**
5	**Very High**	**5**	**10**	**15**	**20**	**25**

The complete and detailed analysis and results of the process are documented in a standalone risk management analysis technical memorandum and incorporated herein. To ensure inclusion and coordination, DDOT involved the external stakeholders of the NHS to review and provide feedback on contents of the technical memorandum and the complete risk management chapter.

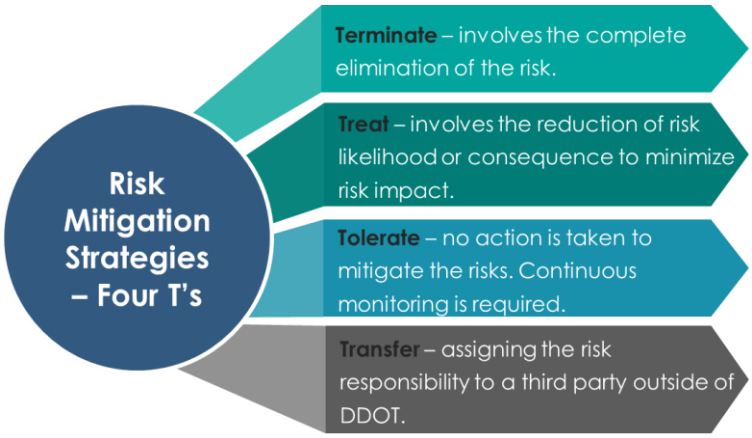
DDOT identified 22 top-priority risks. Top-priority risks are risk events with a risk composite score of at least 12. The risk IDs 14, 23, 2, 9, and 20 represent the top five risks that were identified and include:

Table 5-4 (located at the end of this chapter) is the complete risk register containing all the identified risks, impacts, risk scores, mitigation strategies and actions, and the business functions or divisions responsible for managing the risk. The TAM Steering

Committee will ensure that appropriate steps are taken to implement the strategies and actions.

Developing Mitigation Strategies and Risk Monitoring Actions

DDOT adopts the four T's risk response (i.e., terminate, treat, tolerate, or transfer) approach to managing risks. This procedure enables DDOT to minimize the likelihood of occurrence, reduce the consequences, or to monitor the risk and communicate effectively.



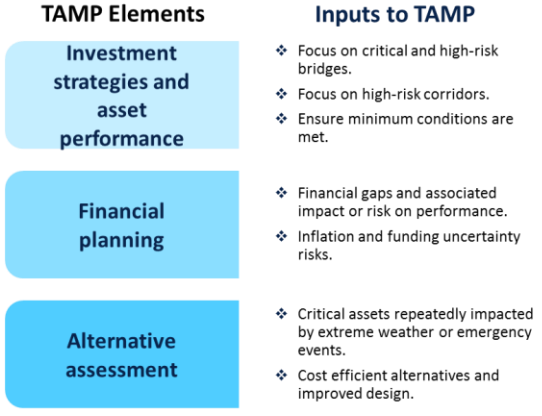
Through a workshop, DDOT identified risk responses or strategies for the risk events as well as designated some actions to help address the risks. To ensure that the risks are managed effectively, DDOT identified and assigned responsibilities to risk owners at the business unit level to ensure the development and implementation of a full-blown risk action plan.

These agency divisions are expected to establish programs and procedures to integrate the actions into the day-to-day activities of staff, develop implementation schedule to complete the actions, and track progress in managing top-priority risks. Progress monitoring is essential to DDOT because risk management is not static and requires a strategic management approach including periodic updates to reflect prevailing conditions.

5.4 Implementing Risk Analysis in TAMP

DDOT has taken various steps to successfully integrate the outcome of the risk analysis process into TAM decision making. For example, DDOT has targeted critical elements and processes in the TAMP to address risk, including:

- **Investment strategies and asset performance** – DDOT took a risk approach in developing investment strategies such that the Department uses resources efficiently and maximizes asset performance while minimizing risk. For example, the Department



ensured that high-risk or critical bridges and Interstate pavements on the NHS received adequate investment to mitigate the risks of not meeting minimum condition requirements and achieving performance targets.

- **Financial planning** – DDOT financial planning procedures accounted for financial risks, such as inflation, funding cuts, unexpected project cost increases, and communicated the potential threats of financial gaps that could cause the failure of achieving stated goals and performance targets.
- **Alternative assessment** – DDOT evaluated existing data to identify alternatives for critical assets repeatedly requiring repair and reconstruction due to emergency events.

Other potential avenues exist throughout the agency that DDOT can integrate mitigation actions into business processes to improve agency-wide risk management. The risk register documents these areas, but the process begins with the development or enhancement of an agency-wide risk management strategy that incorporates asset management risks. The Department will seize current management opportunities to improve risk management and decision making.

5.5 Emergency Evaluation and Alternative Analysis

This section contains the outcome of the Statewide emergency evaluation and alternative analysis in response to the US 23 CFR 667 analysis—Periodic Evaluation of Facilities Repeatedly Requiring Repair and Reconstruction due to Emergency Events. The objective of this analysis was to evaluate and determine if there are reasonable alternatives to roads, highways, bridges, and tunnels that have required repair and reconstruction activities on two or more occasions due to emergency events. DDOT used the framework in Figure 5-3 to conduct the evaluation.

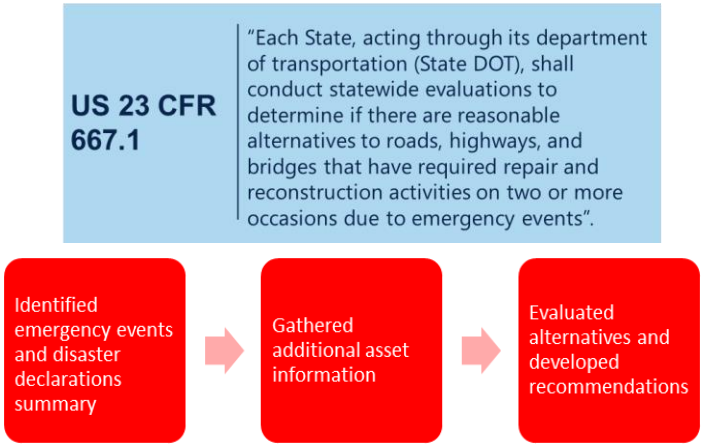


Figure 5-3. Emergency Event and Activity Tracking Framework.

DDOT conducted this evaluation considering all emergency events that have occurred from January 1, 1997 to December 31, 2017. DDOT developed a standalone technical memorandum "Statewide Emergency Evaluation and Alternative Analysis Results" documenting the process, summary of results, and recommendations to improve the process. Highlights of the results are incorporated herein.

The gathered data and the existing information indicated that DDOT had not done any permanent work on this category of assets resulting from the documented disaster declarations.

These observations suggest that no roads or bridges in the District have repeatedly required permanent work, including permanent repair or replacement from the recorded emergency events. However, DDOT has conducted pre- and post-emergency event actions in the past, though these preparation and recovery activities do not qualify as permanent work. For example, after the 2011 earthquake in the Washington metropolitan area, the bridge management division conducted a post-event bridge survey on some critical bridges in the District. DDOT could not link specific repair or reconstruction activities to this event and study.

Table 5-4. DDOT TAMP Risk Register.

Risk ID	Risk Event	Risk Score	Risk Impact on Business Processes	Mitigation Strategy	Responsible Division	Mitigation Actions
14	Inability to procure qualified contractors in a reasonable amount of time to support program delivery.	20	• Delays in project delivery. • Unmet program and performance goals. • Increased customer complaints. • Negative impacts on the Department's reputation.	Treat	Office of Contracting and Procurement (OCP)	• Communicate the impact of project delays on program goals to stakeholders. • Review existing standard operating procedures, procurement timeline, identify improvement areas, and implement actions to expedite the procurement process.
23	Inability to meet performance goals due to a potential drop in performance of large, critical bridges.	20	• Loss of flexibility in using federal funds. • Unmet federal minimum requirements. • Increased deterioration in bridges causing safety concerns.	Treat	Bridge group	• Implement a bridge management system capable of analyzing bridge performance and budget. • Prioritize bridge preservation and investments based on performance, criticality, and risk.
2	Local politics impact local funding appropriation.	19	• Unmet department and program goals and performance targets. • Unfunded local projects. • Increased customer complaints.	Treat	Asset management	• Use performance measures to communicate and inform decision makers. • Communicate the impact of resource reallocation on the overall performance of the network.

Risk ID	Risk Event	Risk Score	Risk Impact on Business Processes	Mitigation Strategy	Responsible Division	Mitigation Actions
9	Program delivery is impacted by funding high-profile and politically-motivated projects.	18	• Delayed projects due to the lack of funding. • Unmet performance targets and goals. • Inefficient use of limited resources.	Treat	Project delivery/asset management	• Use performance measures to inform decision makers. • Communicate the impact of resource reallocation on the overall performance of the network.
20	Loss of performance or damage to assets due to the failure of utility assets or buried pipes.	18	• Premature failure of transportation assets. • Increased cost due to emergency repairs. • Delayed projects due to the diversion of funds for emergency repairs. • Increased safety and mobility concerns.	Transfer	Asset management	• Establish a working understanding with utility agencies. • Require performance-based repairs from utility agencies. • Improve repair and performance enforcements.
31	Use of poor-quality materials and workmanship.	18	• Increased construction defects. • A decreased expected service life of assets. • Increased deterioration rate. • Increased cost due to premature failure.	Transfer	Project delivery	• Enhance project inspections to comply with industry standards and project specifications. • Implement and enforce strict quality control processes in contract documents.
8	Unfunded federal mandates impact the ability to deliver programs efficiently.	16	• Increased asset deterioration. • Unmet programs goals. • Loss of flexibility in using federal funds.	Tolerate	Asset management	• Monitor funding trends. • Adopt effective resource allocation tools and techniques to balance limited resources with performance. • Explore other project delivery methods.

Risk ID	Risk Event	Risk Score	Risk Impact on Business Processes	Mitigation Strategy	Responsible Division	Mitigation Actions
5	Funds are not enough for capital and maintenance projects due to poor prediction of funding.	14	• Deferred maintenance will lead to increased replacement cost. • Unmet performance goals. • Unmet customer expectations.	Treat	Asset management	• Enhance and implement analytical tools to support asset management and needs assessment. • Use innovative analysis techniques. • Communicate the impact of deferred maintenance on future cost and performance.
7	Lack of motivation for an agency-wide asset management program at DDOT.	14	• Reduced efficiency in operation. • Inefficient uses of limited resources. • Lack of consistency in information and business process. • Decreased information sharing	Treat	Office of the Director/Asset management/division heads	• Develop an asset management strategy. • Develop resources and tools (communication and training) to facilitate buy-in at all levels. • Develop a framework to prioritize other assets into the TAM program. • Start with already visible programs such as sidewalks and alleys.

Risk ID	Risk Event	Risk Score	Risk Impact on Business Processes	Mitigation Strategy	Responsible Division	Mitigation Actions
11	Inability to attract workforce with required experience and expertise.	14	• Increased delays in program delivery. • Overstretched workforce. • Increased cost due to increased dependency on external resources.	Treat	Human resources/division heads	• Improve outreach programs to target all levels of the school system to expose students to the opportunities that exist and the required education and skills. • Expand job advertisement to an external audience. • Expand internal training to enable cross-training and effective transfer of internal staff.
13	Inefficient use of project management tools to support program delivery.	14	• Increased costly failed projects. • Unmet project and program goals. • Unmet performance goals. • Unmet customer expectation.	Treat	Human resources/IT/training department	• Enforce or enhance existing project management strategies. • Establish formal training to introduce staff to current tools and techniques. • Develop a complete inventory of current tools and their capabilities.
18	Loss of performance or damage to assets due to vehicle impacts or hazardous material spills.	14	• Increased repair costs. • Unmet performance goals. • Increased mobility concerns.	Treat	Asset group owners	• Increase visible signs in high-risk locations. • Provide effective barriers at high-risk locations.

Risk ID	Risk Event	Risk Score	Risk Impact on Business Processes	Mitigation Strategy	Responsible Division	Mitigation Actions
34	Effects of truck weight on asset performance.	14	• Increased asset rate of deterioration. • Increased cost due to frequent restoration work.	Tolerate	Asset group owners	• Monitor asset deterioration and analyze the impact of truck weight on decline. • Reduce overweight trucks on critical roads and bridges. • Develop adaptive design guidelines.
4	Effects of inflation on funding capital and maintenance projects.	13	• A decreased purchasing power of available funds. • Increased cost in funding projects. • Delayed projects due to the lack of funding. • Unmet performance goals.	Tolerate	Finance	• Maintain consistent and effective escalation rate to use in all financial projections. • Identify other sources of funds for future use.
12	Lack of required data management systems and strategies to support performance-based program delivery.	13	• Decreased objectivity in decision making. • Inefficient use of available resources. • Lack of consistent data on assets. • Increased unexpected asset failure.	Treat	IT/asset group owners	• Develop an agency-wide strategy for data and information flow. • Conduct asset management tools assessment and identify needs and improvements for system capabilities. • Develop a long-term implementation plan to improve asset management system functionalities and capabilities.

Risk ID	Risk Event	Risk Score	Risk Impact on Business Processes	Mitigation Strategy	Responsible Division	Mitigation Actions
15	Unexpected variations in project cost.	13	• Increased change order request. • Delayed projects. • Increased agency costs. • Reduced trust in agency capability.	Treat	Project delivery	• Use practical tools to support better scope development.
16	Inability to meet capacity due to limited availability of contractors	13	• Increased project costs due to less competition. • Unmet performance goals due to delays in project delivery. • Increased customer complaints. • Increased costs due to deferred maintenance work.	Treat	Office of Contracting and Procurement	• Examine proposal requirements that limit the pool of contractors that can bid. • Consider other contracting options to attract contractors.
19	Loss of performance or damage to assets due to retaining wall failure or slope failure.	13	• Increased emergency repair costs. • Unmet performance goals. • Increased mobility and safety concerns.	Treat	Asset management	• Develop a framework to prioritize other assets into the TAM program. • Communicate the impact of wall failure to stakeholders. • Identify critical walls and monitor performance.

Risk ID	Risk Event	Risk Score	Risk Impact on Business Processes	Mitigation Strategy	Responsible Division	Mitigation Actions
10	Loss of expertise and institutional knowledge due to staff turnover and retirement.	12	• Overstretched workforce. • Increased hiring cost. • Loss of consistency in business processes and smooth operation.	Treat	Human resources	• Develop and implement an effective knowledge management strategy to capture essential knowledge and critical skills of retiring generation. • Develop and implement effective employee retention strategies to maintain a steady workforce.
21	Loss of performance or damage to assets due to the failure of other ancillary assets.	12	• Deferred maintenance and preservation due to transfer of funds to address the unexpected failure of ancillary assets. • Unmet performance goals. • Increased mobility and safety concerns.	Treat	Asset management	• Develop resources and tools (communication and training) to facilitate holistic asset management and buy-in from all levels of the Department. • Develop a framework to prioritize other assets into the TAM program. • Start with already visible programs such as sidewalks and alleys.
24	Unanticipated increases in project scope impact project delivery.	12	• Increased change order request. • Delayed projects. • Increased agency costs. • Reduced trust in agency capability.	Tolerate	Project delivery	• Minimize scope uncertainty; track historical changes and use as a benchmark for future, similar plans to build scope and cost.

Risk ID	Risk Event	Risk Score	Risk Impact on Business Processes	Mitigation Strategy	Responsible Division	Mitigation Actions
33	Effect of economic development on asset performance.	12	• Increased usage of assets increases asset deterioration. • Increased cost to maintain and preserve asset performance.	Tolerate	Asset management	• Conduct studies and research to track and project the impact of economic development on asset performance and demand. • Communicate information with decision makers. • Align feature designs with study findings.

Chapter 6 Lifecycle Planning

6.1 Overview

This chapter describes DDOT's approach to conducting lifecycle planning (LCP) for pavements and bridges. LCP is defined as "a process to estimate the cost of managing an asset class, or asset subgroup, over its whole life with consideration for minimizing cost while preserving or improving the condition."[19] This process enables DDOT to identify strategic investments (maintenance, preservation, and/or rehabilitation) at the appropriate time to use resources efficiently and maximize asset performance.

Figure 6-1[20] illustrates the efficiency in using LCP to identify timely investments, extend the service life of assets, and minimize lifecycle cost.

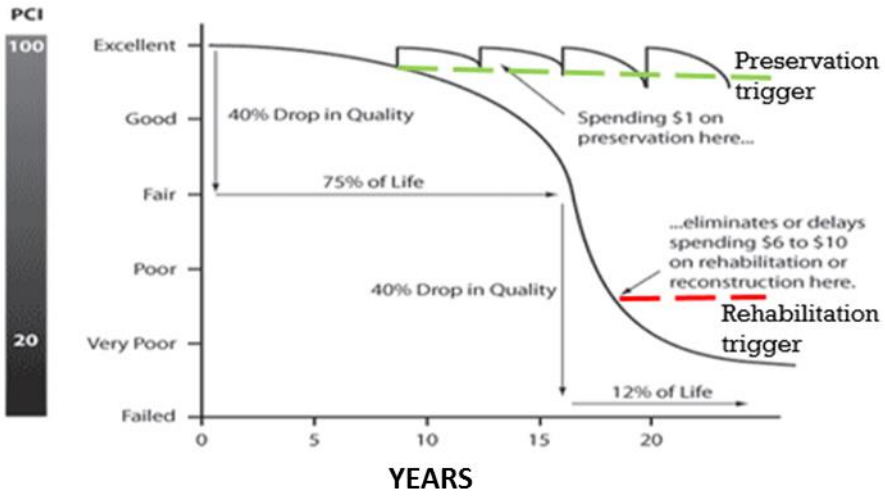


Figure 6-1. Whole Life Management of Pavements.

Achieving LCP objectives requires DDOT to gather useful data, enhance the modeling capabilities of existing systems, identify cost-effective investment strategies, and identify additional methods that support the process and helps DDOT to respond to the Federal requirements.

Specifically, this chapter provides information on the following:

- **Asset data collection to support LCP:** This section outlines asset data availability, gaps, and the approaches to address the gaps.

23 CFR 515.7(b)

A State DOT must establish a process to estimate the cost of managing an asset class at the network level over its whole life with consideration for minimizing cost while preserving or improving the asset condition.

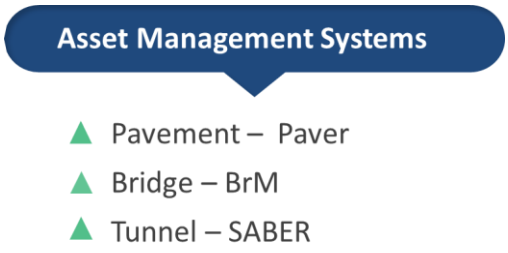
[19] 23 CFR 515.5

[20] Witczak, M. (1978). Determination of Flexible Pavement Life, Report No. FHWA/MD/R-79/1, Federal Highway Administration, Washington, DC.

- **Tools and modeling techniques:** This section describes DDOT's existing asset performance modeling capabilities and strategies to improve upon the approach.
- **Work types, treatment options, and costs:** This section describes the potential work types, treatment options, and the associated unit costs DDOT uses in addressing asset needs.
- **LCP outcome:** This section describes the approach DDOT used to analyze and prioritize investment strategies that support the achievement of performance targets and make progress towards national performance goals while minimizing lifecycle cost.

6.2 Asset Data Collection

DDOT has extensive data on pavement, bridges, and tunnels to support LCP. As described in the State of the System Chapter, DDOT gathers and maintains pavement, bridge, and tunnel historical data in their respective systems. Pavement management is supported by Paver, bridge management is supported the AASHTO Bridge Management (BrM), and tunnel management is supported by SABER.



DDOT draws on this data to evaluate asset conditions, conduct performance analysis, and to support LCP for asset management. Currently, DDOT has complete condition data for pavement and bridges to address significant aspects of the Federal rules pertaining to data requirements, condition reporting, and performance analysis.

For tunnels, DDOT has gathered condition data and performance information on selected tunnel elements since 2005. DDOT conducts biennial NBI inspection on all tunnels. This data will serve as the basis for DDOT's approach to conduct LCP for tunnels when the Department's tunnel management system becomes operational. The Department has a performance-based contract in place that enables preventive maintenance and preservation actions on all major tunnel elements. DDOT is currently undertaking vital initiatives to provide DDOT's tunnel management staff with the required assistance and support services to comply with the biennial inspection and reporting requirements associated with the NTIS and the SNTI, including the quarterly evaluation of tunnel asset conditions. Also, DDOT is working to enhance the analytical capabilities of existing tunnel systems to enable the Department to conduct extensive analysis to support decision making. Consequently, this TAMP does not include LCP analysis for tunnels.

6.3 Tools and Modeling Techniques

Good asset management systems use logical, analytical processes to generate quality information for effective decisions making. The identification of viable treatments and work

types, analysis of funding needs, evaluation of expected performance, and the estimation of service life for applied treatments require strong analytical tools and modeling techniques supplemented with expert opinion. Prior to the federal TAM rules, DDOT used a pseudo-analytical approach in modeling and identifying work for pavement and bridge assets. This approach utilized expert opinion, existing work plans, and historical data to develop project work plans and expected performance. This is a bottom-up approach in modeling and developing work plans.

To respond to 23 CFR 515.17 (the minimum standards for management systems), DDOT initiated a process to develop deterioration models for pavement and bridge assets. These deterioration models are based on the extensive historical data residing in the asset management systems. DDOT considered several important factors, such as traffic demand and environmental factors, in developing the deterioration models. For pavements, performance models were developed for IRI to project the Interstate NHS needs. DDOT excluded the PCC pavement subgroup from the analysis for two reasons: 1) data availability and 2) the asset subgroup was a small percentage of the Department's entire inventory. Additional models for all the FHWA-required metrics stipulated by 23 CFR 490 are currently under development and refinement for use in future needs assessment and reporting. These models are expected to be completed in the next year and incorporated into the proposed management system enhancements.

Although DDOT has gathered data on the subgroups of pavement assets, the available data were not in a usable format to develop representative performance models for PCC pavements. Considering that PCC pavements make up about less than five percent of the entire pavement inventory, DDOT made an engineering judgement to exclude that asset subgroup for the LCP analysis with an understanding that it will not have a significant impact on the overall network conditions. The entire network lifecycle analysis was modeled using separate performance models for Interstate pavements and non-Interstate NHS pavements. DDOT is working to develop separate models for the local roads. To address the PCC modeling gap, DDOT will improve its data collection activities to ensure the necessary data is captured in the desired format to add value to future analysis. DDOT will continue to use and build on existing data stored in the respective data management systems to enhance asset deterioration models. Also, DDOT is undertaking needs analysis to acquire computerized off-the-shelf (COTS) systems to support lifecycle planning incorporating the FHWA performance metrics and multiple performance measures to estimate network-level performance.

6.4 Work Types, Treatment Options, and Costs

Among the basic procedures needed for LCP are the selection of work types, definition of treatment options, analysis of associated costs, and the establishment of treatment schedules and meaningful analysis periods. DDOT uses different work types and treatment options to address asset needs depending on the functional classification of the asset, asset subgroup, condition of the asset, expected performance after the intervention, and available funds. Work

types for preserving assets fall within the preservation and maintenance programs, including maintenance, preservation, and localized rehabilitation treatments. Other work types such as heavy rehabilitation and reconstruction fall within the CIP.

The selection of work types and treatment options across asset classes is governed by stated principles and guidelines—decision trees. Pavement treatment costs vary widely depending on the work type, location, and existing condition.

Tables 6-1 and 6-2 contain the cost data and guiding principles DDOT uses in applying interventions for pavements and bridges, respectively. DDOT uses these principles to support the LCP process.

Table 6-1. Pavement Treatment Guiding Principles and Cost Data.

Pavement Classification	Work Type	Treatment Option	Cost (per unit measure)	Application Selection and Schedule (years)
Interstate	Preservation	Crack seal	$4-5/lb	3-5 years, Pavements rated GOOD
	Preservation	Microsurfacing	Pilot ($10/SY)	Pilot preservation on high-volume roads, GOOD and FAIR
	Minor Rehabilitation	Mill and Resurface	$35-75/SY	10 years or as needed based on condition, Pavements rated POOR
	Major Rehabilitation	Reconstruction	$90-155/SY	As needed based on condition and subsurface data, pavements rated POOR
Non-Interstate NHS and non-NHS federal aid	Preservation	Crack seal	$4-5/lb	0-5 years, Pavements rated GOOD
	Preservation	Microsurfacing	Pilot ($10/SY)	Pilot Preservation on High Volume roads, GOOD and FAIR
	Minor Rehabilitation	Mill and Resurface	$35-75/SY	10 years or as needed based on condition, Pavements rated POOR
	Major Rehabilitation	Reconstruction	$155/SY	As needed based on condition and subsurface data, Pavements rated POOR
LOCAL, Non-Federal	Preservation	Crack Seal	$4-5/lb	4-5 years, Pavements rated GOOD
	Preservation	Slurry Seal	$5/SY	6 years, mostly pavements rated GOOD, but also some FAIR (after some repairs are done)
	Minor Rehabilitation	Mill & Resurface	$35-75/SY	As needed based on condition, Pavements rated POOR
	Major Rehabilitation	Reconstruction	$90-155/SY	As needed based on condition and subsurface data, Pavements rated POOR

Table 6-2. Bridge Treatment Guiding Principles.

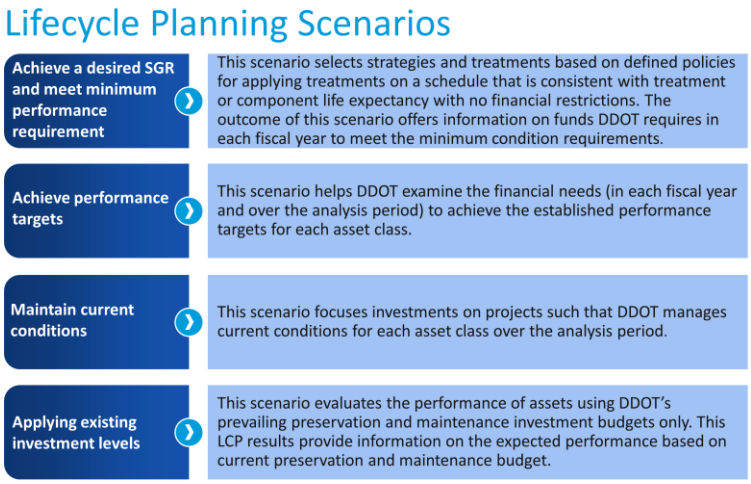
Bridge Component	Work Type	Treatment Option	Cost (per unit cost)	Application Schedule (years)
Deck	Light Preservation	Deck Washing and/or Sweeping	$300/HR	2-3
		Joint Repair	$400/LF	5-10
		Deck Sealing	$20/SY	5-10
		Deck Spall Repair	$200/SY	5-10
		Thin Deck Overlays	$125/SY	10-15
	Heavy Preservation	Deck Full-depth Repair	$350/SY	15-20
		Reconstructing Deck Joints	$500/SY	15-20
Superstructure	Light Preservation	Beam End and Bearing Washing	$300/HR	2-3
		Superstructure Washing	$300/HR	2-3
		Bearing Greasing and Painting Spot and Zone Painting	$30/SF	5-10
	Heavy Preservation	Bearing Replacement		
		Superstructure Repairs Fatigue Retrofitting	$30/LB	10-15
		Superstructure Painting (Smaller Bridges)	$40/SF	10-15
		Pin and Hanger Retrofit		10-15
Substructure	Light Preservation	Concrete Crack Sealing	$60/LF	5-10
		Spot Spall Repairs	$175/SF	5-10
		Crack Sealing		
		Back Wall Beam Seat Repair	$1,250/CY	10-15
		Vegetation Control/Debris Removal from Piers	$300/HR	2-5
		Debris Removal from Channels	$100/CY	5-10
	Heavy Preservation	Pedestals Replacement	$1,000/CY	10-15
		Substructure Repairs	$150/SF	10-15
		Joint Replacement	$40/LF	10-15
All components	Reconstruction/New	Replacement	$400/SF - 700/SF	40-50

6.5 LCP Scenarios

The purpose for developing the LCP scenarios is to offer DDOT a transparent process to determine the lifecycle cost (at the network level) for each asset class, and to evaluate strategies that ensure the efficient use of limited resources. DDOT investigated a variety of LCP scenarios to evaluate options, analyze performance and funding gaps, and to identify investment options to manage the gaps.

Using the pavement and bridge management systems, treatment selection principles (supplemented with expert judgment), unit cost information, and deterioration models developed, DDOT conducted four LCP scenarios. The following sections present results from selected forward-looking scenarios, providing information on the financial needs to achieve the stated goals. The three scenarios presented for pavements provide DDOT with vital information to communicate financial needs and potential risks with decision makers.

The evaluations also showed no significant difference between the results for "maintain current conditions" and "apply existing investment levels" scenarios. Hence the applying existing investment levels results were not presented here. For bridges, the current performance shows that DDOT achieves or exceeds the FHWA minimum performance requirement. If the Department maintains the existing conditions over the duration of the TAMP, bridges will be in SGR. As such, the scenario for achieving minimum condition is similar to maintaining current conditions. The scenario that applies existing investment levels does not offer financial needs information; however, the results provides insight into risk management, and performance management.



6.6 Summary of LCP Results

Using the LCP scenarios described in Section 6.5, the performance and funding needed for DDOT pavement and bridges was conducted. The results of applying the lifecycle cost planning scenarios have been summarized in the sections below.

Pavement LCP Results

Figure 6-2 shows the summary of the 20-year cost (including preservation and maintenance) needed to meet or maintain existing pavement conditions, to achieve

DDOT performance targets, and to meet the minimum federal requirements. The costs associated with achieving each goal is estimated over the assumed 20-years of remaining life for NHS pavements. Maintaining the existing pavement conditions of the system shows higher cost because the existing conditions are higher than the established performance targets and the minimum conditions.

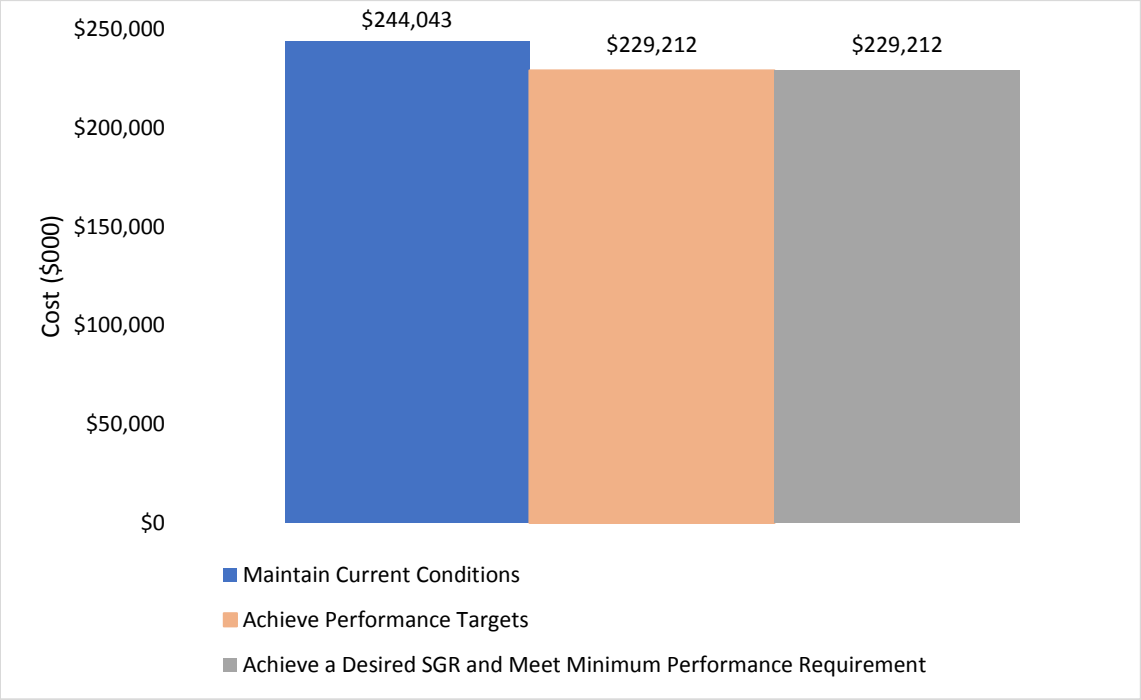


Figure 6-2. Twenty-year Cost for NHS Pavements.

Bridge LCP Results

DDOT evaluated several budget scenarios for NHS bridges. Figure 6-3 shows the costs (including preservation and maintenance and capital improvement) associated with achieving DDOT performance targets for bridges over a 10-year period. The cost includes cost to maintain both NHS and non-NHS bridges. The associated cost to achieve DDOT performance targets is $570 million. Unlike the analysis conducted for pavements, there is a higher level of uncertainty in predicting the funding needed for bridges, as the tools used for the predictions do not have the same level of maturity as the tools used for pavement predictions. However, as the asset management program for bridges matures, DDOT plans on improving these tools for extended analysis of future bridge needs.

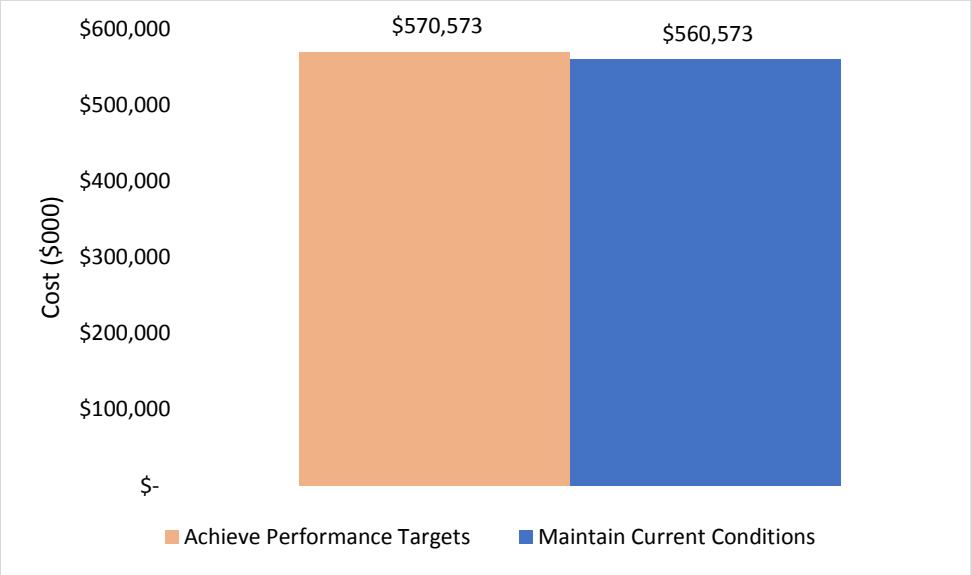


Figure 6-3. Ten-year Cost for Bridges.

Chapter 7 Investment Strategies

7.1 Overview

This chapter outlines DDOT's approach to allocating asset management resources to achieve short- and long-term performance goals, manage risks, and maximize the expected life of assets at a minimum practicable cost. DDOT uses a performance-based approach informed by available funding and expert knowledge to develop investment strategies. Investment strategy is defined as "a set of strategies that result from evaluating various levels of funding to achieve State DOT targets for asset condition and system performance effectiveness at a minimum practicable cost while managing risks."[21]

The remainder of the chapter is as follows:

- **Performance outcome and gap analysis:** This section evaluates network performance and other requirements and assesses existing gaps in asset performance compared to established targets and performance goals.
- **Investment strategies:** This section describes the strategic principles that underline the development of DDOT's investment strategies for TAMP. The section also outlines a 10-year outlook of investment strategies and their expected results.
- **Asset sustainability reporting:** This section provides information related to how DDOT measures asset sustainability to help track, maintain, and improve the value of assets.

7.2 Performance Outcome and Gap Analysis

DDOT conducts constrained and unconstrained scenarios as part of the lifecycle planning analysis to understand annual needs and expected performance and evaluates the resulting gaps between annual needs and projected available funding. In this section, the document evaluates gaps or opportunities. The outcome of the evaluation informs the development of the investment strategies in the subsequent section.

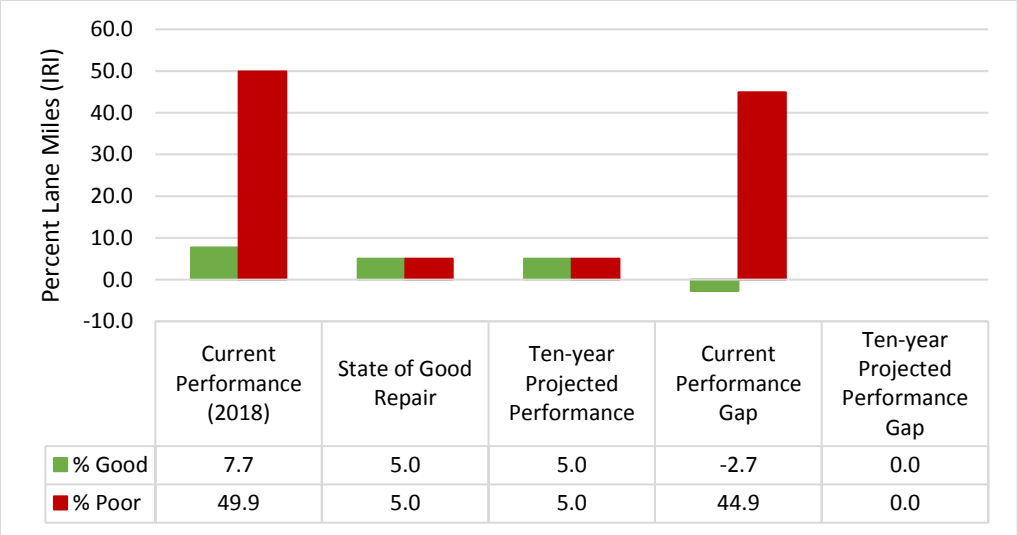
Comparison of Current Conditions with Expected Conditions, FHWA Minimum Asset Performance Requirements, and Established SGR

The section examines the projected conditions of NHS pavement and bridge assets based on forecasted available funding. The baseline conditions are compared to the SGR for assets and the long-term projected performance to help analyze the resulting performance gaps.

[21] FHWA, Developing TAMP Financial Plans, 2017

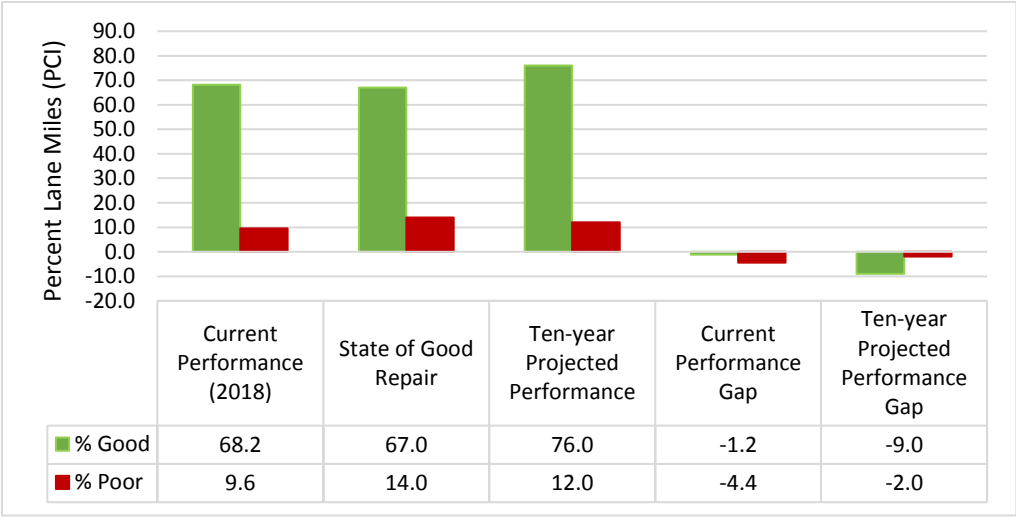
Pavement Performance Gap Analysis

Figures 7-1 and 7-2 show the outcome of the gap analysis for Interstate and non-Interstate NHS pavements. The performance gap is the percentage difference between the long-term projected performance, SGR, and the baseline condition. A negative gap implies that the system performance is declining, and a positive gap implies the system performance is getting better from the baseline condition. It is important to note that this measure is based on only IRI, for Interstate pavements, and can drastically be reduced when DDOT uses all the FHWA pavement distresses. For DDOT to eliminate the 44.9% poor gap, significant investment will be required to resurface almost all the Interstate pavements. As indicated earlier, DDOT is actively working with responsible stakeholders to address this gap.



	Current Performance (2018)	State of Good Repair	Ten-year Projected Performance	Current Performance Gap	Ten-year Projected Performance Gap
% Good	7.7	5.0	5.0	-2.7	0.0
% Poor	49.9	5.0	5.0	44.9	0.0

Figure 7-1. Performance Gap Analysis – Interstate Pavement.

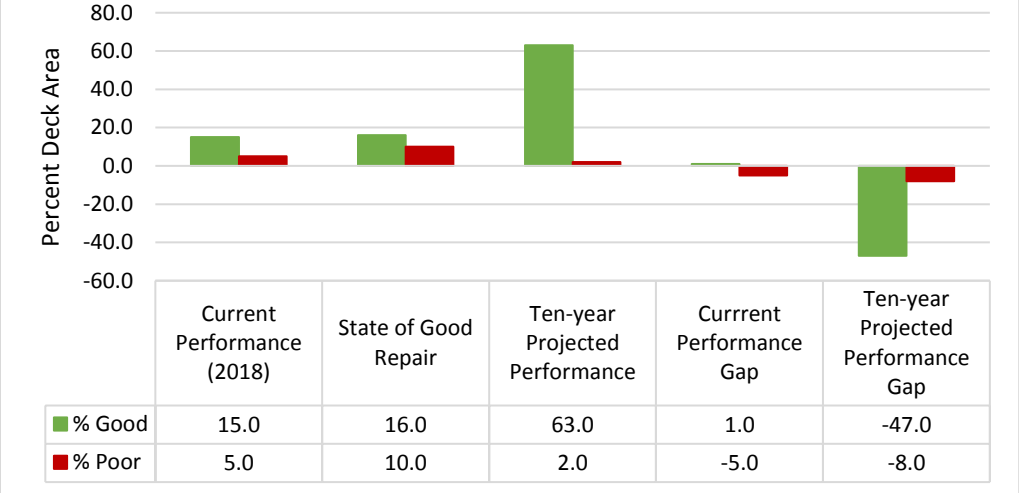


	Current Performance (2018)	State of Good Repair	Ten-year Projected Performance	Current Performance Gap	Ten-year Projected Performance Gap
% Good	68.2	67.0	76.0	-1.2	-9.0
% Poor	9.6	14.0	12.0	-4.4	-2.0

Figure 7-2 Performance Gap Analysis – Non-Interstate NHS Pavement.

Bridge Performance Gap Analysis

Figure 7-3 shows the outcome of the gap analysis for DDOT NHS bridges[22]. The figure shows that the long-term performance and targets are achievable considering the number of bridge programs in the pipeline expected to be completed in the next three years. Currently, DDOT meets and exceeds the minimum condition requirement for NHS bridges. In fact, only 5% of DDOT's NHS bridge inventory is classified as poor. DDOT expects to reduce the poor percent deck area in the coming years.



	Current Performance (2018)	State of Good Repair	Ten-year Projected Performance	Currrent Performance Gap	Ten-year Projected Performance Gap
% Good	15.0	16.0	63.0	1.0	-47.0
% Poor	5.0	10.0	2.0	-5.0	-8.0

Figure 7-3 Performance Gap Analysis – All NHS Bridges.

7.3 Investment Strategies

Guiding Principles

Based on the performance gap analysis, risk analysis results, and the financial planning, DDOT has adopted a set of strategic principles to guide the development of investment strategies that seek to maintain SGR while making progress towards the achievement of performance targets and national goals. The effect of TAMP processes are reflected in the guiding principles. The principles focus on strategic investment in preservation, consider asset and system performance-improvement, apply risk, and balance available funding.

The five strategic principles guiding the investment strategies include:

Apply low-cost treatments (preservation) to "Good" condition assets to maintain a state of good repair

DDOT adopts this strategy as the first defense to ensure that existing asset conditions do not decline significantly for the prevailing financial situation. This "fix it first" approach ensures that assets in good conditions receive appropriate funding to keep them in good condition for longer periods. This approach enables DDOT to avoid higher-cost remedies

[22] These bridges do not include non-DDOT NHS bridges. For example, bridges owned by NPS.

in the future. As indicated in the lifecycle planning chapter, a quick fix preservation activity to return assets into their original condition could save DDOT a significant amount of dollars in the future by avoiding costly rehabilitation or reconstruction activity.

SGR strategies refer to the application of treatments on a defined schedule consistent with the expected life of asset components and backed by policies or decision principles. This approach ensures that minimum amount of maintenance is deferred considering financial constraints. Deferred maintenance accelerates deterioration of assets and increases lifecycle costs, since costly and extensive work will be required in the future. This strategy ensures that the decision principles for treatment selection and application developed in the lifecycle planning chapter are applied during the development of investment strategies. DDOT uses this strategy for pavement, bridge, and tunnel assets.

Maintain or reduce the number of poor bridges

DDOT uses this investment strategy to address the need to meet federal minimum performance requirements. In the past, DDOT's bridge inventory included a significant number of poor bridges, far over the required minimum surface area for NHS bridges stipulated in the federal rules. Consistent investments in bridge assets have resulted in the steady decline in the number of poor bridges on the District network. Currently, less than one percent of DDOT-owned NHS bridge inventory is considered poor. DDOT's goal is to ensure the number of poor bridges does not increase. This investment strategy enables DDOT to prioritize bridge projects to keep this steady state.

Halt the deterioration of large, critical bridges and pavements in the District

DDOT bridge inventory includes large bridges that contribute significantly to the total surface area of NHS bridges in the District. During the risk analysis process, the risk workgroup discussed the threats that exist if one of these large, critical bridges is categorized as poor condition. Due to the size of their deck area, these bridges can significantly increase the total deck area of bridges considered to be poor and hence impact DDOT's ability to meet federal regulations and established performance targets. To address this risk, DDOT uses this investment principle to identify high-risk bridges and target resources to ensure preservation and maintenance treatments address critical elements and components on these large bridges to halt their deterioration.

DDOT uses these strategic principles to address pavement needs as well, and to develop investments for the available budget to ensure that resources are efficiently allocated, risk is efficiently managed, and cost is practicably minimized.

Improve asset conditions

The preceding investment principles focus on halting and preserving existing asset conditions from further deterioration. They mainly focus on preservation and preventive maintenance programs. DDOT targets these investments to ensure that existing conditions of physical assets on the network are properly maintained to avoid reactive

and costly repairs as well as to help meet national goals. Since asset management seeks to improve decision-making processes to benefit asset conditions, this investment principle focuses on actions that will improve upon current conditions and to enable DDOT to meet and exceed the national performance goals as well as achieve established performance targets. Whereas the previous investment principles prioritize preservation, this approach will focus on capital investments in rehabilitation and reconstruction to help DDOT improve asset conditions and to meet expected demand and performance.

Align investments to improve system performance

DDOT maintains several infrastructures that collectively work to move goods and people efficiently. Improving the conditions of physical assets must align with other investments that seek to improve the overall performance of the District's transportation network. Hence, addressing asset conditions must consider efforts to promote safety, reduce congestion, and improve access to multimodal transportation. Investment types in this category will apply investments that holistically address multiple needs such as improving intersection turning lanes, adding bicycle lanes, improving sidewalks, etc. This investment principle encourages tradeoff analyses in the decision-making process.

Investment Strategies Development Process

Figure 7-4 shows the framework DDOT used in developing the investment scenarios with available data. DDOT used this step-by-step approach to conduct the investment scenarios (refer to the Lifecycle Planning Chapter for the scenarios) applying the guiding principles.

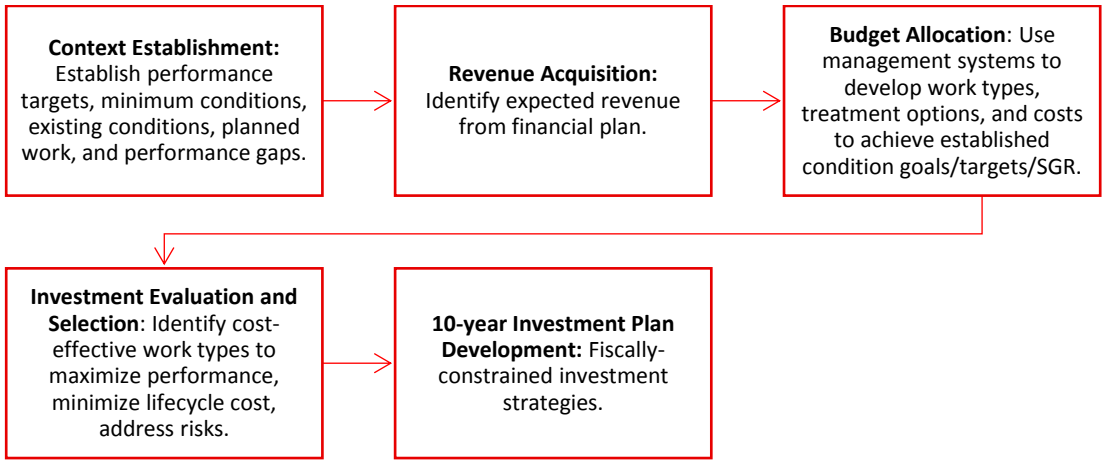


Figure 7-4. Investment Strategies Development Steps.

Investment Strategies Outcome

NHS Pavement Investments

Figure 7-5 illustrates the investment mix for DDOT-maintained NHS pavements for the duration of the TAMP. In the next ten years, DDOT expects to invest approximately $320

million in NHS pavements consisting of preservation, minor rehabilitation, and capital improvement investments. Fifty-nine percent (approximately $190 million) of this total is expected to go into CIP (mostly reconstruction projects) with 41% (about $130 million) going into preservation and maintenance program (mostly preservation and minor rehabilitation projects).

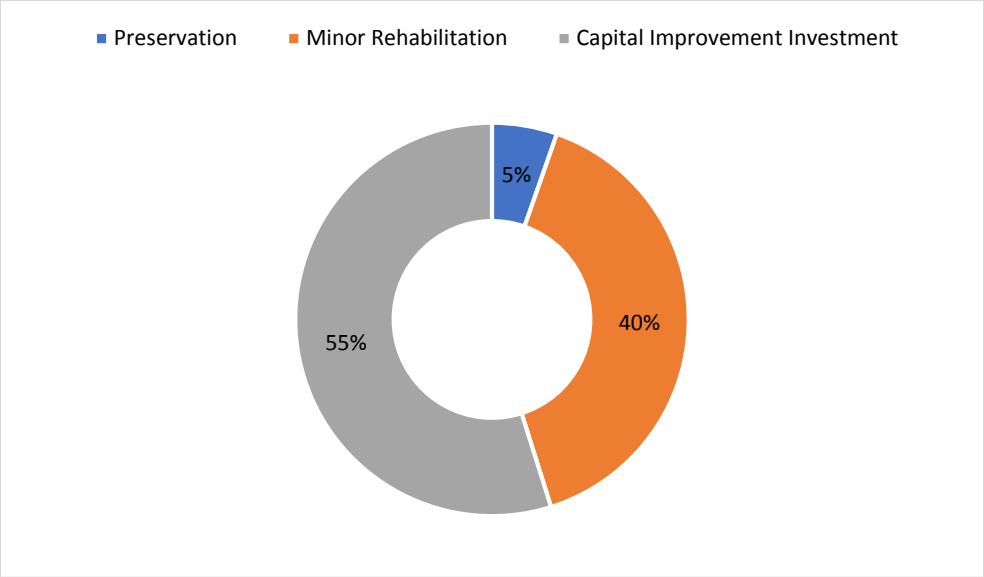
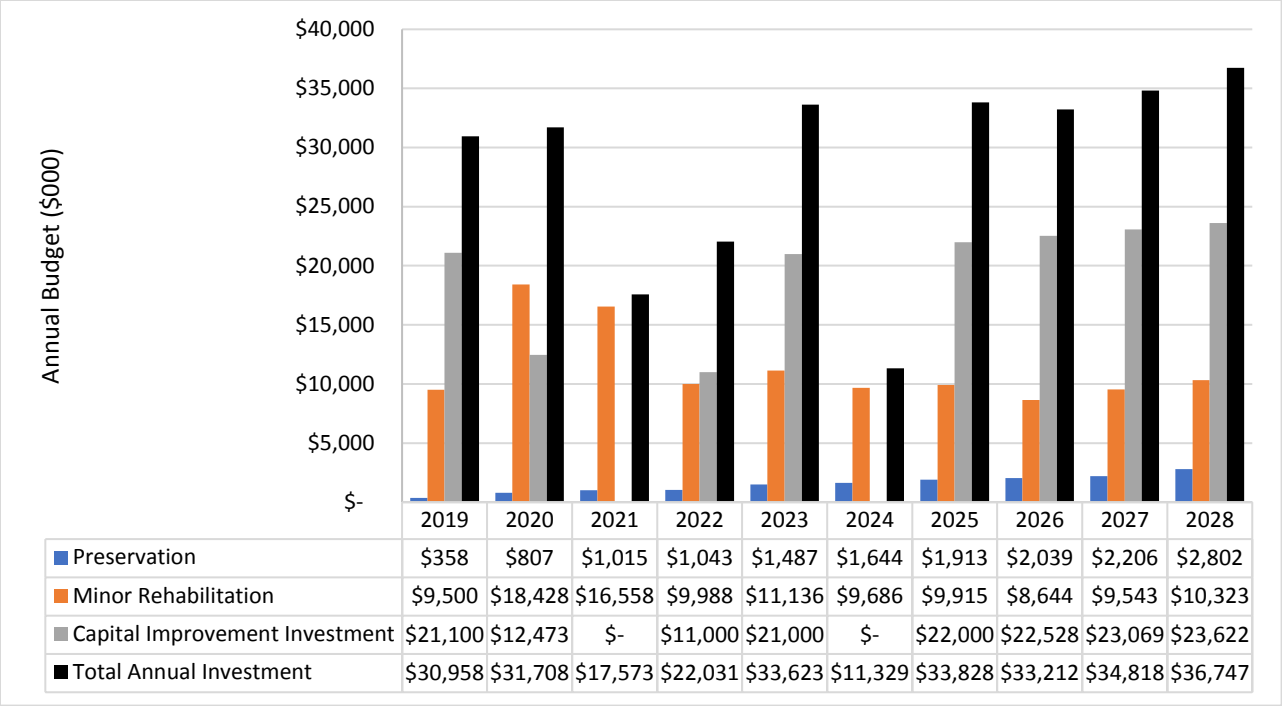


Figure 7-5. NHS Pavement Ten-year Investment Strategy.

Figure 7-6 shows the expected annual expenditure in each investment type—preservation, minor rehabilitation, and capital improvement investment.

Figure 7-7 shows the expected performance outcome for Interstate pavements considering the expected preservation and maintenance funding and investment strategies. Using IRI as a measure, DDOT will be able to achieve the percent good performance target by the year 2022. The percent poor on the Interstate decreases significantly for the first two years and remains steady to reach and exceed the minimum allowable of 5% or achieves the performance targets. This indicates DDOT will have to invest additional funds in the Interstate pavement to reduce the percent poor pavements significantly, which is indicated in the figure below. The financial chapter shows the funding gaps between current and needed funds to achieve the targets.



	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
Preservation	$358	$807	$1,015	$1,043	$1,487	$1,644	$1,913	$2,039	$2,206	$2,802
Minor Rehabilitation	$9,500	$18,428	$16,558	$9,988	$11,136	$9,686	$9,915	$8,644	$9,543	$10,323
Capital Improvement Investment	$21,100	$12,473	$-	$11,000	$21,000	$-	$22,000	$22,528	$23,069	$23,622
Total Annual Investment	$30,958	$31,708	$17,573	$22,031	$33,623	$11,329	$33,828	$33,212	$34,818	$36,747

Figure 7-6. Annual Investment Trend – NHS Pavement.

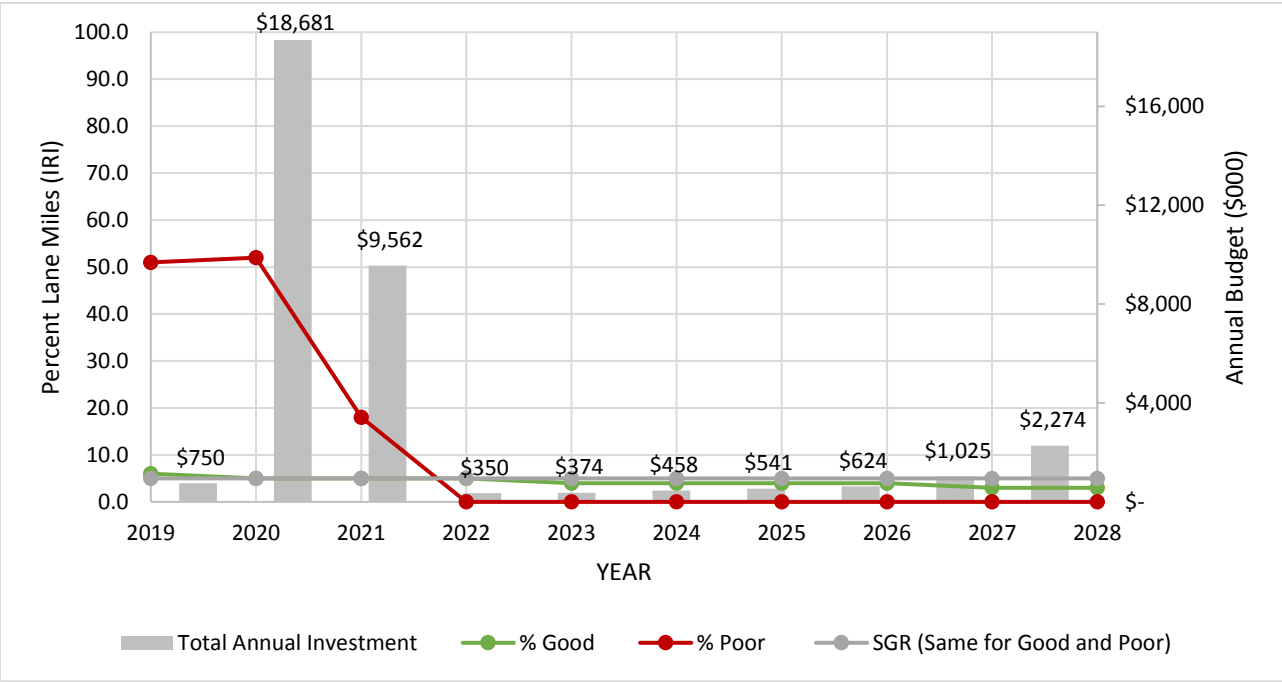


Figure 7-7. Projected Performance and Funding – Interstate Pavement.

Similarly, Figure 7-8 shows the expected performance outcome for non-Interstate NHS pavement. The figure shows that with PCI as a measure of performance, the Department far exceeds the performance targets (i.e., % Good and % Poor) for this pavement category. For the prevailing investment strategies, DDOT achieves and exceeds the performance for

the out years until 2028. This achievement is very significant considering that majority of the travels on the NHS occurs on the non-Interstate NHS pavement. As the Department transitions to using all the condition metrics in assessing network performance, there is an expectation for some of these performance outcomes to become better in the future.

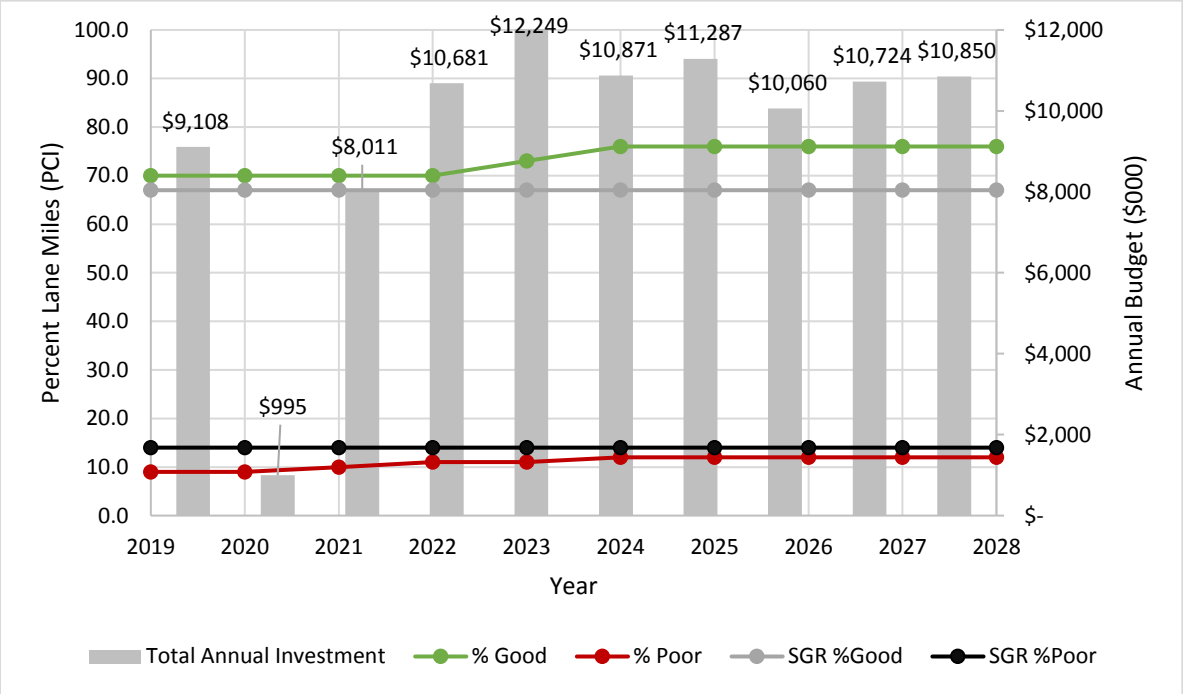


Figure 7-8. Projected Performance – Non-Interstate Pavement.

NHS Bridge Investments

Figure 7-9 represents the expected investment mix for DDOT maintained NHS bridges for the duration of the TAMP. In the next ten years, DDOT expects to invest approximately $570 million in bridges on the network. Ninety percent (approximately $515 million) of this total investment is expected to go into capital improvement investment. The preservation and maintenance program make up 10% of the total investment. Figure 7-10 shows the expected annual expenditure in each investment type—preservation and maintenance (i.e., light preservation and heavy preservation) and capital improvement investment.

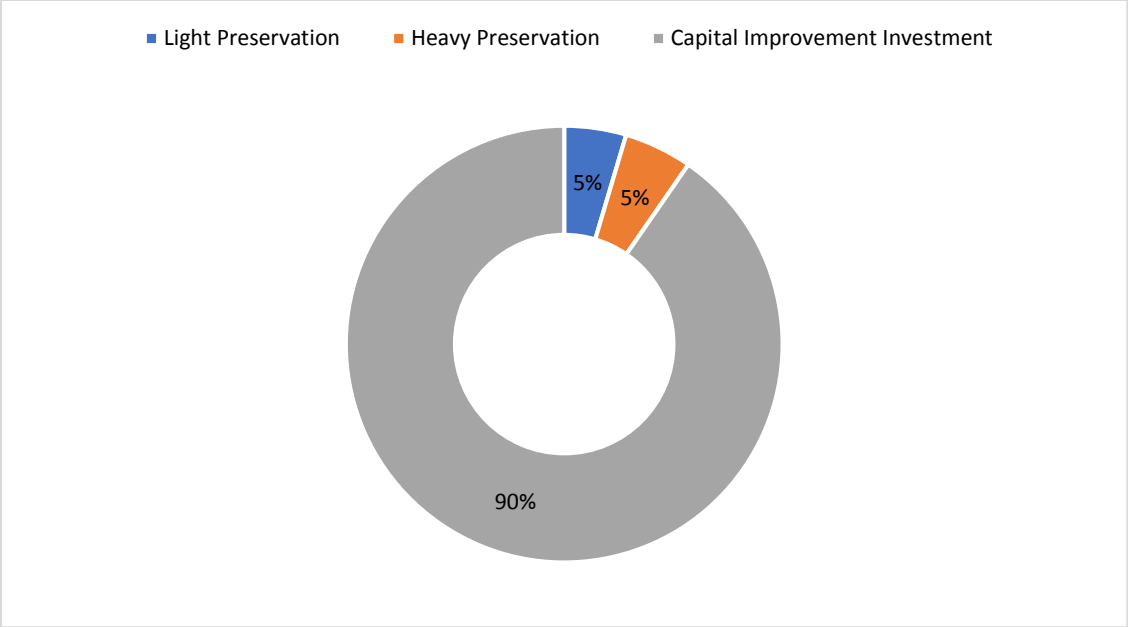
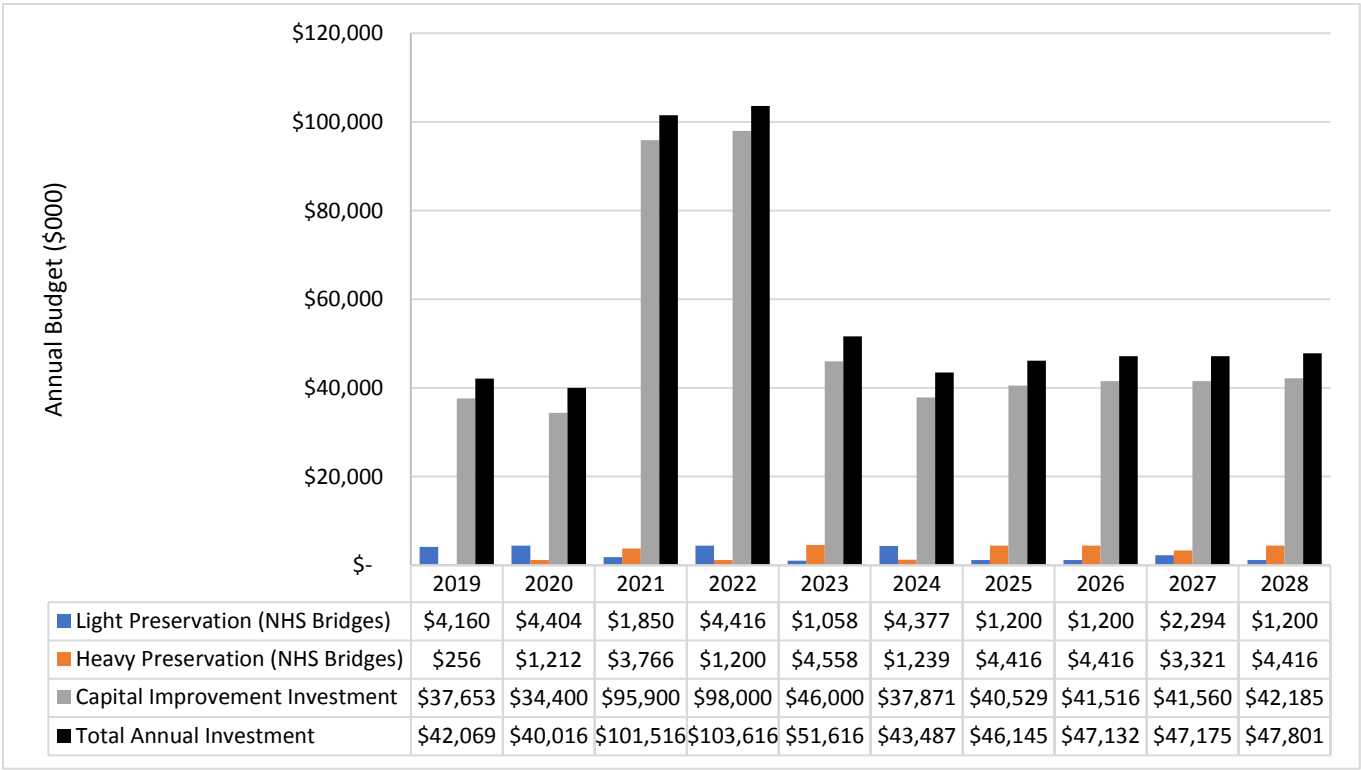


Figure 7-9. NHS Bridges 10-year Investment Strategy.



	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
Light Preservation (NHS Bridges)	$4,160	$4,404	$1,850	$4,416	$1,058	$4,377	$1,200	$1,200	$2,294	$1,200
Heavy Preservation (NHS Bridges)	$256	$1,212	$3,766	$1,200	$4,558	$1,239	$4,416	$4,416	$3,321	$4,416
Capital Improvement Investment	$37,653	$34,400	$95,900	$98,000	$46,000	$37,871	$40,529	$41,516	$41,560	$42,185
Total Annual Investment	$42,069	$40,016	$101,516	$103,616	$51,616	$43,487	$46,145	$47,132	$47,175	$47,801

Figure 7-10. Annual Investment Trend – DDOT-owned Bridges.

Figure 7-11 shows the expected performance outcome for DDOT NHS bridges considering the available funding and investment strategies. DDOT will be able to achieve the percent good performance target by the year 2022. On the other hand, the percent poor deck

area does not reach the performance target until 2024. However, the percent poor deck area does not exceed the minimum allowable of 10%. After 2024, the percent poor deck area almost reaches zero for all DDOT NHS bridges.

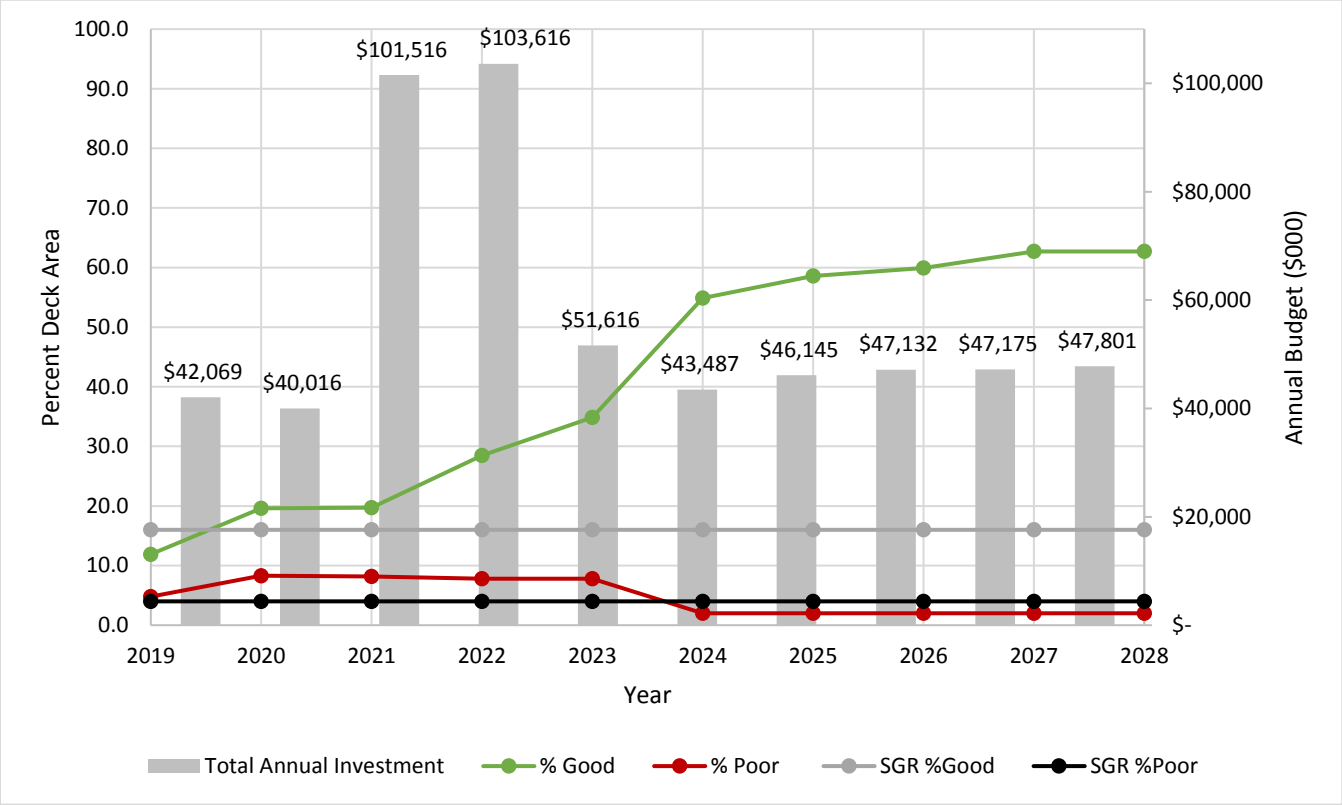


Figure 7-11. Projected Performance – DDOT-owned NHS Bridges.

Challenges and Gaps Hindering Performance Targets and SGR Achievement

DDOT recognizes the challenges that could hinder the Department from making progress toward the achievement of SGR or performance targets. For example, DDOT's NHS bridge inventory shows that three percent of the total deck area is on SD or poor bridges. This indicates that DDOT has achieved or exceeded the minimum requirement for DDOT-owned NHS bridges. However, a portion of the NHS bridges managed by external stakeholders is not in very good condition. Specifically, over 50 percent of NPS bridge deck area is on SD bridges, which can impact the overall performance of NHS bridges on the District's network. NPS is working to address the condition of the GWMP bridge. The expected completion of this project is 2021. Upon completion, this project will significantly impact the achievement of performance targets and SGR for bridges.

In addition, NPS uses different pavement performance measures in assessing conditions and their established performance targets based on these metrics. The disparity in performance measures can challenge or hinder DDOT from achieving the national goals and performance targets, or from sustaining a desired SGR for pavement assets in the

long-term. DDOT will continue to collaborate with NPS to ensure these gaps are addressed to improve the communication of the TAMP. One opportunity that DDOT will leverage in the future to address this issue is using gathered data on all NPS pavements to conduct a holistic analysis for the District's pavements based on the national measures and project performance based on available budget.

DDOT has undertaken several initiatives to establish performance targets for the District by including all external stakeholders. The challenge is that NPS is a multijurisdictional agency overseeing and administering investment priorities in multiple States. DDOT has limited authority to influence the investment priorities of NPS (the second-largest owner of NHS assets in the District) to support target achievement or sustain a desired SGR for assets in the District. However, DDOT's continuous collaboration with NPS will enable DDOT to identify strategies to address these challenges and bring all vehicular bridges and pavement assets in the District to SGR.

DDOT's mission and vision statements embody safety and the efficient movement of people and goods. These strategic statements are evident in key initiatives undertaken within the District. For example, the Mayor's Vision Zero initiative looks to achieve zero fatalities and serious injuries to travelers of the Districts' transportation system. DDOT envisions that investments in these initiatives and other programs such as the "Complete Streets" policy will impact the safety of road users and the efficient movement of goods and people. The "Complete Street" policy has gained positive reviews pertaining to the safety and commute of residents. For example, intersection safety projects could eliminate right turns on red, add turning lanes, bike lanes, and measures to protect the safety of pedestrians. These types of work may also include resurfacing existing pavements and improving asset conditions.

7.4 Asset Sustainability Reporting

Asset sustainability is a concept for measuring the long-term performance of physical assets. This concept uses different indices to measure asset owners' ability to invest appropriately to address asset needs and maintain or improve asset value. Asset sustainability index (ASI) can be measured in terms of financial capacity to maintain some level of performance or as a measure of asset value over a defined period. Asset sustainability in this context means the ability of DDOT to meet financial obligation to achieve the established performance targets.

FHWA recommends four methods for measuring an agency's sustainability in managing assets[23].

DDOT used the following ratio adopted from the FHWA Quick Guide for ASI to develop the resultant indices:

[23] FHWA, Asset Sustainability Index: Quick Guide. 2013

$$Asset\ Class\ Sustainability\ Ratio = \frac{Asset\ Class\ Fiscal\ Year\ Budget}{Asset\ Class\ Fiscal\ Year\ Needs}$$

An index of 1.0 or more indicates that DDOT is investing at optimum levels to maintain or improve performance. An index of less than 1.0 indicates that DDOT is underfunding asset needs and will need additional investment to close the investment gap to achieve and exceed the performance targets. Using the results from the financial projections and LCP analysis, DDOT estimates the ASI for bridges to be around 0.98.

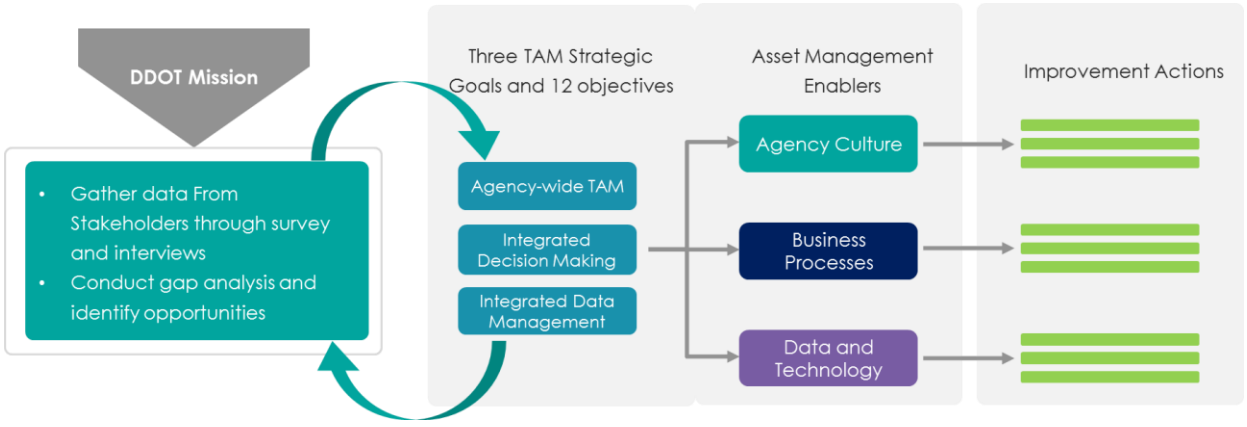
Chapter 8 Opportunities for Improvement

8.1 Overview

This chapter contains priorities to achieve incremental improvement in the processes that enable efficient and effective asset management. These priorities address existing gaps and take advantage of opportunities to enhance asset management and create efficiencies in resource application. The priorities also set the foundation for continuous improvement in processes while building on existing strengths and resources.

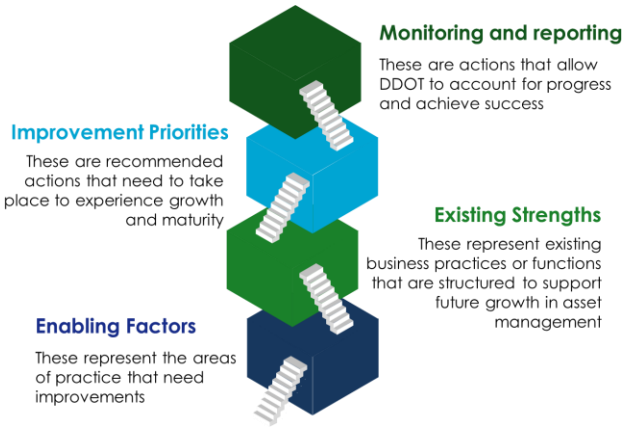
In 2017, DDOT initiated an effort to conduct a TAM self-assessment, establish TAM maturity, and develop a TAM strategic direction to guide the improvement of TAM across the Department. The improvement areas and priorities described in this chapter focus on key actions to improve the quality of the information in the TAMP and effectiveness of TAM processes.

The contents of this chapter are reinforced by information gathered from conducting the agency-wide TAM self-assessment and gap analysis and are linked to the Department's mission and asset management strategic direction including goals and objectives. The figure below shows how these elements are connected to produce the improvement actions.



Specifically, this chapter documents the following:

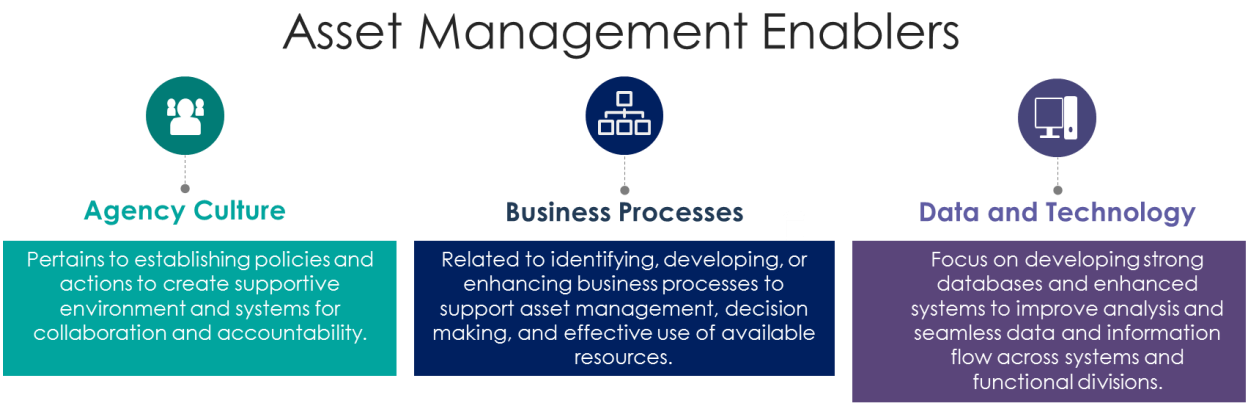
- **Asset management enablers:** Related to agency culture, business processes, and data and technology.
- **Existing strengths**
- **Improvement areas and priorities**
- **Monitoring and reporting:** Procedures to help account for progress and successes.



Integrating these four components for enhancement would enable DDOT to capitalize on existing strengths and develop an improvement plan to augment the practice of asset management.

8.2 Asset Management Enablers

Asset management enablers are policies, procedures, structures, and tools that provide additional motivation for improvement. The TAM self-assessment, gap analysis, stakeholder interviews, and TAMP development process revealed the need for DDOT to focus on three key asset management enablers—developing a stronger ***agency culture*** for asset management, enhancing ***business processes***, and improving ***data quality and technological capabilities*** to support data-driven decision making. Asset management relies on quality and accurate data and information. By enhancing the analytical capabilities of the asset management systems, DDOT can improve the efficiency and reliability of asset management decisions.



8.3 Existing Strengths

Across DDOT, various divisions and business functions engage in actions and implement business processes that lead to effective and efficient use of resources. Many of the existing principles can provide a strong foundation for implementing and improving TAM practice. These strengths were identified through the self-assessment and gap analyses. Examples of the strengths have been grouped under the three asset management enablers—agency culture, business processes, and data and technology. It is important to note that these strengths are not exhaustive. A complete list of the strengths identified during the TAM self-assessment and gap analysis is documented in a standalone technical memorandum[24]. One of the biggest strengths is the availability of data to support analysis. In fact, DDOT estimates PCI by combining all the data metrics under 23 CFR 490. This indicates that DDOT has been collecting data in compliance with 23 CFR 490, except that the Department did not apply the data the same way FHWA requires conditions to be assessed. The data is available and will be used appropriately in future TAMPs.

[24] District Department of Transportation (DDOT) TAM Baseline, January 2018.

Agency Culture

Strength

- There is a strong recognition within the Department that an asset management approach is essential to the sustainable performance of the transportation network and the efficient use of limited resources.
- The workforce possesses a combination of asset management skills, knowledge, experience, and values to support the Department to achieve asset management objectives while adapting to changing budget needs.
- There is an increased asset management awareness/competence in key divisions beyond pavement and bridges to support an agency-wide approach to TAM.
- DDOT is a centralized organization, which can enable the seamless flow of information, better collaboration with managers, and elimination of duplicate efforts and activities among divisions.

Business Processes

Strength

- The Department has built a strong foundation in performance management through the annual Performance Accountability Report (PAR), which can be extended to physical infrastructure.
- DDOT has an logical approach to project selection that can be formalized to enable future replication.
- There exists an approach to projecting future financial needs using condition-based goals and a historical expenditure approach for local roads.

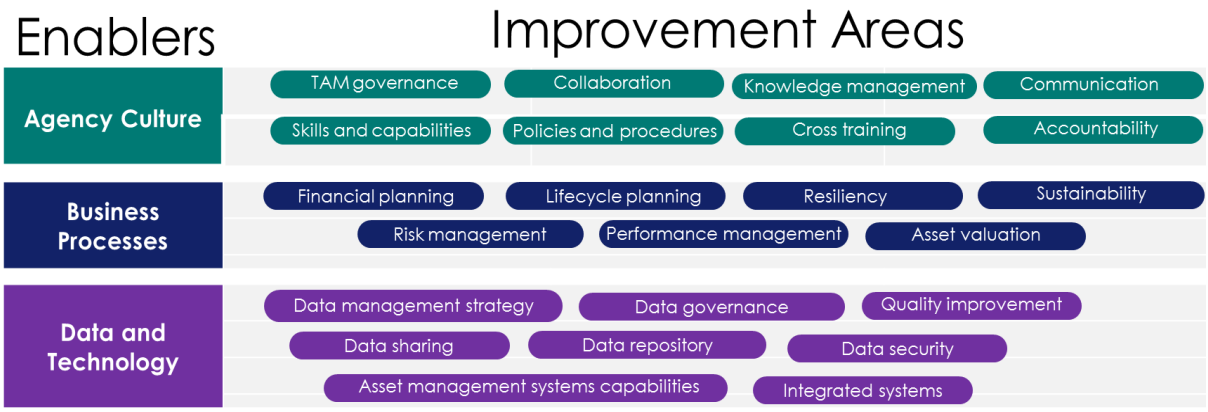
Data and Technology

Strength

- Asset data availability – The Department gathers and maintains up-to-date data on its assets including bridge, pavement, tunnels, alleys, and sidewalks.
- Asset condition metrics – DDOT has been gathering data on all roadways using all the required FHWA condition metrics including IRI, faulting, cracking percentage, and rutting.
- Existing assets (bridge and pavement) metrics are expected to meet the federal standards over the timeframe of the TAMP.
- Information systems – There are well-developed information systems for the bridge and pavement programs that can be enhanced to support the critical analysis required in the TAMP.
- There is great potential in existing information management tools to support asset management. For example, tools such as the Protrack-Plus, CityWorks, Capital Asset Replacement Scheduling System (CARSS), SABRE, etc. can provide avenues for data integration and information sharing.

8.4 Improvement Areas

The improvement areas are the parts DDOT will have to direct resources to in order to make an incremental improvement in asset management maturity. Each improvement area is linked to one of the asset management enablers as illustrated in the figure.



8.5 Improvement Priorities

The effective way to drive and sustain the incremental improvements envisioned by DDOT is by aligning the improvement priorities with the asset management strategic direction. The improvement priorities are recommended actions to address the identified gaps as well as to take advantage of existing opportunities, such as a performance management culture, existing data, and tools, etc., to grow asset management practice and to improve resource utilization. The following paragraphs list and categorize the recommended actions under specific asset management enablers. While some of these actions are continuous and have no completion dates, several of them are ongoing and are expected to be completed in the next year or two.

Agency Culture Action Items	Status	Complete
Complete the TAM Strategic Plan, continuously monitor and evaluate progress, and update the plan frequently—at least every three years.	In progress	December 2019
Improve TAM governance throughout the Department to accommodate continuous staffing changes—update the governance structure frequently and communicate with the team regularly to accommodate staffing changes and requirements updates.	In progress	Continuous process
Develop a knowledge management plan to capture and retain existing staff knowledge and address succession challenges.	Not started	December 2020
Develop a TAM communication plan to guide the effective dissemination of TAM information among internal (including the executive team) and external stakeholders including the public.	Not started	June 2020
Develop a TAM training plan targeting skills and capabilities assessment, development, and enhancement.	Not started	June 2020
Develop an asset management implementation framework to facilitate the inclusion of other assets beyond pavement, bridge, and tunnels into the Agency's TAMP.	Not started	June 2020

Business Processes Action Items	Status	Complete
Develop and document pavement management policies detailing governing decision trees, key assumptions, and deterioration models.	In progress	June 2021
Develop and document bridge management policies detailing governing decision trees, key assumptions, and deterioration models.	In progress	June 2021
Develop a knowledge management plan to capture and retain existing staff knowledge and address succession challenges.	Not started	December 2020
Develop treatment decisions and cost information databases for bridge and pavement work to improve long-term financial planning, lifecycle planning, and asset valuation.	Not started	June 2020
Establish standard definitions and conventions for processes among finance and other divisions to help integrate other planning processes with TAM and to track financial information related to project and program types.	In progress	June 2020
Develop a plan to include the national highway performance program measures in decision evaluations—evaluate network performance outcomes based on multiple performance measures.	Not started	June 2020
Develop and document an objective and more integrated approach to value highway assets based on asset conditions and other important decision criteria.	Not started	June 2020
Identify an improved, objective approach to analyzing the risk impact on agency goals and asset performance.	In progress	June 2023
Develop a risk management implementation plan to address the identified risks, improve system resiliency, and improve accountability.	In progress	June 2023
Integrate and align existing performance management activities in the Department with asset management.	In progress	December 2020
Review performance targets frequently and update them accordingly.	In progress	Continuous process

Data and Technology Action Items	Status	Complete
Establish a common understanding of strategic data management agency wide.	Not started	June 2021
Establish an agency-wide data governance structure.	In progress	June 2021
Develop an implementation framework and guide to manage critical data throughout its lifecycle.	Not started	June 2021
Develop a strategic data management plan for assets to facilitate the seamless flowing and sharing of data and information both vertically and horizontally across the Agency.	Not started	June 2021
Develop quality management plans (QMP) for bridge and pavement data collection and processing.	In progress	June 2020
Develop an inventory of existing management systems that support effective asset management.	Not started	June 2020
Discover and enhance the analytical capabilities of existing asset management systems to meet federal requirements.	In progress	June 2020
Develop a systems architecture to support an integrated asset management system incorporating legacy data and multiple linear referencing systems.	Not started	June 2020
Develop a decision-support framework and supporting tools to enable the implementation of tradeoff analysis.	Not started	June 2023

8.6 Monitoring and Reporting

As demonstrated throughout this chapter, several initiatives such as structuring the governance of TAM, communicating the purpose and importance of TAM, and demanding accountability from stakeholders can enable DDOT to align agency culture and behavior with asset management goals, objectives, and practices. The foundation of cultural or behavioral change is effective communication to foster integrated decision-making. DDOT will work with key divisions and stakeholders to implement these actions to support the strategic direction of the Department's asset management program. As part of the recommendations, DDOT will establish an asset management implementation team to oversee the implementation of these actions collaborating with principal owners across the Agency. DDOT will review these actions annually to ensure that significant progress is made to accomplish these efforts. In the TAM strategic plan, DDOT will identify responsible parties or individuals to own these actions and monitor implementation. The implementation team will act as an oversight group providing guidance and ensuring there are adequate resources available to implement the activities.

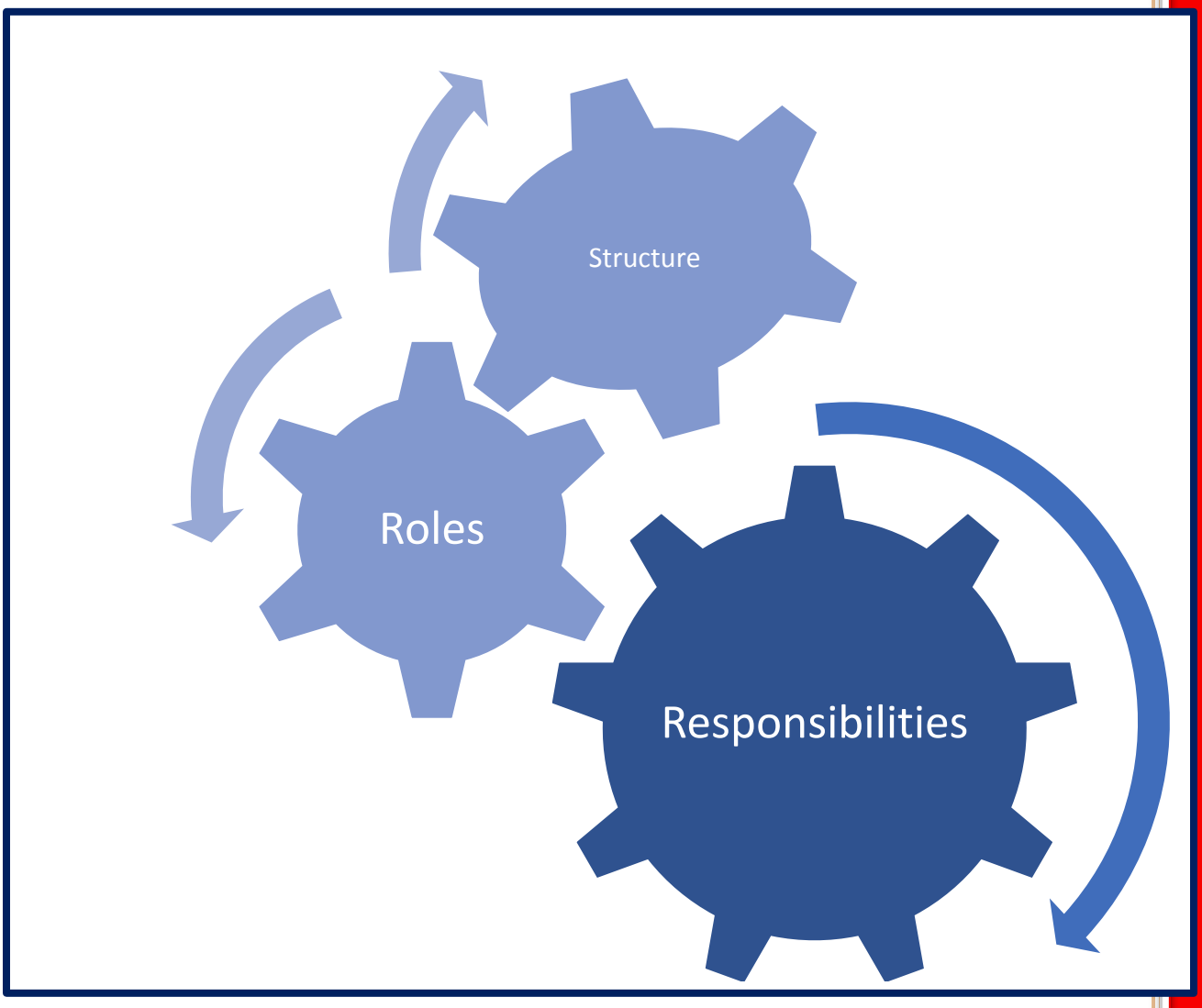
Glossary

AASHTO	American Association of State Highway and Transportation Officials
AOC	Architect of Capitol
ASI	Asset Sustainability Index
BrM	Bridge Management
CIP	Capital Improvement Program
CS	Condition State
DDOT	District Department of Transportation
DOTs	Departments of Transportation
EFLHD	Eastern Federal Lands Highway Division
FAST	Fixing America's Surface Transportation Act
FHWA	Federal Highway Administration
FY	Fiscal Year
HPMS	Highway Performance Monitoring System
HTF	Highway Trust Fund
IPMD	Infrastructure Project Management Division
IRI	International Roughness Index
ISO	International Organization for Standardization
LCP	Lifecycle Planning
MAP-21	Moving Ahead for Progress in the 21st Century
MWCOG	Metropolitan Washington Council of Governments
NBI	National Bridge Inventory
NBIS	National Bridge Inspection Standard
NHPP	National Highway Performance Program
NHS	National Highway System
NPS	National Park Service
NTIS	National Tunnel Inspection Standard
PCI	Pavement Condition Index
PMS	Pavement Management System
ROW	Right-of-way
SHF	State Highway Fund
SNTI	Standards for National Tunnel Inspection
SGR	State of Good Repair
SOS	State of the System
STIP	Statewide Transportation Improvement Program
SY	Square Yard
TAM	Transportation Asset Management
TAMP	Transportation Asset Management Plan
TMS	Tunnel Management System
TMMS	Tunnel Maintenance Management System

TOMIE	Tunnel Operations, Maintenance, Inspection, and Evaluation
VMT	Vehicle Miles Traveled
WMATA	Washington Metropolitan Area Transit Authority

Appendix A – DDOT Asset Management Governance Document

DDOT Asset Management Governance Document



District Department of Transportation

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

Introduction

This Governance Plan describes the framework governing the District Department of Transportation (DDOT) Transportation Asset Management Plan (TAMP). DDOT views Transportation Asset Management (TAM) as a way of doing business and acknowledges that TAM is pervasive, extending across all business divisions within the Department to ensure assets are maintained in a state of good repair. As such, DDOT has developed a TAMP governance structure that looks to integrate the expertise of representatives from various divisions to help propagate and apply this business practice into the day-to-day decision-making process in the Department.

Sections in this plan will be synthesized and included in Chapter Two (Transportation Asset Management) of DDOT's TAMP.

Asset Management Governance and Structure

The success and maturity of DDOT's TAM program are dependent on the integral linkages between DDOT's business strategy and direction and the divisions responsible for the implementation and application of TAM strategies to develop a coherent TAMP. The TAM governance and structure provides a formal process and authority for decision making in the Department related to TAM.

TAMP Governance Goals

DDOT's TAMP Governance is developed to:

- Establish and implement a structure within DDOT to administer the TAMP.
- Make day-to-day decisions concerning the contents and direction of the TAMP.
- Provide strategic direction, develop TAMP contents, and implement TAM procedures to ensure the achievement of asset management goals.

TAMP Governance Structure

Figure 1 shows the main components forming the governance body of the TAMP at DDOT. DDOT's TAMP governance structure is a four-tier authority and guidance bodies consisting of four key components namely:

- The Director and Executive Oversight Team
- Senior Management Oversight and Steering Committee
- Project Management Team
- Asset Management Workgroups

d. TAMP Team

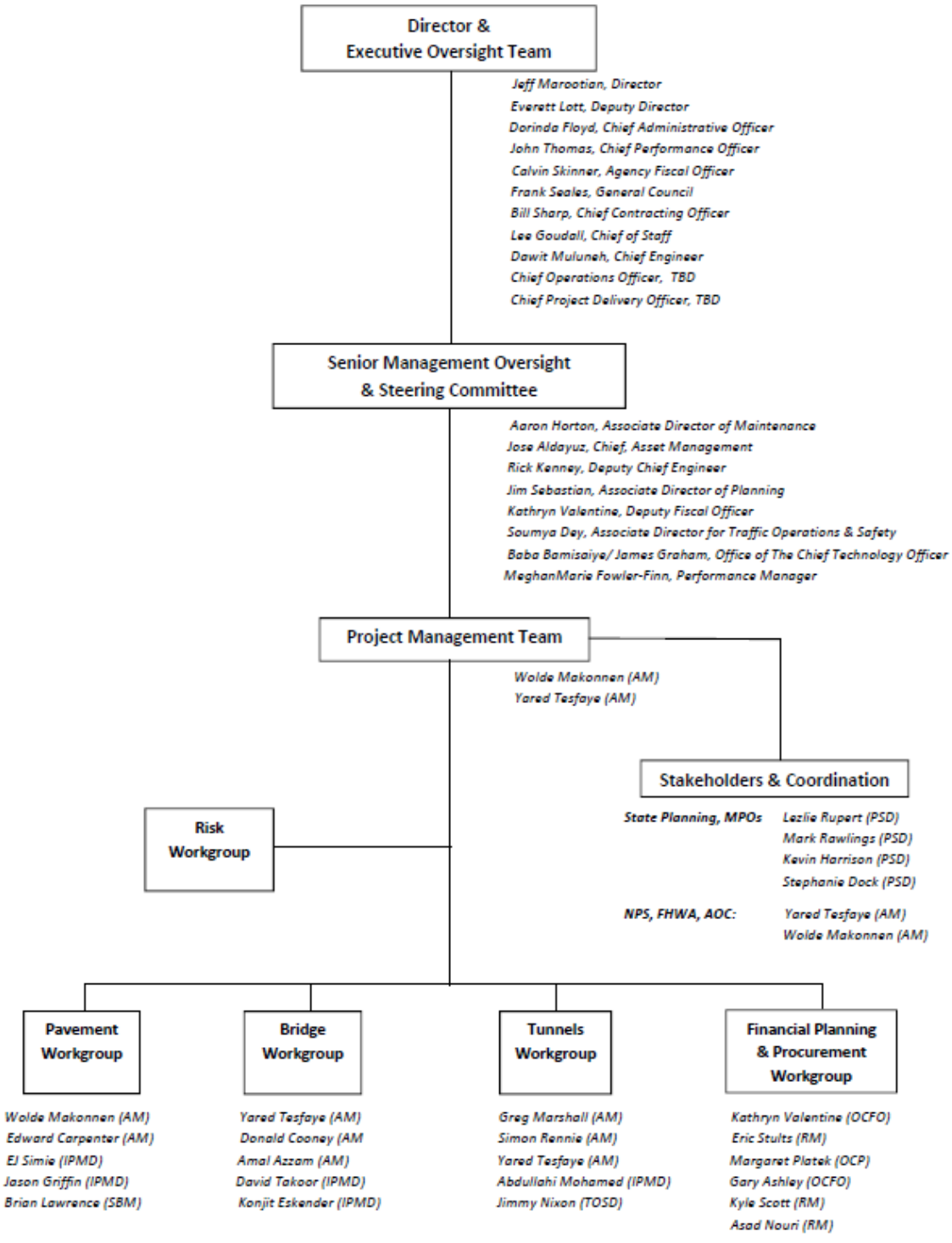


Figure 1. TAMP Governance Structure and Team Members.

Roles and Responsibilities

DDOT has defined and structured the following roles and responsibilities, with the goals and objectives of TAM in mind, to align with existing DDOT business and strategic management practices. Representatives from each governance component are expected to work cohesively to develop the TAMP and support the integration of the results into decision making.

Table 1 shows the components of the TAMP governance structure and the assigned roles and responsibilities.

Table 1. TAMP Governance Roles and Responsibilities Matrix.

Governance Component/Membership	Role	Responsibilities
Director and Executive Oversight Team ***Membership includes the Director and Division Chiefs key to transportation asset management.***	This team serves as the executive champions of TAM, providing strategic direction to the TAMP development process and making key decisions concerning the contents of the TAMP.	• The Director signs off on the first TAMP. • Approves the asset management strategy that directs TAM. • Approves the contents of the TAMP. • Ensures the availability of resources to undertake TAM and to develop and implement the TAMP.
Senior Management Oversight and Steering Committee ***Membership includes key Associate Directors in Maintenance, Planning, Safety and Budget Offices, the Chief Engineer and Deputy Chief Engineer, and to include the Office of the Chief Technology Officer.***	This team acts as the advisory body to DDOT's TAM program, providing regular guidance to the Project Management Team on direction and technical matters.	• Ensures asset management information is clear, consistent, and well-documented. • Reviews and provides comments on the contents of the TAMP. • Meets periodically with the project management team for program updates. • Provides guidance to the project management team. • Identifies asset management risks pertaining to the organization.

Governance Component/Membership	Role	Responsibilities
Project Management Team ***Membership includes the TAMP Project Manager and the Assistant Project Manager.***	This team is to ensure that the TAMP project deliverables are on schedule and stay current. The team is responsible for the delivery of the contents of the workgroups to produce an easy-to-follow TAMP product.	• Ensures that the TAMP is developed and certified within schedule. • Coordinates meetings between the key workgroups. • Identifies and engages with key external stakeholders (transportation agencies and consultants). • Ensures the smooth flow of asset management information between key stakeholders. • Reviews the contents of the TAMP.
Resiliency Workgroup ***Membership includes representatives from the individual components making up the governance structure and other representatives assigned by the Director or the Executive Steering Committee.***	This workgroup is responsible for guiding the development of the risk management portion of the TAMP.	• Guides the development of risk management policies and procedures. • Identifies potential risks to the operation of the transportation system. • Participates in risk workshops to analyze risks (assign risk probabilities and consequences). • Provides recommendations for risk mitigation strategies. • Supports the development and implementation of the risk management plan.
Stakeholders Coordination Team ***Membership includes the Project Management Team, representatives from the Senior Management Oversight and Steering Committee, and the Planning and Sustainability Division.***	This team will support the coordination of all engagement, communication, and planning activities with key stakeholders.	• Helps to identify key external stakeholders. • Supports the development of stakeholder strategies such as planning, training/communication/meeting plans. • Provides support to the Project Management Team. • Liaison with key stakeholders.

Governance Component/Membership	Role	Responsibilities
Pavement Workgroup ***Membership includes representatives from the Asset Management, Infrastructure Project Management, and Planning and Sustainability Divisions responsible for activities pertaining to the sustainable management of pavement assets.***	These subject matter experts provide guidance on the technical analysis and contents related to pavement management for the TAMP. The key roles of this workgroup are to run analysis and review sections of the TAMP.	• Maintains and update the inventory of pavement assets. • Provides support in developing pavement performance measures and targets. • Develops and validates the technical analysis (performance assessments, projections, and resource needs) for pavement assets. • Recommends treatment strategies for investment planning. • Identifies pavement management risks (including performance, failure, financial risks, etc.).
Bridge Workgroup ***Membership includes representatives from the Asset Management, Infrastructure Project Management, and Planning and Sustainability Divisions responsible for activities pertaining to the sustainable management of bridge assets.***	These subject matter experts provide guidance on the technical analysis and contents related to bridge management for the TAMP. The key roles of the workgroup are to run analysis and review sections of the TAMP.	• Maintains and updates the inventory of bridge assets. • Provides support in developing bridge performance measures and targets. • Develops and validates the technical analysis (performance assessments, projections, and resource needs) for bridge assets. • Recommends treatment strategies for investment planning. • Identifies bridge management risks (including performance, failure, financial risks, etc.).

Governance Component/Membership	Role	Responsibilities
Tunnel Workgroup ***Membership includes representatives from the Asset Management, Infrastructure Project Management, and Planning and Sustainability Divisions responsible for activities pertaining to the sustainable management of tunnel assets.***	These subject matter experts provide guidance on the technical analysis and contents related to tunnel management for the TAMP. The key roles of the workgroup are to run analysis and review sections of the TAMP.	• Maintains and updates the inventory of tunnel assets. • Provides support in developing tunnel performance measures and targets. • Develops and validates the technical analysis (performance assessments, projections, and resource needs) for tunnel assets. • Recommends treatment strategies for investment planning. • Identifies tunnel management risks (including performance, failure, financial risks, etc.).
Financial Planning and Procurement Workgroup ***Membership includes representatives from the Offices of the Chief Financial Officer, Contracting and Procurement, and Resource Allocation.***	The Financial Planning and Procurement Workgroup key role is to provide guidance and support the development of the Financial Plan and Investment Strategies to accomplish the goals of the TAMP.	• Supports the development and validation of TAM financial information. • Supports the development of financial projections for the TAMP. • Guides the development of AM resources allocation policies and procedures. • Reviews and provides comments on the TAMP financial and investment strategies plan.

Appendix B – FHWA Pavement and Bridge Metric Thresholds

FHWA Pavement Metric Thresholds

§ 490.311 Metric Thresholds in Final Rule

Rating	Good	Fair	Poor
IRI *(inches/mile)*	<95	***95-170***	***>170***
PSR* *(0.0-5.0 value)*	≥4.0	2.0-4.0	≤2.0
Cracking Percent *(%)*	<5	***CRCP: 5-10 Jointed: 5-15 Asphalt: 5-20***	***>10 >15 >20***
Rutting *(inches)*	<0.20	0.20-0.40	>0.40
Faulting *(inches)*	***<0.10***	0.10-0.15	>0.15

*PSR may be used only on routes with posted speed limit < 40mph.

FHWA Bridge Metric Thresholds

§ 490.409 Metric Thresholds

NBI Rating Scale *(from 0 – 9)*	9 8 7 Good	6 5 Fair	4 3 2 1 0 Poor
Deck *(Item 58)*	**≥7**	**5 or 6**	**≤4**
Superstructure *(Item 59)*	**≥ 7**	**5 or 6**	**≤ 4**
Substructure *(Item 60)*	**≥ 7**	**5 or 6**	**≤ 4**
Culvert *(Item 62)*	**≥ 7**	**5 or 6**	**≤ 4**

Appendix C – Sample Tunnels Performance Measures

Sample of Tunnel Asset Performance Measures:

APPENDIX A-1 ASSET CONDITION PERFORMANCE MEASURES

					PERFORMANCE LEVEL					
ASSET	ELEMENT	MEASURE TYPE	UNIT OF MEASURE	PM #	LEVEL 5 - Excellent	LEVEL 4 - Good (Pass)	LEVEL 3 - Fair	LEVEL 2 - Poor	LEVEL 1 - Unsatisfactory	COMMENTS
STRUCTURAL										
Tunnels	Tunnel Walls, Columns, and Columns Bases	Cleanliness	100' section in Length	1	See photo attached. To be evaluated within 7 days of the scheduled cleaning.	See photo attached. To be evaluated within 7 days of the scheduled cleaning.	See photo attached. To be evaluated within 7 days of the scheduled cleaning.	See photo attached. To be evaluated within 7 days of the scheduled cleaning.	See photo attached. To be evaluated within 7 days of the scheduled cleaning.	
	Ceiling Tiles	Cleanliness	100' section in Length	2	See photo attached. To be evaluated within 7 days of the scheduled cleaning.	See photo attached. To be evaluated within 7 days of the scheduled cleaning.	See photo attached. To be evaluated within 7 days of the scheduled cleaning.	See photo attached. To be evaluated within 7 days of the scheduled cleaning.	See photo attached. To be evaluated within 7 days of the scheduled cleaning.	
	Ceiling Panels	Cleanliness	100' section in Length	3	See photo attached. To be evaluated within 7 days of the scheduled cleaning.	See photo attached. To be evaluated within 7 days of the scheduled cleaning.	See photo attached. To be evaluated within 7 days of the scheduled cleaning.	See photo attached. To be evaluated within 7 days of the scheduled cleaning.	See photo attached. To be evaluated within 7 days of the scheduled cleaning.	
	Ceiling Paint	Cleanliness (Paint)	100' section in Length	4	Ceiling is in like new condition with no peeling paint. To be evaluated within 7 days of the scheduled cleaning.	No more than 10 square ft. of peeling paint. To be evaluated within 7 days of the scheduled cleaning.	Nor more than 20 square ft. of peeling paint. To be evaluated within 7 days of the scheduled cleaning.	No more than 30 square ft. of peeling paint. To be evaluated within 7 days of the scheduled cleaning.	More than 30 square ft. of peeling paint. To be evaluated within 7 days of the scheduled cleaning.	
	Expansion Joint	Physical	Each Joint	5	Joint is in like new condition.	Joint is functional allowing expansion. No loose material.	Joint is functional allowing expansion. Some loose material present.	Joint is not functioning properly, or has loose material present or shows signs of deterioration.	Joint is not functional, has no expansion material present, or is severely deteriorated.	
Tunnel Support Spaces	Walls, Roof, Floor	Physical	Room	6	Like New	No loose/spalling concrete material.	Minor cracking or spalling concrete	Moderate cracking or spalling concrete	Severe cracking or spalling concrete	
		Physical	Drips in Room	7	No water leakage.	Surface is wet but no drips are visible. No signs of water dripping on equipment.	Water leakage less than 30 drips per minute (DPM).	Water leakage greater than 30 drips per minute (DPM).	Free flowing water.	
		Physical	Area / Room	8	Clean and free of debris/trash.	Free of debris/trash and no impedance for maintenance / control personnel access	Areas of debris, no trash, no impedance for maintenance / control personnel access	Debris or trash is present, no impedance for maintenance / control personnel access	Debris/Trash impedes maintenance personnel / control personnel access.	
Tunnel Support Spaces	Fan Support Bases	Physical	One Fan Base	9	Fan bases are clean and have no stains or corrosion.	Fan base has minor stains (less than 20% of surface area), free of oil/grease and corrosion.	Fan base has moderate stains (less than 50% of surface area), sheen of oil/grease and minor corrosion with no section loss.	Fan base has major stains (greater than 50% of surface area), build-up layer of oil/grease and moderate corrosion with no section loss.	Fan base has major stains (greater than 50% of surface area), pooling of oil/grease and major corrosion with section loss.	
	Doors and Door Locks	Physical	Each Door	10	Doors are secure and in like new condition.	Doors are secure. Latch and door functioning and with only slight visible corrosion. Latch is lubricated and easily turned.	Doors are secure. Latch and door functioning and has less than 10% section loss.	Doors are secure. Latch and door functioning with moderate corrosion less than 20% section loss.	Doors are not secure and/or the latch and door not functioning. Severe corrosion with greater than 20% section loss.	
Tunnel Air Plenums, Ventilation Shafts	Entire Structure	Physical	Each Plenum Shaft	11	Clean and free of debris and standing water.	Minor areas of debris, with no impedance for maintenance personnel access or air flow.	Major areas of debris, with no impedance for maintenance personnel access or air flow.	Debris impedes maintenance personnel access or air flow.	Debris blocks maintenance personnel access or air flow.	

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We would like to acknowledge the valuable contribution from DDOT workgroup members, (noted in appendix A, Figure 1) as well as all external stakeholders, including the Federal Highway Administration, National Park Service, the Metropolitan Washington Council of Governments and the Architect of the Capitol, during the development and review of the TAMP.

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District Department of Transportation