West Virginia Division of Highways

Transportation Asset Management Plan

August 2019 Complete Plan

WEST VIRGINIA DEPARTMENT OF TRANSPORTATION
Division of Highways
1900 Kanawha Boulevard East • Building Five • Room 110
Charleston, West Virginia 25305-0430 • (304) 558-3505

Byrd E. White, III
Secretary of Transportation

Jimmy Wriston, P. E.
Deputy Secretary/
Deputy Commissioner

August 30, 2019

Mr. Brian Hogge
Acting Division Administrator
Federal Highway Administration
154 Court Street
Charleston, West Virginia 25301

Dear Mr. Hogge:

On behalf of the West Virginia Department of Transportation (WVDOT), and the West Virginia Division of Highways (DOH), I am pleased to submit our Transportation Asset Management Plan (TAMP) for review and certification by the Federal Highway Administration (FHWA) in compliance with the Moving Ahead for Progress in the 21st Century Act (MAP-21) and the subsequent 2015 Fixing America's Surface Transportation Act (FAST Act), as codified in 23 U.S.C. 119 and 23 CFR part 515.

Should you have any questions, please contact Aaron C Gillispie, P.E., our State Highway Engineer, at (304) 558-2804.

Sincerely,

Byrd E. White, III
Secretary of Transportation

BEW:Bj

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Chapter 1

Introduction

The Moving Ahead for Progress in the 21st Century (MAP-21) Federal Transportation Authorization passed by Congress in 2012, and the subsequent 2015 Fixing America's Surface Transportation Act (FAST Act) established a performance-based highway program with the goal of ensuring federal transportation funds are fully leveraged to provide the greatest benefit with respect to safety, mobility, and highway and bridge asset condition. This legislation requires each state department of transportation (DOT) to develop a risk-based Transportation Asset Management Plan (TAMP) that contains the following elements:

1. A summary listing of the pavement and bridge assets on the National Highway System (NHS) in the State, including a description of the condition of those assets;
2. Asset management objectives and measures;
3. Performance gap identification;
4. Lifecycle cost and risk management analysis;
5. A financial plan; and
6. Investment strategies.

Asset Management is defined in federal law[1] as "a strategic 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." Following established federal rule making protocols, a series of amplifying rules governing TAMP development and Transportation Performance Management were codified in the Code of Federal Regulations. As such, each State DOT was required to submit an initial TAMP to their respective Federal Highway Administration (FHWA) Division office by April 30, 2018.

Within the West Virginia Department of Transportation (WVDOT) the West Virginia Division of Highways (WVDOH) is responsible for planning, engineering, rights-of-way acquisition, construction, reconstruction, traffic regulation and maintenance of more than 34,000 miles of state roads and bridges. As the responsible division within the WVDOT the WVDOH took the lead in developing the state's TAMP to meet the federal requirements.

The initial TAMP had slightly different requirements from this Complete TAMP, in part because it was used by FHWA to certify the State's TAMP development processes. The WVDOH completed the initial TAMP in April 2018 and subsequently submitted the document to FHWA for certification. The FHWA certified the WVDOH TAMP in 2018 and this Complete TAMP document has been developed in accordance with all applicable federal requirements and was submitted prior to the June 30, 2019 deadline.

In its initial TAMP submission to FHWA, WVDOH included performance measures for pavement and bridge conditions, and established two and four-year performance management targets for good and poor. These performance targets for both pavements and bridges are carried forward from the initial TAMP to this Complete TAMP document with any subsequent revisions. However, as explained in the following chapters, the robust 10-year analysis performed for this TAMP using WVDOH's new bridge management system and enhanced pavement management system show that it will be unlikely for WVDOH to meet some of the established performance targets. Accordingly, it is anticipated that WVDOT will make adjustments to the initial performance targets in 2020 as allowed by FHWA.

The WVDOH TAMP addresses pavements and bridges, as follows:

- Pavements – Those pavements on the National Highway System (NHS) Only. The remainder of state-owned pavements may be added at a later date.
- Bridges – Those bridges on the NHS Only. The remainder of state-owned bridges may be added at a later date.

Additional asset classes may be added in future versions of the TAMP.

TAMP Development Approach

Efforts to organize an approach for developing the TAMP along with necessary changes to existing business processes and management systems for pavements and bridges began about two years prior to the initial document submission date established by the FHWA. WVDOH selected a consultant to assist with this undertaking and opted to include both the TAMP development and a bridge and pavement

[1] See 23 CFR 515.5 "Definitions"

management software implementation within the project scope to ensure alignment of data needs with asset management processes.

A TAMP Steering Committee was created and comprised of representatives from Finance, Programming & Planning, Maintenance, Districts, and FHWA. The Steering Committee working under the leadership of the Asset Management Project Manager, was established to provide oversight and guidance to the consultant team throughout the development process for both the initial and complete TAMPs. For the initial TAMP numerous workshops were conducted throughout the life of the project, first validating existing or "as is" conditions and processes, followed by an extensive gap analysis effort and development of a Risk Register. From there, the Steering Committee and a group of WVDOH stakeholders worked collaboratively with the consultant team to draft the TAMP document for the initial submission to FHWA. A similar approach was followed for the development of this Complete TAMP document as well. The extensive commitment of time, valuable feedback and subject matter expertise provided by WVDOH stakeholders was critically important to ensuring that the TAMP becomes a "living document" that not only meets Federal requirements; but, more importantly serves the unique needs of WVDOH.

Overview of West Virginia

West Virginia is the 41st largest and the 38th most populous state in the nation. In 2018, West Virginia's population was estimated at 1.8 million.[2] Despite its relatively small size, West Virginia is home to approximately 3,100 cities, towns, and small communities. Linking them are approximately 38,770 miles of public roads, of which about 89% are owned and operated by the WVDOH, making it the 6th largest state-maintained highway network in the nation. WVDOH does not maintain federal or municipal system streets, but is one of only a few states (Alaska, Delaware, North Carolina, Virginia, and West Virginia) in the nation to manage virtually all other public road mileage. The WVDOH maintained system includes 7,124 bridges exclusive of the WV Turnpike, which operates an 87-mile toll facility with 97 bridges. Turnpike pavement and bridge assets located on the NHS have been included in the TAMP inventory, analysis and investment strategies. Figure 1 details the public road mileage in West Virginia.

FIGURE 1: WEST VIRGINIA PUBLIC ROAD SYSTEM

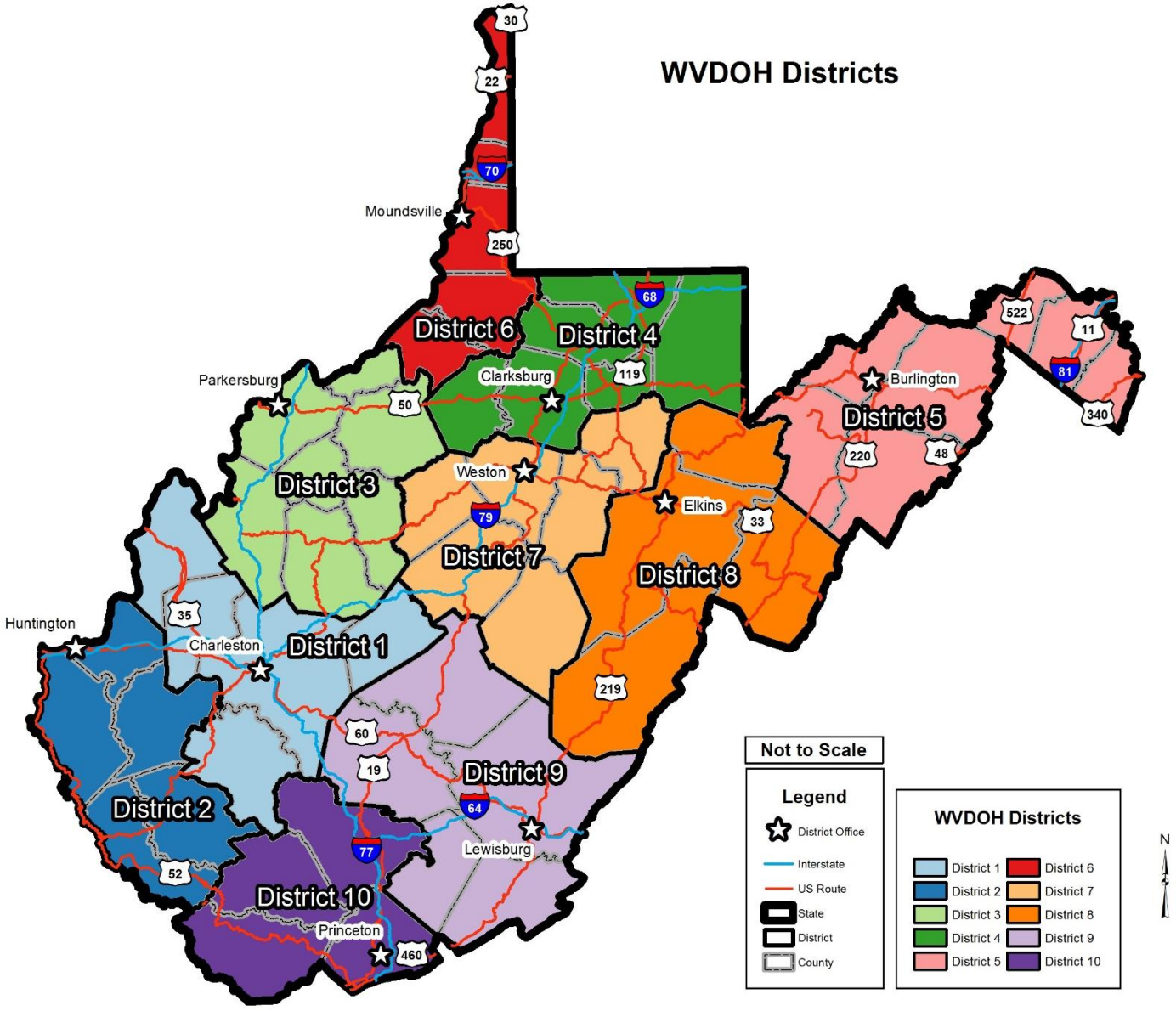
	Mileage
State Owned Highways	34,691
Federally Owned	835
Municipally Owned	3,244
Total Public Roads	**38,770**
Interstate Highway	555
WV Turnpike	87
National Highway System	1,986

Source: 2016 Public Certified Mileage, Federal Highway Administration Highway Statistics 2016, https://www.fhwa.dot.gov/policyinformation/statistics/2016/

The WVDOH is divided into 10 geographic districts (Figure 2) which are responsible for delivering the Division's construction, maintenance, and operations programs. District Maintenance and Bridge Engineering staff are integral players in the bridge and pavement program development process for the NHS.

[2] U.S. Quick Facts, West Virginia, U.S. Census Bureau, https://www.census.gov/quickfacts/fact/table/WV/PST045218

FIGURE 2: WV DISTRICT MAP



Source: WVDOH

Importance of the National Highway System

The National Highway System (NHS) in West Virginia is comprised of the WV Turnpike (portions of I-77 / I-64), Interstate Highway network, Appalachian Development Highway System (ADHS), and other primary highways. The Interstate and ADHS are multi-lane freeway and expressway facilities while the remainder of NHS routes are typically two-lane facilities. A comparison of NHS mileage and vehicle miles traveled (VMT) to the total public road network (including the WV Turnpike) is provided in Figure 3. The NHS serves as the backbone of the state transportation system. While it represents only 5% of public road centerline miles, it carries 54% of the VMT. Similarly, 18% of the total number of state-owned bridges are located on NHS routes, representing 60% of the total deck area.

FIGURE 3: 2016 PUBLIC ROAD MILEAGE AND VEHICLE MILES TRAVELED

System	Miles	VMT (M)	% Total Mileage	%Total VMT
Interstate	554	5,808	1.4%	30%
Non-IS NHS	1,432	4,661	3.7%	24%
NHS Total	1,986	10,469	5.1%	54%
Other FA	8,553	6,919	22.1%	35%
FA Total	10,539	17,388	27.1%	89%
Non-FA	28,231	2,152	72.8%	11%
Totals	38,770	19,539	100%	100%

Source: Federal Highway Administration Highway Statistics 2016, https://www.fhwa.dot.gov/policyinformation/statistics/2016/

The strategic importance of the NHS to commerce and the overall economic vitality of West Virginia, as is the case with other states, led Congress to enact the MAP 21 and FAST Act legislation ensuring state of good repair standards were instituted to maintain this critical network. WVDOH has historically given priority to projects that protect the investment in NHS pavements and bridges, utilizing the best data available to drive these decisions. However, it is important to note that WVDOH is also responsible for managing a very large highway network with many competing needs and a finite budget. Accordingly, Executive Leadership must make investment trade-off decisions which require careful assessment of all transportation needs. As the agency implements this TAMP, it will leverage refined business processes combined with the extensive analysis and forecasting functionality associated with its new bridge and pavement management systems to inform long term programming decisions. These new capabilities will better enable WVDOH to sustain or improve NHS infrastructure conditions while also addressing other transportation needs. The asset management business processes related to bridges, pavements, risk, and finance, detailed in subsequent chapters of this document, have been thoughtfully developed to meet the spirit and intent of MAP 21 and FAST Act legislation and associated rules promulgated after legislation enactment.

Asset Management at WVDOH

WVDOH's asset management strategy has continued to evolve in recent years with the agency placing a high priority on development and implementation of integrated Enterprise Resource Planning (ERP) and Asset Management systems. The vision for an agency management system represents a significant commitment and investment in both financial and human resources. When completed, this integrated

systems approach will provide the ability to tightly manage financial and physical assets as well as delivery of projects to support investment and programming decisions, placing the agency in an enviable position with most of their peers.

There is a well-established program and associated procedures for performing routine maintenance and repairs on roadway and bridge assets. The management system projects currently underway, or planned for the near-term, will serve to bolster maintenance, preservation, and capital investment decision making. It is important to note that WVDOH staff within the Maintenance, Pavement and Bridge groups have proactively embraced the principals and concepts of asset management. For example, in recent years the agency has become an active participant in the American Association of State Highway and Transportation Officials (AASHTO) sponsored regional bridge and pavement preservation partnerships. Preservation is an important asset management strategy, and because of this engagement with peer states, WVDOH is now integrating these early intervention actions into its program of work to cost-effectively extend the life of these critical assets.

Management Systems

The WVDOH has been a key participant in the State's multi-agency ERP project, known as wvOASIS, which began in 2012 to modernize financial and human resource systems and processes through a phased approach. Integrated with the ERP, WVDOH has also been developing an enterprise asset management system (AMS) for managing roadway maintenance operations and assets, signs and signals, safety, fleet, facilities, and right of way. Additionally, implementation of the ESRI Roads and Highways tool for managing the agency's road inventory and Linear Referencing System (LRS) is nearly complete. A new software solution is also in the planning stage to replace the existing mainframe Project Tracking System (PTS) which is envisioned to provide robust analytics to support project management, reporting, and decision making.

Automated pavement inventory and condition data has been collected on Interstate and ADHS routes for more than 20 years. Inventory and condition data has also been collected on the remaining NHS routes, though not historically analyzed in the PMS until the new TAMP requirements were established. A new Data Quality Management Plan has been certified by FHWA and is now in place to govern the collection of data for HPMS 0.10-mile pavement segments on the entire NHS. Over this same period, the agency has utilized its Deighton dTIMS pavement management system (PMS) for analysis of pavement data and project identification. The PMS models and decision trees support scenario analysis and the system has recently been enhanced to perform analysis required for this TAMP using HPMS data. The PMS can perform scenario analysis based upon budget and condition objectives, which produce an optimized workplan with recommended projects. Pavement management is a collaborative effort by the District Pavement staff, the State Materials staff, and the Pavement Management staff.

The Bentley InspectTech Bridge Inspection System was implemented several years ago to support management of National Bridge Inventory (NBI) bridges. The agency follows well established inspection and quality assurance protocols for the collection of bridge inspection data and its importation into the system as inspections are completed. This system is used for generating reports on condition data to FHWA on an annual basis and for identifying maintenance repair needs and replacement candidates.

To support the new business process and program management changes arising from the TAMP development, WVDOH has also recently completed development and implementation of a new Deighton dTIMS Bridge Management System (BMS). Similar to the pavement system, the new BMS has been successfully utilized to perform data analysis and the 10-year forecasts required for the TAMP. Together, these asset management systems will support lifecycle planning and strategic investment decision making which is detailed in subsequent chapters of this document. Further, the vision is for these systems to interface with the ERP, Roads and Highways, Project Tracking, and other agency asset management systems, providing enhanced agency-wide access to critical data.

This Complete WVDOH TAMP, describes how the agency manages its bridges and pavements throughout their lifecycle. It also provides a framework that will guide funding decisions. In addition to meeting the requirements of MAP-21, WVDOH's TAMP meets the following objectives:

- Establishes a process to complete a performance gap analysis and to identify strategies to close gaps;
- Establishes a process to complete lifecycle planning;
- Establishes a process to complete a risk analysis and develop a risk management plan;
- Establishes a process to develop a financial plan covering at least a 10-year period;
- Establishes a process to develop investment strategies;
- Establishes a process to obtain necessary data from NHS owners other than the WVDOH; and
- Establishes a process to ensure the TAMP is developed with the best available data and that WVDOH uses bridge and pavement management systems meeting the requirements in 23 CFR 515.17 to analyze NHS bridge and pavement condition.

Strategic Plan

In 2019 the WVDOT Senior Leadership initiated development of a Strategic Plan for the agency to support the advancement of asset management and create an important linkage across all program areas. The plan was recently adopted to serve the entire department. It provides a clearly defined mission and vision supported by actionable goals reflecting the core responsibilities of the Department which can be readily measured and communicated throughout the organization.

TAMP Process Overview

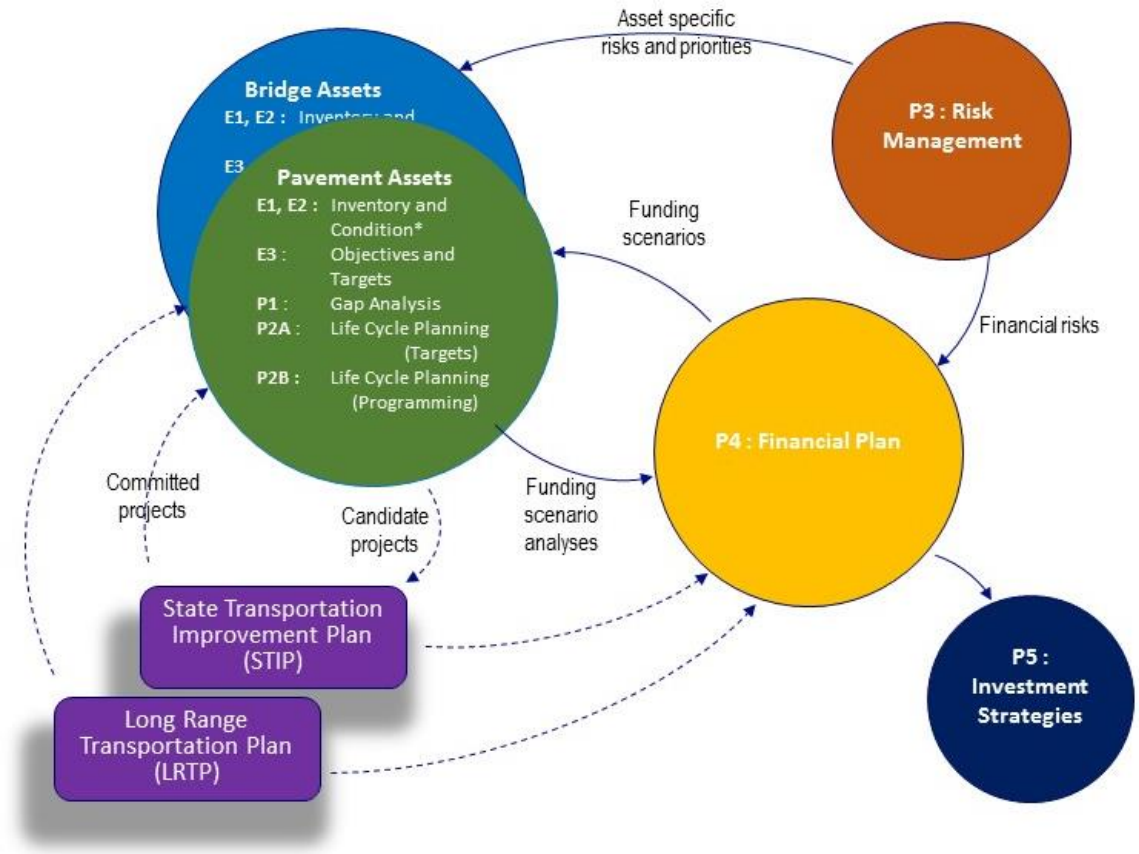
The overall TAMP development process, and how this interacts with the State Transportation Improvement Plan (STIP) and the Long Range Transportation Plan (LRTP), is shown in Figure 4. This diagram describes the elements and processes required in the TAMP. The processes for obtaining data from NHS owners other than WVDOH, ensuring use of the best available data, and management systems, are descibed in this document. These processes are not part of the diagram.

As shown in Figure 4, a portion of the process takes place separately within each of the groups managing the different asset types. For instance, the pavement management group is responsible for updating inventory and condition, as well as lifecycle planning for that asset type.

Other portions of the TAMP development process are conducted more centrally as interactions and trade-offs between asset types are being considered. The WV Turnpike system is included in the WVDOH PMS/BMS analysis process but its program is separately funded by WV Turnpike accounts and not accounted for in the STIP or LRTP.

This document uses a similar structure to describe the processes and associated analysis where applicable. The Bridge (Chapter 2) and Pavement (Chapter 3) processes are discussed first. Thereafter the processes for Risk Consideration (Chapter 4), Financial Planning (Chapter 5), and Investment Strategies (Chapter 6) are described.

FIGURE 4: TAMP PROCESS



E1: Element 1 - A summary listing of NHS pavement and bridge assets and conditions, regardless of ownership.
E2: Element 2 - The national performance measures for NHS pavements and bridges.
E3: Element 3 - The State DOT's asset management objectives.
P1: Process 1 – Gap analysis.
P2: Process 2 – Life Cycle Planning
P3: Process 3 – Risk Management
P4: Process 4 – Financial Plan
P5: Process 5 – Investment Strategies

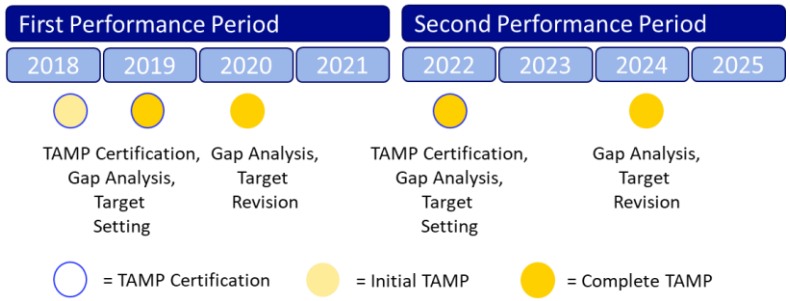
*Note: Condition is reported in terms of the national performance measures for pavements and bridges.

Regarding the timing of the processes, while there is a 'consistency determination' every year, the TAMP will be updated and re-certified at the beginning of each 4-year Performance Period. At this point analysis will be conducted by WVDOH, using the processes described in this TAMP, for setting targets and developing financial plans for the next 10 years. These targets, as well as discussion of the baseline condition at the beginning of the Performance Periods, will be included in the Baseline Progress Reports submitted by October in the first year of the Performance Period.

In addition, at the mid-point of each performance period every two years, progress towards targets will be analyzed using the Gap Analysis and Lifecycle Analysis described in this TAMP. This will enable

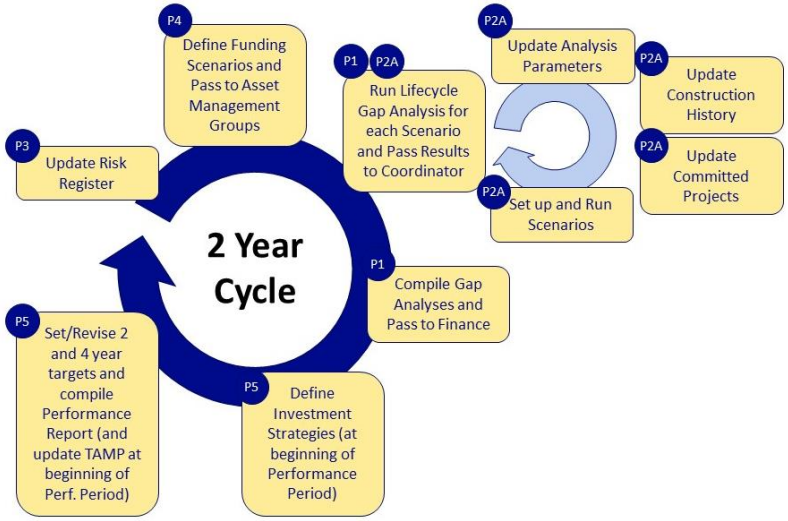
WVDOH to set, revise, and report on progress towards the targets. The results of this analysis will be submitted in the Progress Reports that are required by 23 CFR 490 in October of years following the mid-points of the Performance Periods, as shown in Figure 5.

FIGURE 5: PERFORMANCE PERIODS



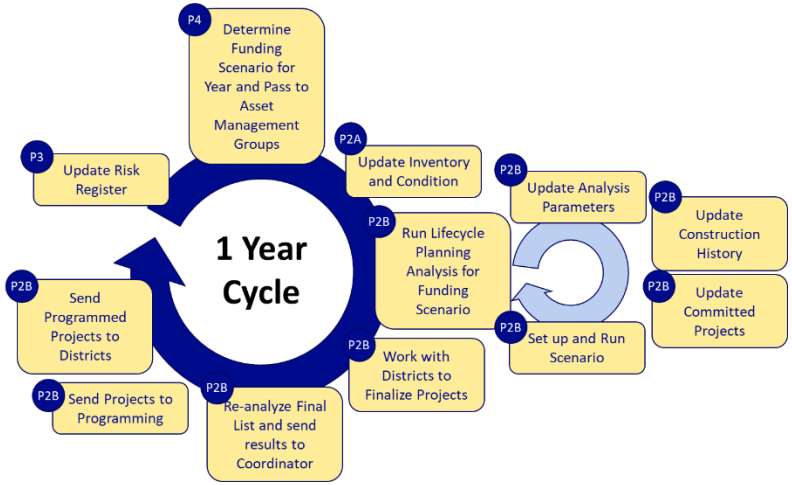
The process for the 2-year cycle created by the need to set targets at the beginning of the Performance Period and analyze gaps and progress at mid-points of the Performance Period, is summarized in Figure 6.

FIGURE 6: PERFORMANCE PERIOD (2-YEAR CYCLE)



The Lifecycle Analysis that is used annually to identify recommended projects is summarized in Figure 7.

FIGURE 7: PERFORMANCE PERIOD (1-YEAR CYCLE)



These processes are described in more detail in the remainder of this document.

Source: WVDOH

Chapter 2

Managing Bridge Assets

Inventory and Condition

Inventory

West Virginia currently has 1,294 bridges comprising 24,504,470 square feet of deck area on the NHS. These are split relatively equally between Interstate and Non-Interstate systems as can be seen in Figure 8 and Figure 9.

WVDOH owns the majority of NHS bridges. However, a portion of the Interstate bridges are owned by the West Virginia Turnpike (WV Turnpike or Turnpike).

In total, WVDOH owns 1,195 (92%) of the NHS bridges and 22,590,843 square feet (92%) of the total NHS deck area. The WV Turnpike owns 97 (8%) of the NHS bridges and 1,823,323 square feet (8%) of the total NHS deck area. Two bridges, totaling 90,304 square feet are owned by Mittal Steel Company and Mt. Storm Power Plant as shown in Figure 10 and Figure 11.

FIGURE 8: BRIDGE STATISTICS

	WVDOH	WV Turnpike	Other	Total
Interstate (bridges)	556	95	0	651
Non-IS NHS (bridges)	639	2	2	643
Interstate (sf)	9,693,560	1,805,570	0	11,499,130
Non-IS NHS (sf)	12,897,283	17,753	90,304	13,005,340

FIGURE 9: BRIDGES BY OWNER

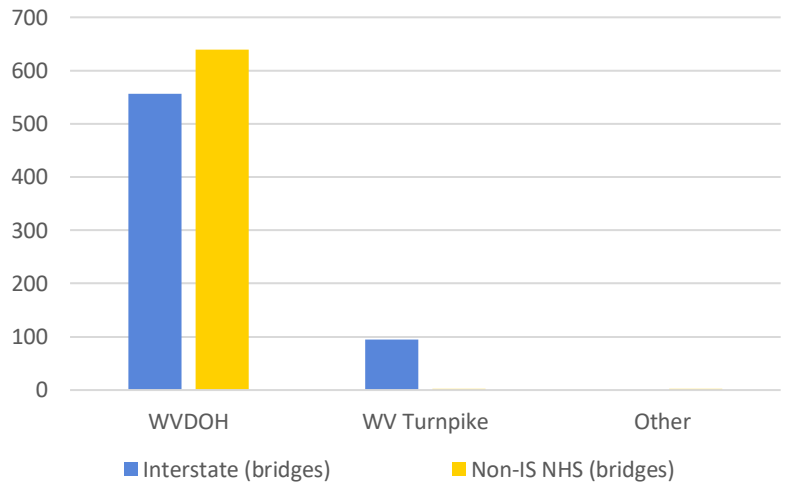


FIGURE 10: NHS BRIDGES

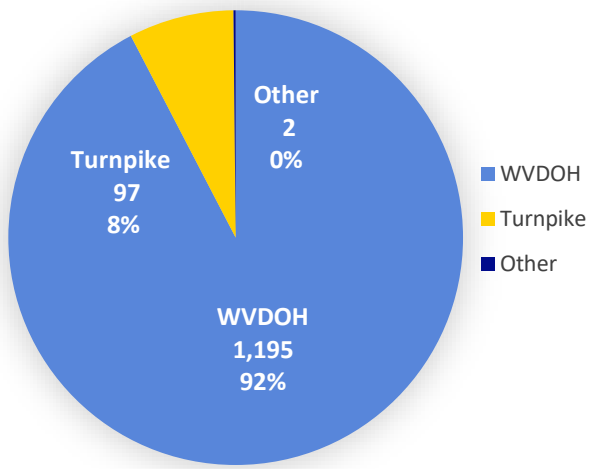
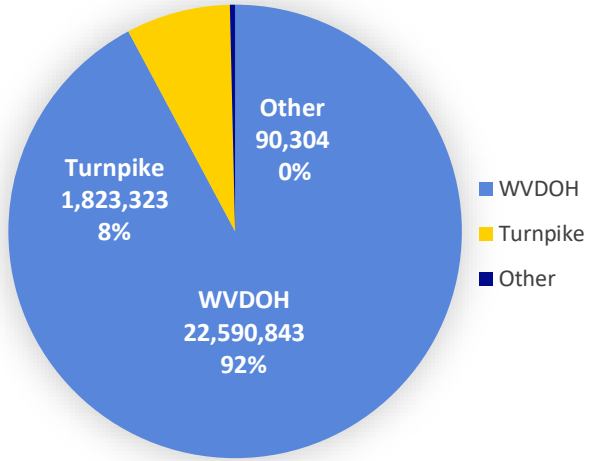


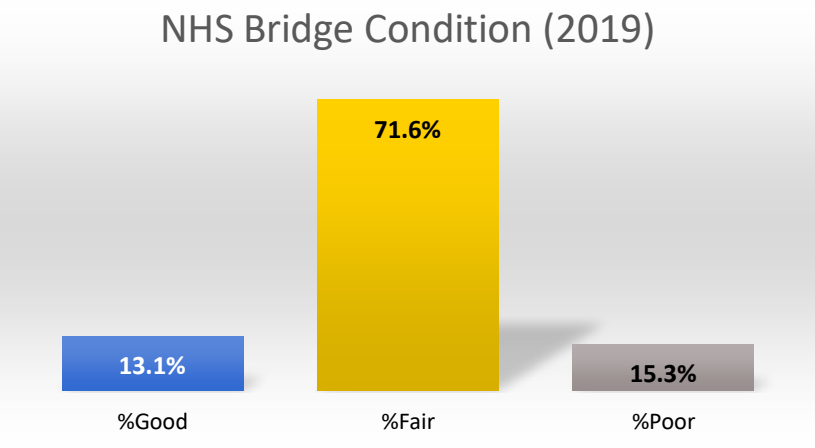
FIGURE 11: NHS BRIDGES BY SQUARE FEET



Condition

Based on the 2019 data, the majority of WVDOH bridges are currently in Fair condition, with 13.1% of deck area in Good condition and 15.3% in Poor condition. This is shown in Figure 12.

FIGURE 12: CONDITION OF NHS BRIDGES BY DECK AREA



The deck and superstructure elements are in better condition (4.02% and 6.55% Poor respectively) than the substructure element (10.30% Poor) as seen in Figure 13.

FIGURE 13: CONDITION OF NHS BRIDGE COMPONENTS BY DECK AREA

	Good	Fair	Poor
Deck	27.44%	68.47%	4.02%
Superstructure	37.48%	55.97%	6.55%
Substructure	27.26%	62.43%	10.30%
Culvert	33.49%	63.23%	3.28%
Overall NBI Bridge	13.1%	71.6%	15.3%

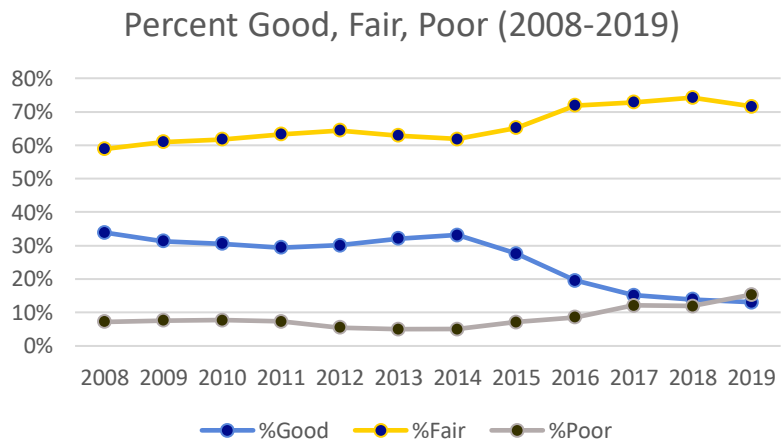
Trends Over Time

The proportion of bridges in Good condition by deck area has declined over time. Historically it has remained in the 30% range but has recently seen a drop to below 20%.

The proportion of bridges in Poor condition by deck area has stayed relatively stable over time but has worsened over the last 3 years.

The Fair proportion of bridges by deck area has slowly risen over the last 10 years from 58.9% in 2008 to 74.2% in 2018 as shown in Figure 14.

FIGURE 14: BRIDGE CONDITION OVER TIME



Process for Obtaining Data from NHS Owners other than WVDOH

Owners input data directly into InspectTech (central database managed by WVDOH). WVDOH analyzes the data for errors and works with other NHS bridge owners, principally the WV Turnpike, to correct any errors prior to federal submittal. Any corrections are communicated back to the WV Turnpike or other owners for clarity.

Objectives and Targets

WVDOH desires to maintain the NHS bridges in a state of good repair by adopting the following objectives:

- Use a bridge management system to project deterioration and effects of maintenance, preservation, rehabilitation, and replacement projects to analyze different funding scenarios.
- Maximize the average of the weighted NBI rating by deck area for the deck, superstructure, and substructure (or culvert rating) over a 10-year lifecycle, subject to budget constraints. This involves:
  - Using maintenance and preservation treatments on bridges to keep them in Good condition since maintenance and preservation treatments show a high benefit-cost ratio.
  - Replacing bridges to minimize the number and deck area of bridges in Poor condition, and minimize the number of load posted bridges, where the benefit-cost ratio supports this.
- Include the following weighting factors for replacement candidates in the calculation of benefit for assessment of benefit-cost ratios:
  - Risks from scour and low vertical clearance,
  - Annual Average Daily Traffic (AADT),
  - Detour length,
  - District priority, and
  - Repeated emergency response claims evaluated based on 23 CFR 667.

WVDOH has established the following targets:

- The percentage of bridges on the NHS in a Good condition [23 CFR 490.407(c)(1)] by deck area should be at least 20%.
- The percentage of bridges on the NHS in a Poor condition [23 CFR 490.407(c)(2)] by deck area should not exceed 10%.

Gap Identification and Strategies for Attaining Targets

Physical Condition of Assets

Based on the current conditions shown in the beginning of this chapter (Inventory and Condition) and the targets defined in the previous section, there are currently gaps between the present condition of the NHS bridges and the target condition.

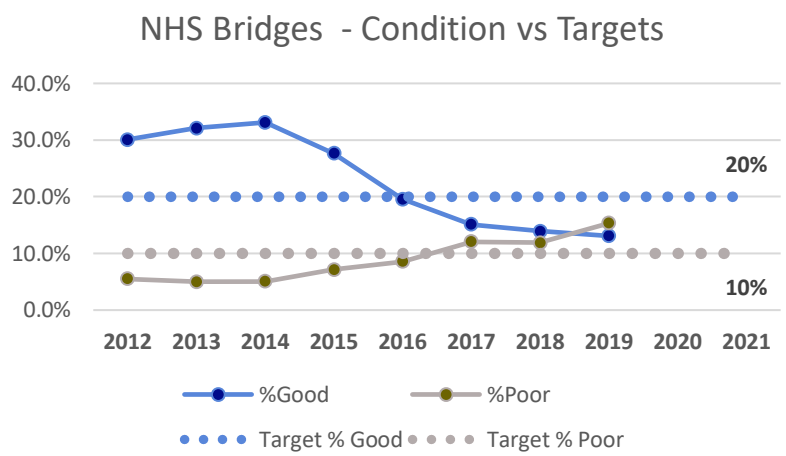
Currently there is a 6.9% gap between the current Good condition value of 13.1% and the target value of 20%. Projects currently listed in the STIP are expected to narrow this gap, and will help ensure that it does not get appreciably wider over the next 4-year period.

The current gap for Poor condition is at 5.3%, as shown in Figure 15 and Figure 16.

FIGURE 15: BRIDGE CONDITIONS TARGETS AND GAPS

	Current Condition	Target	Gap
% Good	13.1%	20%	6.9%
% Poor	15.3%	10%	5.3%

FIGURE 16: NHS BRIDGES – CONDITION VS TARGETS



Discussion of Deficiencies

Based on the 10-year projections, some of the deficiencies affecting WVDOH's ability to make progress towards the desired goals include:

- Overall funding has declined in recent years for the bridge program. This is due to an increased interest in expansion and repaving projects resulting in an associated reduction in bridge maintenance. Other areas competing for funds are economic development related projects in depressed areas of the state and safety projects.
- Project delivery poses some challenges since there is a relative shortage of internal pre-construction staffing in the areas of design, utilities, permitting and environmental, creating a bottleneck in the programming and delivery pipeline. In some cases, funding initially earmarked for bridge projects that were delayed has been redirected to pavement projects.

Identification of Alternative Strategies

As noted above, because all program areas compete for funding, one of the primary ways in which WVDOH will develop funding strategies will be to use its new bridge management system to analyze and run scenarios to be able to project the effects of different funding levels.

In addition to developing alternative funding strategies, the following strategies are also expected to help mitigate some of the possible deficiencies identified above. Currently, management is working through compensation plans for staff recruitment and retention. The 2017 Roads to Prosperity state legislation is providing increased funding for transportation needs, especially major capital projects.

Process for Performing Gap Analysis

The methodology for Gap Analysis consists of four main steps:

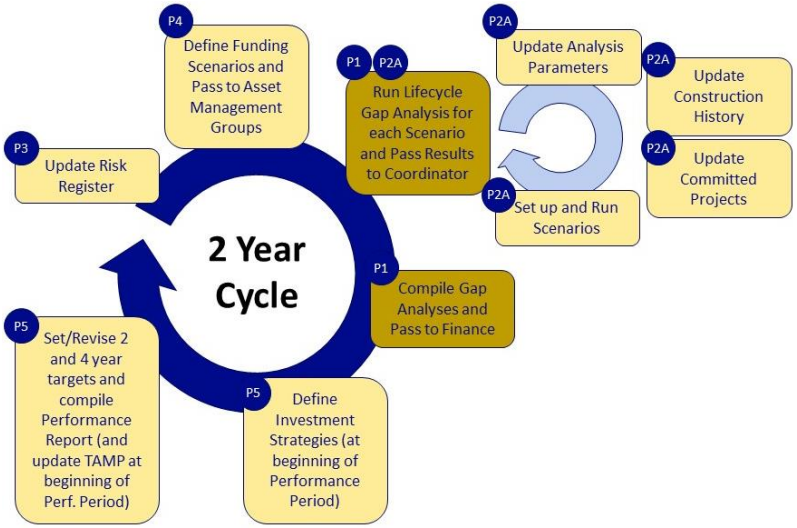
1. Update Inventory and Condition.
2. Check progress against current Targets and Objectives.
3. Project future gap between Condition and Targets at the end of the Performance Period under different scenarios.
4. Compile Gap Analysis.

The assumption is that targets are already in place for specific future years (in this case the targets are for the first Performance Period ending in December 2021).

This process is depicted as part of the larger process shown in

Figure 17. Note that the lifecycle analysis will be conducted to project conditions out over a 10-year analysis period and this will be used to inform the two and four-year targets.

FIGURE 17: TWO-YEAR PERFORMANCE PERIOD



1. **Update Inventory and Condition** – The first step in the process of identifying and analyzing gaps between current condition and future targets is to update the inventory and condition. Both data sets are updated using the latest NBI condition data (2017 in this case). The latest percentage of Good and percentage of Poor conditions are calculated using the worst rating across Deck, Superstructure, and Substructure, or Culvert rating to define a bridge as being in Good or Poor condition as specified in 23 CFR 490.407. Thereafter, percentage of Good and percentage of Poor are calculated based on summing the deck area of the bridges in each condition and dividing by the total deck area.
2. **Check Progress against Targets and Identify Gaps** – Targets for percentage of Good and percentage of Poor metrics are discussed in the previous section. To check progress against these targets, the trend of these metrics during the current performance period will be plotted against the targets to identify current gaps.
3. **Project future gap between Condition and Targets** – The WVDOH will then use the lifecycle costing bridge management tools discussed in the next section, to project the condition of bridges out to the end of the current performance period for each of the different funding scenarios identified in the Financial Plan. This process is outlined in the subsequent sections regarding the lifecycle planning process.
4. **Compile Gap Analysis** – Once the scenarios have been analyzed, the results are provided to the Asset Management Coordinator (by each asset management group). The Asset Management Coordinator will then compile these and provide the gap analysis to the Executive Leadership for consideration in the next budget cycle.

Identification of Alternative Strategies

The process for identifying alternative strategies, and specifically the identification of specific alternative funding strategies that need to be analyzed, is undertaken as part of the Financial Planning processes described later in this document. Examples are given in the more detailed section on Lifecycle Planning.

In addition to those strategies identified in in this chapter and the Financial Planning processes, the bridge management group may also analyze alternative strategies informally to test different policies (such as differing budgets for different work types) and objective functions. However, it should be noted that the bridge management system generates an optimum strategy for each funding scenario that defines the ideal mix of work types. While it is interesting to view the results, manual adjustment of the optimum recommended mix of work types will invariably result in a less optimal strategy.

NHS Effectiveness Performance

The MAP 21 and FAST Act legislation focused on multiple aspects of NHS performance, including safety, mobility, congestion, and freight, in addition to the requirements for a TAMP. While the goal of the legislation is to ensure safe and efficient movement of people and goods on the NHS, WVDOH has the added challenge of maintaining the entire network of pavements and bridges throughout the state of West Virginia.

Accordingly, WVDOH recognizes the need to balance investments made to maintain targets in the areas of safety, mobility, congestion, and freight. Within the framework of the TAMP, the program of projects not only will focus on perpetually maintaining a state of good repair for NHS pavements and bridges, but within the context of the LRTP, work to close the gaps identified, in a coordinated approach, in those related areas of safety, mobility, congestion and freight. This integrated approach, while focusing on the NHS, recognizes that the WVDOH has additional responsibilities that include the entire network of roads and bridges for the remainder of the state network, and all which are to be maintained within budget.

Based on the performance targets submitted by WVDOH to FHWA on May 18, 2018, the agency's analysis has determined that the travel time reliability performance targets are conservative. This indicates that significant gaps do not currently exist for the efficient movement of people and freight.

Future issues and concerns relative to climate-change and extreme weather are also being considered in risk management scenarios and are being added to discussions on how best to manage the overall program.

Additionally, as NHS facilities are widened for capacity or modernized to enhance mobility or safety, lifecycle management of the associated improvements must be planned. WVDOH is already working proactively to extend the performance life of its critical assets by employing pavement and bridge preservation strategies which minimize construction delays by pushing rehabilitation to a later date.

As the Complete TAMP is finalized, work on integrating the TAMP with the LRTP is set to begin soon ensuring the overall effectiveness of the NHS as well as the rest of the WVDOH highway network.

Lifecycle Planning Analysis for Gap Analysis and Target Setting

WVDOH has successfully implemented a bridge management system since the Initial TAMP was submitted to FHWA in 2018. This system has greatly increased the capacity to analyze multiple scenarios using potential work types and deterioration modeling over chosen analysis periods to generate multiple workplan strategies. The process of generating these lifecycle planning strategies is described in the following sections (Process for Selecting Scenarios, and Process for Performing Lifecycle Optimization Analysis).

The conducted analysis is not completely based on the Statewide Transportation Improvement Plan (STIP). Near-term projects from the STIP that are in the process of being contracted or constructed, are considered underway projects and 'fixed' during this analysis process and as such are included in the projections. However, in future analyses, the process is reversed with the analysis occurring first, and the recommended projects from the analysis being added to the STIP.

While there is expected to be some period where the detailed configuration (such as deterioration models, treatments, triggers, reset

values, etc.) of the software tools are being refined, this process is now being used for planning analysis and the TAMP.

With regard to the projected conditions, 30% of the bridges currently in service in West Virginia were built in the 1960's and 1970's. Specifically for bridges on the NHS, this percentage is even higher at 38%. This indicates that between a third and a half of all NHS bridges are in the neighborhood of 50 years old and, based on the design standards of the time, are approaching their original design life. This indicates that a large portion of the State's bridges are projected to cross the threshold into the Poor category where the lowest of the NBI general condition ratings for deck, superstructure and substructure is designated as 4 or lower. This 'wave' of bridges is expected to build over the coming years and reach a peak in the 2023 timeframe. The distribution of bridge age based on decade of construction is seen in Figure 18.

The projections from the funding scenarios show the 'wave' of bridges built in the 1960's and 1970's starting to slide into the Poor category all in the 2023 timeframe. However, by using the BMS tools, WVDOH was able to identify this wave and has been able to plan ahead. WVDOH intends to ramp up funding to almost double the budget for NHS bridges by 2024. The specific funding scenarios analyzed in detail are discussed in the following section.

FIGURE 18: PERCENT OF BRIDGES CURRENTLY IN SERVICE BY DECADE OF CONSTRUCTION

Decade	Individual Decade %/Total Deck Area			Cumulative %/Total Deck Area		
	Total	NHS	Non-NHS	Total	NHS	Non-NHS
1880s	0%	0%	0%	0%	0%	0%
1890s	0%	0%	0%	0%	0%	0%
1900s	0%	0%	0%	0%	0%	0%
1910s	1%	0%	1%	1%	0%	2%
1920s	1%	0%	3%	2%	0%	5%
1930s	1%	0%	3%	4%	1%	7%
1940s	1%	1%	2%	5%	1%	10%
1950s	3%	1%	6%	8%	2%	15%
1960s	7%	10%	4%	15%	12%	20%
1970s	23%	28%	15%	38%	40%	34%
1980s	17%	18%	16%	55%	58%	51%
1990s	18%	16%	22%	73%	74%	72%
2000s	18%	18%	18%	92%	92%	91%
2010s	8%	8%	9%	100%	100%	100%

Scenario Analysis Results

Multiple funding scenarios were considered for analysis in cooperation with leadership which resulted in two scenarios being analyzed in detail for bridges using the lifecycle planning benefit cost analysis processes described in the section Process for Performing Lifecycle Optimization Analysis. The funding scenarios selected for detailed modeling and analysis were:

1. Baseline Funding Scenario – the projected funding for bridges over the 10-year analysis period
2. Baseline Scenario with increased funding from 2024 – a funding scenario where the funding for NHS bridges was increased by $50 million from 2024 onwards

These funding scenarios are summarized in Figure 19 and Figure 20.

FIGURE 19: SCENARIO 1 - BASELINE FUNDING

Capital Program NHS and Non-NHS Expenditure Projections (millions $)	FY 2019	FY 2020	FY 2021	FY 2022	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	FY 2028	FY 2029
Bridge Program (NHS)	$73.6	$68.3	$147.0	$66.4	$66.2	$66.1	$66.0	$68.3	$68.1	$68.0	$68.0
Turnpike Bridge Program (NHS)	$73.6	$17.9	$15.0	$15.2	$15.3	$15.5	$15.6	$15.8	$16.0	$16.2	$16.2
Bridge Program (Non-NHS)	$95.0	$88.2	$189.8	$85.8	$85.5	$85.4	$85.3	$88.2	$88.0	$87.8	$87.8
Total	$242.2	$174.5	$351.7	$167.4	$167.1	$167.0	$167.0	$172.4	$172.1	$172.1	$172.1

FIGURE 20: SCENARIO 2 - BASELINE SCENARIO WITH INCREASED FUNDING FROM 2024

Capital Program NHS and Non-NHS Expenditure Projections (millions $)	FY 2019	FY 2020	FY 2021	FY 2022	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	FY 2028	FY 2029
Bridge Program (NHS)	$73.6	$68.3	$147.0	$66.4	$66.2	$116.1	$116.0	$118.3	$118.1	$118.0	$118.0
Turnpike Bridge Program (NHS)	$73.6	$17.9	$15.0	$15.2	$15.3	$15.5	$15.6	$15.8	$16.0	$16.2	$16.2
Bridge Program (Non-NHS)	$95.0	$88.2	$189.8	$85.8	$85.5	$85.4	$85.3	$88.2	$88.0	$87.8	$87.8
Total	$242.2	$174.5	$351.7	$167.4	$167.1	$217.0	$217.0	$222.4	$222.1	$222.1	$222.1

By using the deterioration modeling and lifecycle benefit cost optimization processes described in the previous sections, and using the funding scenarios shown in Figure 19 and Figure 20, the projected conditions were forecast for the two scenarios as shown in Figure 21 and Figure 22.

FIGURE 21: PROJECTED FHWA CONDITION METRICS FOR BASELINE FUNDING ON NHS BRIDGES

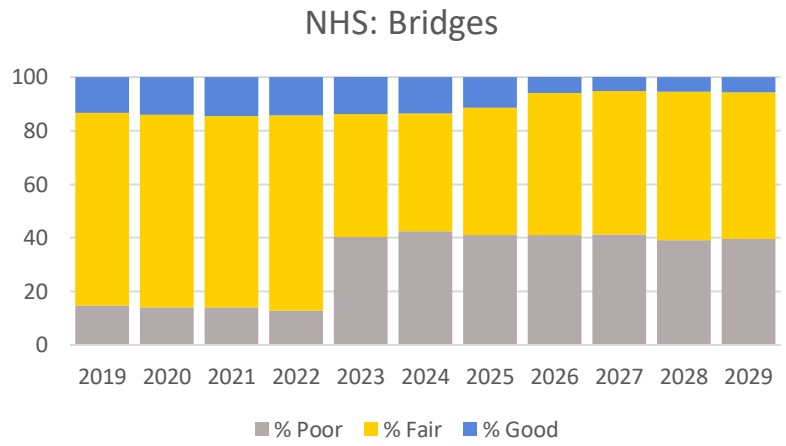
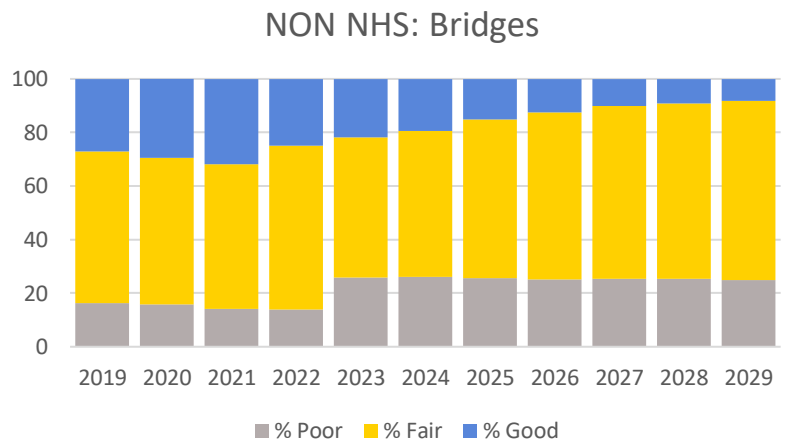


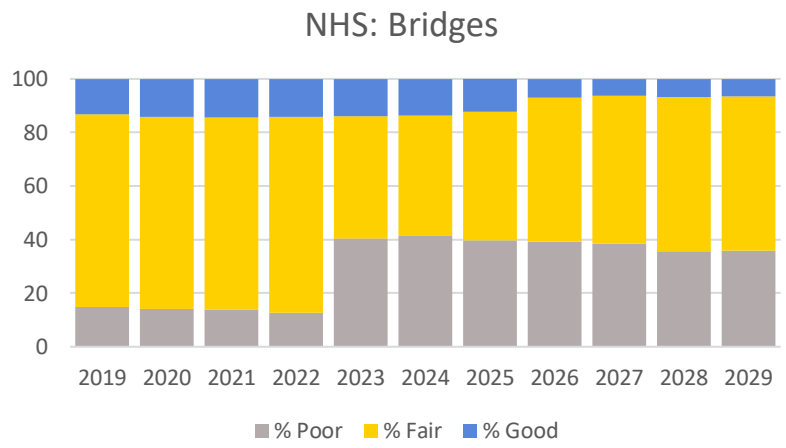
FIGURE 22: PROJECTED FHWA CONDITION METRICS FOR BASELINE FUNDING SCENARIO ON NON-NHS BRIDGES



As noted previously, the projections from the Baseline funding scenario show the 'wave' of bridges built in the 1960's and 1970's starting to slide into the Poor category all in the 2023 timeframe. It can also be seen from the figures that although there is an anticipated wave of bridges becoming Poor in the Non-NHS network, this effect is more pronounced in the NHS network.

In anticipation of this wave, a second scenario was also analyzed to model ramping up funding to almost double the budget for NHS bridges by 2024 while leaving Baseline scenario funding in place for Non-NHS bridges. The results of this Baseline Scenario with increased funding from 2024 are shown in Figure 23 for the NHS system.

FIGURE 23: PROJECTED FHWA CONDITION METRICS FOR BASELINE WITH INCREASED FUNDING FROM 2024 ON NHS BRIDGES



The projected results for this scenario show a steady decrease in the percentage of Poor deck area up until 2022 and then again from 2023 onwards. This shows that the inevitable large wave of older bridges will be smoothed out over time and the percentage of Poor deck area will be continuously decreased both before and after 2023.

A summary of the condition projections for the analyzed scenarios is shown in Figure 24.

FIGURE 24: SUMMARY PROJECTED STATISTICS FOR NHS BRIDGES

	2019-2022		2023-2029	
Scenario	**% Deck Area Good (7-9)**	**% Deck Area Poor (≤4)**	**% Deck Area Good (7-9)**	**% Deck Area Poor (≤4)**
Baseline Funding Scenario	2019: 13.2% 2022: 14.2%	2019: 14.8% 2022: 12.8%	2023: 13.8% 2029: 5.8%	2023: 40.4% 2029: 39.6%
Baseline Plus 10% Increased Funding	2019: 13.2% 2022: 14.2%	2019: 14.8% 2022: 12.8%	2023: 13.8% 2029: 6.6%	2023: 40.4% 2029: 35.9%

Each of these scenarios represents a recommended workplan consisting of projected projects and project costs over the next 10 years. Each project is categorized as a specific work type ranging from preservation treatments to replacement as shown in Figure 25. Based on each of these workplans, the resulting investment strategy in terms of planned investment in dollars across the mix of work types can therefore be projected over the 10-year analysis period. The chosen investment strategy is discussed in Chapter 6 Investing Wisely.

Process for Selecting Scenarios

At the beginning of the performance period, the targets from the previous performance period will be re-adopted or new targets will be set. During the performance period, a gap analysis will be conducted. In both cases, the Asset Management Coordinator will work with the Executive Leadership and the Planning and Programming Division to decide on a set of scenarios for analysis by the different asset management groups.

Process for Performing Lifecycle Optimization Analysis

Analyzing a specific scenario involves following the basic steps:

1. Update or confirm available treatment actions – The treatments that are currently proposed for use in the bridge management system are shown in Figure 25.

FIGURE 25: TREATMENT ACTIONS AND DESCRIPTIONS

Treatment	Work Type	Description
Seal Deck	Preservation	Adds 5 years of life to the Wearing Surface index.
Replace Joints	Preservation	Replace seals and minor armor repairs. Adds 5 years of life to Substructure index. Resets Joint age to zero.
Spot Paint	Preservation	Painting approximately 20% of surface area. Adds 5 years of life to the Superstructure and Paint indices.
Patch Deck	Maintenance	Partial depth patching. Adds 3 years of life to the Deck index.
Superstructure Rehabilitation	Rehabilitation	Steel repairs (approximately 5% of structural steel) and spot painting. Adds 2 to the Superstructure index and adds 5 years of life to the Paint index.
Overlay and Joint Replacement	Preservation	Hydrodemolish, overlay, and replace joint seals and armor. Adds 5 years of life to the Deck and Substructure indices. Resets the Wearing Surface index and resets Joint age to zero, and Seal Deck counter to zero.
Substructure Rehabilitation	Rehabilitation	Patching concrete surfaces at bearing seats and exposed areas. Adds 2 to the Substructure index.
Re-Paint	Preservation	Paint 100% of surface area. Adds 10 years of life to the Superstructure index. Resets Spot Paint counter to zero.
Re-Deck	Rehabilitation	Does not include Super or Substrate Rehab. Resets counters to zero for: Seal Deck, Replace Joints, Patch Deck, and Overlay and Joint Replacement. Does not reset counter for Substructure Rehab.
Superstructure Replacement	Rehabilitation	Does not include Substrate Rehab. Resets counters for all superstructure related interventions to zero.
Structure Replacement	Replace	Resets all counters to zero.
Culvert Re-Lining	Rehabilitation	
Culvert Replacement	Replace	Resets Counter for Culvert Relining to zero.

2. **Update or confirm deterioration models** – Deterioration models for the following performance indices are incorporated into the BMS.

FIGURE 26: PERFORMANCE INDICES

Index	Source
Deck	NBI Condition Rating
Superstructure	NBI Condition Rating
Substructure	NBI Condition Rating
Wearing Surface	Age (yrs.)
Joints	Age (yrs.)
Paint	Age (yrs.)
Culverts	NBI Condition Rating

3. **Update or confirm benefit calculations** – The benefit is calculated as the area between the 'Do Nothing' projection of the objective function (e.g. NBI condition rating) and the projection for the proposed treatment, multiplied by various priority factors as discussed in the previous section, Objectives and Targets on page 16.
4. **Update construction history** – Projects that have been completed in the last year will be updated by first capturing in the bridge inspection system and then bringing them into the bridge management system.
5. **Update Committed Projects (including STIP)** – The list of committed bridge projects that have been funded for delivery will be a manually maintained list in the bridge management system and will be updated based on the current STIP. Each project will be given a status that will allow it to be considered during the scenario analysis. If it is considered, the analysis will assume that the project is already committed and so will assume it is fixed and will not attempt to find alternatives.
6. **Identify Objectives and Constraints for Scenarios** – The objective function for the scenario will be confirmed. The objective function defines what the optimization will be attempting to maximize or minimize. In addition to the objective function, the constraints for each scenario will be confirmed. For example, if the scenario is 'maintain current funding levels', the analysis may be to maximize the average weighted NBI utility rating (objective function), subject to an annual budget equal to the current or latest budget (constraint). If the scenario was 'meet target' the analysis may be to minimize cost (objective function) subject to the target metric value for the scenario being no worse than the set target value (constraint).
7. **Run scenarios** – Once all the inputs for the scenarios have been confirmed, multiple long-term alternative strategies for the scenarios are generated and evaluated.
8. **Review and Adjust Scenario Results** – At this point, the user has the option to review and adjust scenario strategies, to accept, or override them.
9. **Run optimization** – After candidate strategies have been evaluated, the optimization analysis for each scenario will be run. This will result in an optimum strategy being recommended for each bridge included in the analysis. These strategies result in an overall workplan for the scenario detailing each treatment for each year (including 'do nothing' treatments) for each bridge.
10. **Analyze effect of scenarios on metrics** – Because each scenario analysis results in a workplan strategy for each bridge, this allows

the values of all metrics to be predicted for the analysis period (e.g. 10 years).

11. **Predict gap at end of performance period for each scenario** – The predicted values over the analysis period can then be used to see if, for any scenario, these values meet, exceed, or fall short of target values that have been set for the year.
12. **Submit results of analyses to Asset Management Coordinator** – The results, including the predicted metrics over time for each scenario, will be given by the Bridge Management lead to the Asset Management Coordinator. As part of this submission there will be a discussion of any gaps between scenarios and current/future targets, including explanations and possible reasons and solutions. In addition, if it is a year in which targets are to be adjusted, or new targets are to be set, the submission may also include discussion of possible target values. However, targets can only be finalized once the financial analysis of funding tradeoffs between pavement and bridge has been conducted and shared with the Executive Leadership. Once that analysis is complete, a specific scenario and funding strategy will be adopted and used for allocating a budget. This budget (and subsequent funding scenario) will be communicated back to the bridge management group for use in Lifecycle Planning Analysis for Work Planning and Programming as described in the next section.

Lifecycle Planning Analysis for Work Planning and Programming

Once a budget has been set for the current year, it is communicated to the Bridge Management group along with a funding scenario to be used for analysis for work planning and programming near term (over the next two to three years) projects. Once already committed projects are updated, the analysis will identify specific short term recommended projects based on long term deterioration projections and benefit cost ratio calculations and optimization.

The funding scenario is analyzed to generate a recommended optimum workplan over the next 10 years. From this analysis, recommended projects for the near term are generated based on optimization and benefit cost considerations.

Process for Selecting Scenarios

Once the budget for the year has been allocated, it is communicated to the Bridge Management group by the Program Administrator. This budget will be the full budget for the program, including the cost of upcoming committed projects. This will constitute the funding scenario to be analyzed.

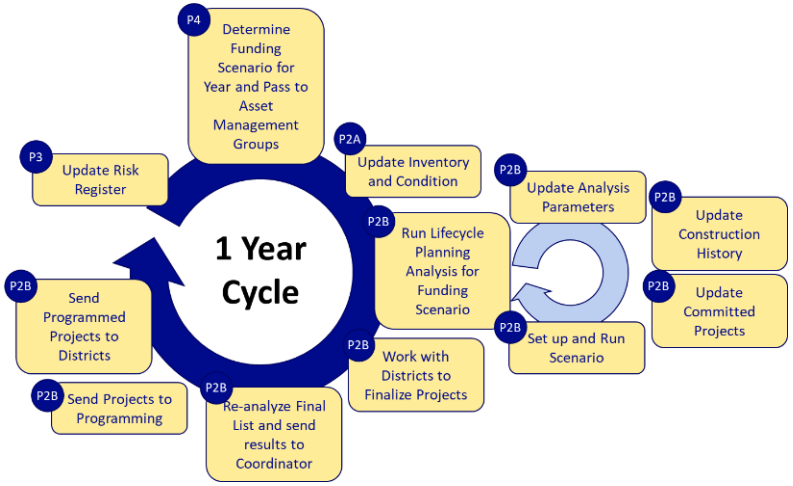
In addition to this funding scenario, the Bridge Management Group may run other scenarios informally to test different policies (such as differing budgets for different work types) and objective functions.

Process for Performing Lifecycle Optimization Analysis

Analyzing a specific scenario will involve many of the same basic steps as described above for the Lifecycle Planning Analysis for Gap Analysis and Target Setting, except that the results will be used for short term work planning and programming. These steps are:

1. **Update or confirm available treatment actions**
2. **Update or confirm deterioration models**
3. **Update or confirm benefit calculations**
4. **Update construction history**
5. **Update committed projects (including STIP)**
6. **Identify objective functions and constraints for scenarios** – The objective function will be as described in the section on Objectives and Targets, to maximize the weighted average NBI utility index. The constraints will be defined by the funding scenario.
7. **Run scenario** – The goal will be to run the designated budget and funding scenario, but other scenarios involving different work types etc. may also be run informally.
8. **Analyze resulting workplan** – The list of recommended projects resulting from the scenario optimization analysis will be analyzed to ensure they are reasonable and practical.

FIGURE 27: ONE-YEAR WORKPLAN CYCLE



9. **Send recommended projects list to Districts for review** – After running the budget scenario and checking the resulting recommended workplan, 5-year project lists will be sent by the Bridge Management group to the Districts for review.
10. **Receive District project lists** – Districts will compile their own lists based on District priorities, budget, etc. Each District's list will be finalized with justifications for any differences from the Bridge Management group list and returned to the Bridge Management Section.
11. **Validate treatment selections** – The recommended projects from the analysis run will be validated by the Bridge Management Section against the District recommendations and the project list finalized. During this process, the Bridge Management group and Districts will discuss the results and comments to show how the system will be impacted by adjusting different mixes of projects or treatment types. This serves to ensure Districts understand the effects of different scenarios. It also serves as feedback to continue to improve the modeling in the management system.
12. **Send Project List to Programming Division** – The Bridge Management group will send the final list of projects to the Programming Division to initiate the project development processes. This list will also be sent to the Districts.
13. **Send Final Programmed Projects to Districts** – The Bridge Management group will then send final programmed projects to the Districts.

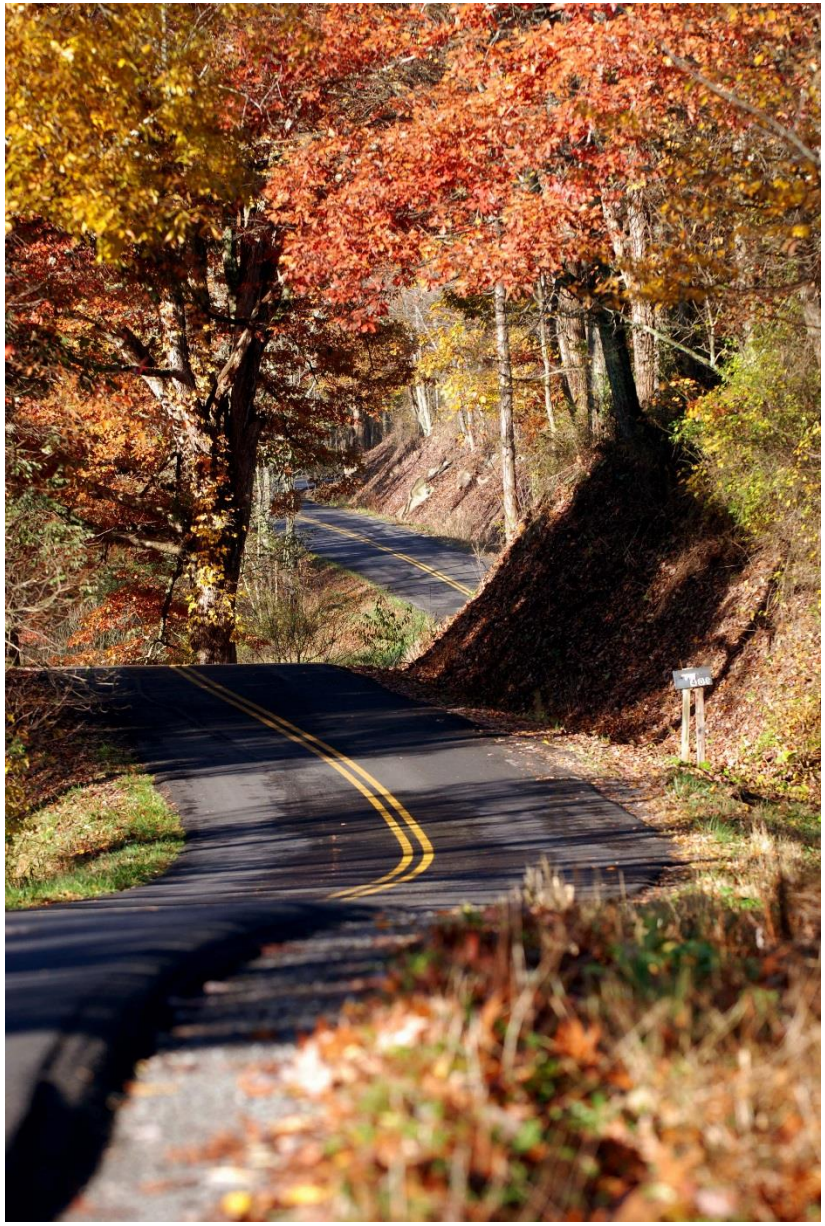
Ensuring Use of Best Available Data and Use of Management Systems

The most recent inventory and condition data will be used as inputs as part of the Gap Analysis process and the Lifecycle Planning Analysis process as described in the previous section. The Lifecycle Planning process includes use of a commercial bridge management system (Deighton dTIMS) to perform optimization analyses of various scenarios. This software and associated processes will enable:

- Collecting, processing, storing, and updating inventory and condition data;
- Forecasting deterioration;
- Determining the benefit-cost over the lifecycle of assets to evaluate alternative actions (including no action decisions);
- Identifying short- and long-term budget needs; and
- Recommending workplans and project implementation schedules.

The process will also involve using the current STIP as input for maintaining a list of committed projects that is used in the scenario analyses. The procedures for using the bridge management system for short and long-term planning are described in the sections on Lifecycle Planning Analysis for Gap Analysis and Target Setting and Lifecycle Planning Analysis for Work Planning and Programming respectively. With regard to implementation, the configuration for the bridge management system, including definiton of deterioration models, work types and their effects, and trigger rules has already been defined and approved. The implementation and system testing of this configuration in the dTIMS framework was completed at the end of 2018. User acceptance and refinements of the configuration occured in the first and second quarters of 2019, and then lifecycle analyses were run for the Complete TAMP submission in June 2019.

Source: WVDOH



Source: WVDOH

Chapter 3

Managing Pavement Assets

Inventory and Condition

Inventory

The highway network maintained and operated by WVDOH consists of several different systems as shown in Figure 28 and Figure 29.

FIGURE 28: TOTAL MILEAGE BY SYSTEM

	Centerline Miles	Lane Miles
Interstate	1,103	4,663
US	3,640	9,093
WV	3,805	8,029
CO	28,883	57,788
State Park/Forest	197	394
Federal Aid Non-State	278	570
Harp	879	1,757

Note: Centerline miles include dual direction when designated. Interstate includes the Turnpike as well as I-68. Data was pulled from the Road Inventory Log as of 2/6/2017.

In addition to the 1,103 centerline miles of Interstate, an additional 2,348 centerline miles of Non-Interstate mileage result in a total NHS mileage of 3,451, as shown in Figure 29.

FIGURE 29: ADDITIONAL SYSTEMS MILEAGE

	Centerline Miles
Interstate (NHS)	1,103
Non-Interstate NHS	2,348
ADHS (w/o I-68)	785
Non-NHS US Routes	1,876

The owners of the NHS pavements within the state of West Virginia are WVDOH and the WV Turnpike Authority. The breakdown of mileage[3] between these owners is shown in Figure 30 and Figure 31.

FIGURE 30: NHS ROADWAY BY OWNER

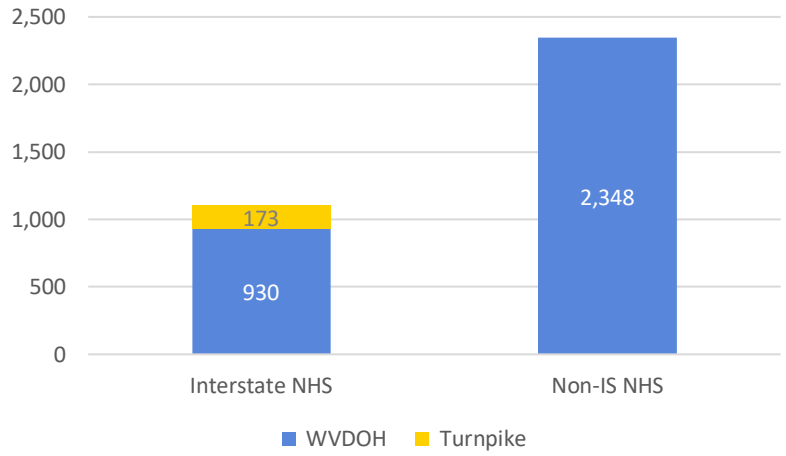


FIGURE 31: NHS MILEAGE

	WVDOH	Turnpike	Total
Interstate NHS	930	173	1,103
Non-IS NHS	2,348	-	2,348
Total	3,278	173	3,451

Condition

The majority of the NHS in West Virginia is generally in Good condition based on the FHWA metrics adopted through the rule making process for MAP-21 and the FAST Act. The FHWA metrics are based upon the percentage of tenth-mile Highway Performance Monitoring System (HPMS) section data that are in Good, Fair, or Poor condition. Each tenth-mile HPMS section is classified as being in Good, Fair, or Poor condition based on the 23 CFR 490.313(c) where:

(1) A pavement section shall be rated an overall condition of Good only if the section is exhibiting Good ratings for all three conditions (IRI, Cracking Percent, and rutting or faulting);

(2) A pavement section shall be rated an overall condition of Poor if two or more of the three conditions are exhibiting Poor ratings (at least two ratings of Poor for IRI, Cracking Percent, and rutting or faulting).

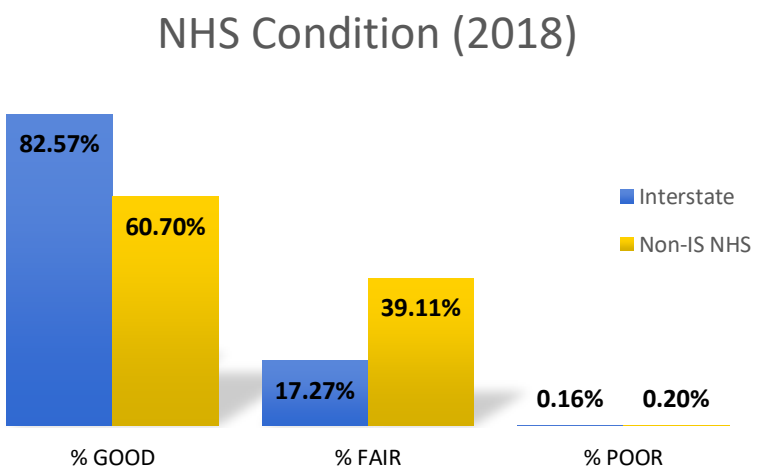
(3) A pavement section shall be rated an overall condition of Fair if it does not meet the criteria in paragraphs (c)(1) or (c)(2) of 23 CFR 490.313(c).

Agencies are required to set targets for percentage of Good and percentage of Poor for Interstate and the Non-Interstate NHS. As

[3] Centerline miles on mainline highway. Source: MAP-21 Reporting Criteria Summary 2014-2017.

expected, the Interstate, with 83% in Good condition, is generally in better condition than the Non-Interstate NHS, with 61% in Good condition. For the interstate, only 0.16% is in Poor condition, whereas for the Non-Interstate NHS, 0.20% is currently in Poor Condition. Accordingly, WVDOH Interstate pavements are currently well below the 5% maximum threshold for poor condition (See Figure 32).

FIGURE 32: NHS CONDITION

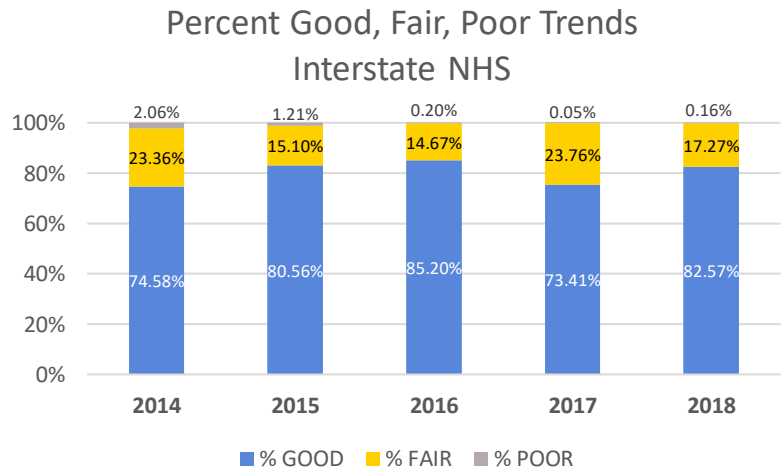


Trends Over Time

For interstates, the proportion of roadway in Good condition has been increasing in general but began to decline between 2016 and 2017. The reverse of this can be seen for the proportions of roadway in Fair condition where they had been decreasing (with successively more roadway in Good condition), but a reversal of this trend began in 2017.

The proportion of interstate pavements in Poor condition has fluctuated yearly but overall continues to trend downward and is currently at 0.16% (See Figure 33).

FIGURE 33: INTERSTATE NHS CONDITION TRENDS

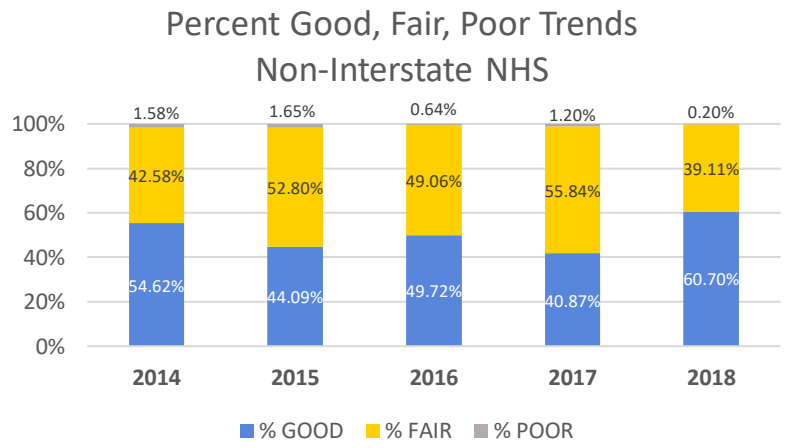


Note: Percentages shown exclude missing data and thus do not necessarily sum to 100%.

For Non-Interstate NHS, the proportion of roadway pavements in Good condition has been variable with an average downward trend, except for 2018 where it increased. The proportion of roadway in Fair condition has also been variable but shows an overall increase, with the

proportions of Good and Fair roadway reversing over time from 54.62% and 42.58% in 2014, to 39.11% and 60.70% in 2018 respectively (See Figure 34).

FIGURE 34: NON-INTERSTATE CONDITION TRENDS



Note: Percentages shown exclude missing data and thus do not necessarily sum to 100%.

Process for Obtaining Data from NHS Owners other than WVDOH

Pavement condition data for the full NHS, including the WV Turnpike, is collected each year, by contract. This data is imported directly into the dTIMS pavement management system.

Objectives and Targets

WVDOH desires to maintain the NHS pavements in a state of good repair by adopting the following objectives:

- Use a pavement management system to project deterioration and effects of maintenance, preservation, rehabilitation, and reconstruction projects to analyze different funding scenarios.
- Maximize the average of the weighted WVDOH Composite Condition Index (CCI) rating over a 10-year analysis period, subject to budget constraints. The CCI Index is weighted by the square root of the AADT multiplied by the lane miles for each section. This involves:
  - Using maintenance and preservation treatments on pavements to keep them in Good condition since maintenance and preservation treatments show a high benefit-cost ratio.

Based on the objectives above, WVDOH has established the following targets:

- The percent of Interstates in a Good condition [23 CFR 490.307(a)(1)] by tenth-mile section mileage should be at least 75%.
- The percent of Interstates in a Poor condition [490.307(a)(2)] by tenth-mile section mileage should not exceed 4.0%.
- The percent of Non-Interstate NHS in a Good condition [23 CFR 490.307(a)(3)] by tenth-mile section mileage should be at least 45%.
- The percent of Non-Interstate NHS in a Poor condition [490.307(a)(4)] by tenth-mile section mileage should not exceed 5.0%.

Gap Identification and Strategies for Attaining Targets

Physical Condition of Assets

Based on the current pavement conditions shown and the targets outlined in the previous sections, the current gaps are shown in Figure 35.

The current metric value for Interstate percentage of Good is better than the target value and should allow for minor fluctuations in actual values over a 4-year horizon. Similarly, the current percentage of Poor for Interstates is well below the allowable 5% mandated threshold as well as the 4.0% target that has been established. Again, no major changes in condition values are expected over the near-term planning horizon, though minor fluctuations may occur.

The current percentage of Good condition value of 60.70% for Non-IS NHS routes is well above the target value of 45%. The current gap for Poor condition on Non-IS NHS routes is 0.20%, well below the target of 4.0%, allowing for fluctuations in actual values over a 4-year horizon, as shown in Figure 36.

FIGURE 35: NHS CONDITION TARGETS AND GAPS

Metric		Current Condition	Target	Gap
Interstate	% Good	82.57%	75%	No Gap
	% Poor	0.16%	4.0%	No Gap
Non-IS NHS	% Good	60.70%	45%	No Gap
	% Poor	0.20%	5.0%	No Gap

FIGURE 36: INTERSTATE CONDITIONS VS TARGETS

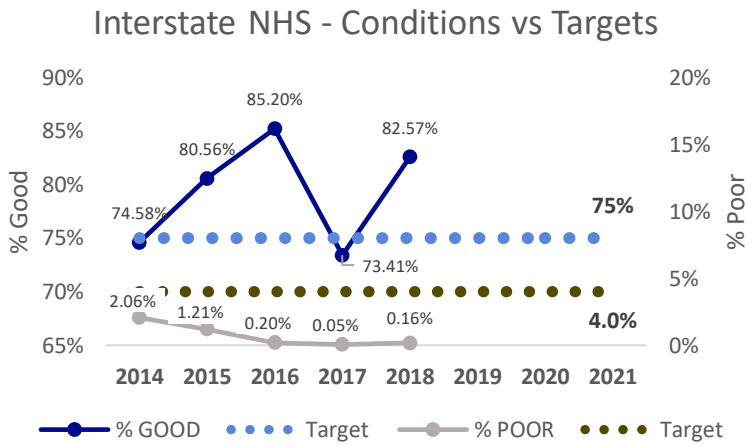
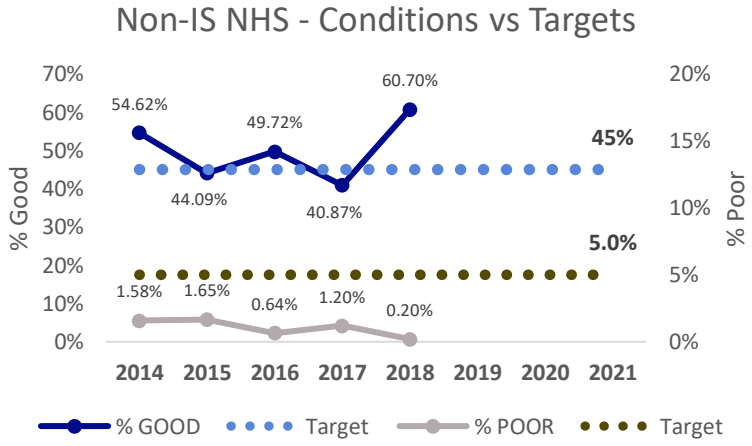


FIGURE 37: NON-INTERSTATE CONDITIONS VS TARGETS



Discussion of Deficiencies

For NHS pavements, no gaps exist for the percentage of Poor targets (See Figure 35). Similarly, no gap exists for the percentage of Good on Interstate pavements, and no gap exists for Non-Interstate NHS pavements.

One of the challenges impacting the ability to make accurate projections is that District Purchase Order paving work is not currently captured in the construction history for the pavement management system and therefore is not presently available for use in the analysis. As such, this may affect the 10-year condition projections. WVDOH does have plans to complete a new Asset Management System in the near future which will enhance the agency's ability to capture and report on this type of work activity.

Identification of Alternative Strategies

Like programs for other asset types, funding for NHS pavements must be balanced, and traded off, against other WVDOH objectives as well as Non-NHS pavements. To make these trade-offs as objective as possible, WVDOH will analyze the effects of different levels of funding on the NHS pavements. As a result, multiple funding strategies are developed and passed to the Pavement Management group so that the condition resulting from each funding scenario can be projected over the next 10 years.

In addition to developing alternative funding strategies, the following are also anticipated to help maintain the percentage of Good condition targets identified above:

- There is now a bond program to leverage funding for larger projects.
- The Roads to Prosperity initiative is expected to increase the funding available for pavement projects on the NHS.

Process for Performing Gap Analysis

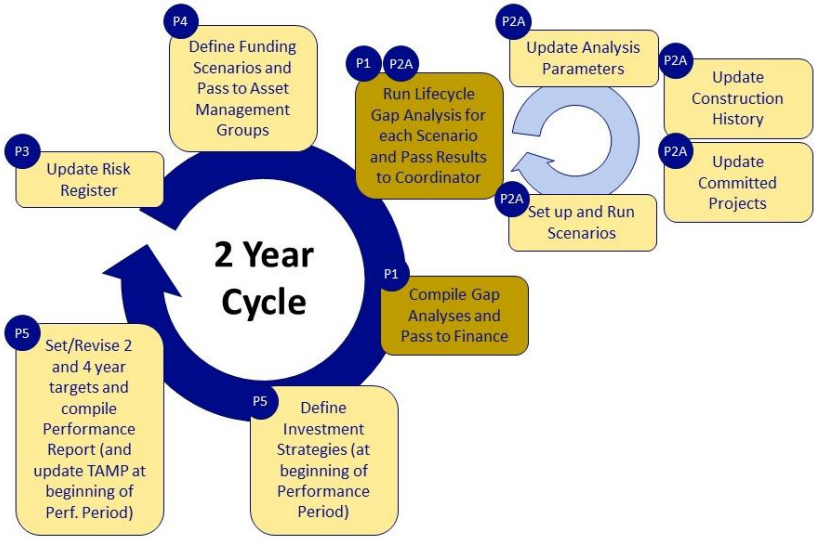
The future methodology for Gap Analysis will consist of four main steps:

1. Update Inventory and Condition.
2. Check progress against current Targets and Objectives.
3. Project future gap between Condition and Targets at the end of the Performance Period under different scenarios.
4. Compile Gap Analysis.

The assumption is targets are already in place for specific future years (in this case the targets are for the first Performance Period ending in December 2021). Note that the lifecycle analysis will be conducted to project conditions out over a 10-year analysis period and this will be used to inform the two and four-year targets.

This process is depicted as part of the larger process shown in Figure 38 and described in the following pages.

FIGURE 38: GAP ANALYSIS 2 YEAR CYCLE



1. **Update Inventory and Condition** – To update the inventory and condition of the network, the Pavement Management group notifies Planning and Programming which roads are going to have condition data collected each year. Planning and Programming will then inform the data collection vendor. Data collection typically starts in March. Interstates are completed in April or May while data collection continues on remaining roads throughout the summer. Condition data is collected and summarized for each tenth-mile of the network. Data collection will be governed by a data quality management plan (DQMP) developed by WVDOH. Once data collection is complete, the % Good, % Fair, and % Poor FHWA metrics, as well as numerous state statistics can be evaluated for the latest year.
2. **Check Progress against Targets and Identify Gaps** – Targets for % Good and % Poor metrics are discussed in the previous section. To check progress against these targets, the trend of these metrics during the current performance period will be plotted against the targets to identify current gaps.
3. **Project future gap between Condition and Targets** – In the future, the agency will use the pavement management system, as discussed in the next section, to project the condition of NHS pavements out to the end of the current PMS performance period for each of the different funding scenarios identified in the Financial Plan (Chapter 5). This process is outlined in the subsequent sections regarding the lifecycle planning process.
4. **Compile Gap Analysis** – Once the scenarios have been analyzed, the results are provided to the Asset Management Coordinator (from each asset management group). The Asset Management Coordinator will then compile these and provide the gap analysis to the Executive Leadership for consideration in the next budget cycle.

Identification of Alternative Strategies

The process for identifying alternative strategies, and specifically the identification of specific alternative funding strategies that need to be analyzed, is undertaken as part of the Financial Planning processes described in Chapter 5. Examples are given in the more detailed section on Lifecycle Planning Analysis for Gap Analysis and Target Setting.

In addition to the strategies identified in the Financial Planning processes (Chapter 5) the pavement management group may also analyze alternative strategies informally to test different policies (such as differing budgets for different work types) and objective functions. However, it should be noted that the pavement management system

generates an optimum strategy for each funding scenario that defines the ideal mix of work types. Note that while it is interesting to view results, manual adjustment of the optimum recommended mix of work types will invariably result in a less optimal strategy.

NHS Effectiveness Performance

The MAP 21 and FAST Act legislation focused on multiple aspects of NHS performance, including safety, mobility, congestion, and freight, in addition to the requirements for a TAMP. While the goal of the legislation is to ensure safe and efficient movement of people and goods on the NHS, WVDOH has the added challenge of maintaining the entire network of pavements and bridges throughout the state of West Virginia.

Accordingly, WVDOH recognizes the need to balance investments made to maintain targets in the areas of safety, mobility, congestion, and freight. Within the framework of the TAMP, the program of projects not only will focus on perpetually maintaining a state of good repair for NHS pavements and bridges, but within the context of the LRTP, work to close the gaps identified, in a coordinated approach, in those related areas of safety, mobility, congestion and freight. This integrated approach, while focusing on the NHS, recognizes that the WVDOH has additional responsibilities that include the entire network of roads and bridges for the remainder of the state network. All of which are to be maintained within budget.

Based on the performance targets submitted by WVDOH to FHWA on May 18, 2018, the agency's analysis has determined that the travel time reliability performance targets are conservative. This indicates that significant gaps do not currently exist for the efficient movement of people and freight.

Future issues and concerns relative to climate-change and extreme weather are also being considered in risk management scenarios and are being added to discussions on how best to manage the overall program.

Additionally, as NHS facilities are widened for capacity or modernized to enhance mobility or safety, lifecycle management of the associated improvements must be planned. WVDOH is already working proactively to extend the performance life of its critical assets by employing pavement and bridge preservation strategies which minimize construction delays by pushing rehabilitation out further in time.

Work on integrating the TAMP into the Long-Range Transportation Plan will ensure the overall effectiveness of the NHS as well as the rest of the WVDOH highway network.

Lifecycle Planning Analysis for Gap Analysis and Target Setting

The WVDOH pavement management system has been recently modified to enhance its capacity to analyze multiple scenarios using pavement work types and deterioration modeling over chosen analysis periods to generate multiple workplan strategies. The process of generating these lifecycle planning strategies is described in the following section (Process for Performing Lifecycle Optimization Analysis).

Scenario Analysis Results

For pavements, two funding scenarios were chosen for detailed modeling and analysis. These scenarios were:

1. Baseline Funding Scenario – the projected funding for pavements over the 10-year analysis period
2. Baseline Scenario with 10% increased funding – a funding scenario where funding for NHS pavements was increased by 10% in all years of the 10-year analysis period

The projected condition for these funding scenarios is summarized in Figure 39 and Figure 40.

Using these funding scenarios combined with the deterioration modeling and lifecycle benefit cost optimization processes described later under the section Process for Performing Lifecycle Optimization Analysis, the projected conditions were forecast for the two scenarios as shown in Figure 41 and Figure 42.

FIGURE 39: SCENARIO 1 - BASELINE FUNDING

Capital Program NHS and Non-NHS Expenditure Projections (millions $)	FY 2019	FY 2020	FY 2021	FY 2022	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	FY 2028	FY 2029
Pavements Program (NHS)	$141.7	$131.7	$283.2	$128.0	$127.6	$127.5	$127.3	$131.7	$131.3	$131.1	$131.1
Turnpike Pavements Program (NHS)	$122.7	$29.9	$24.9	$25.3	$25.5	$25.8	$26.1	$26.4	$26.7	$27.0	$27.0
Pavements Program (Non-NHS)	$111.7	$103.8	$223.3	$100.9	$100.6	$100.5	$100.3	$103.8	$103.5	$103.3	$103.3
Total	$376.2	$265.4	$531.5	$254.2	$253.8	$253.8	$253.7	$261.8	$261.4	$261.4	$261.4

FIGURE 40: SCENARIO 2 - BASELINE SCENARIO WITH 10% INCREASED FUNDING

Capital Program NHS and Non-NHS Expenditure Projections (millions $)	FY 2019	FY 2020	FY 2021	FY 2022	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	FY 2028	FY 2029
Pavements Program (NHS)	$155.90	$144.8	$311.6	$140.8	$140.4	$140.2	$140.0	$144.8	$144.4	$144.2	$144.2
Turnpike Pavements Program (NHS)	$122.7	$29.9	$24.9	$25.3	$25.5	$25.8	$26.1	$26.4	$26.7	$27.0	$27.0
Pavements Program (Non-NHS)	$111.7	$103.8	$223.3	$100.9	$100.6	$100.5	$100.3	$103.8	$103.5	$103.3	$103.3
Total	$390.4	$278.5	$559.8	$267.0	$266.6	$266.5	$266.4	$275.0	$274.6	$274.6	$274.6

FIGURE 41: SCENARIO 1 - PROJECTED FHWA CONDITION METRICS FOR BASELINE FUNDING SCENARIO ON INTERSTATE PAVEMENTS

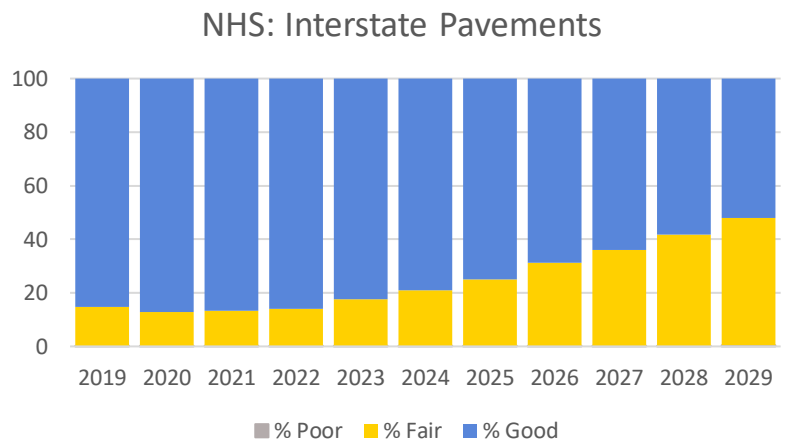
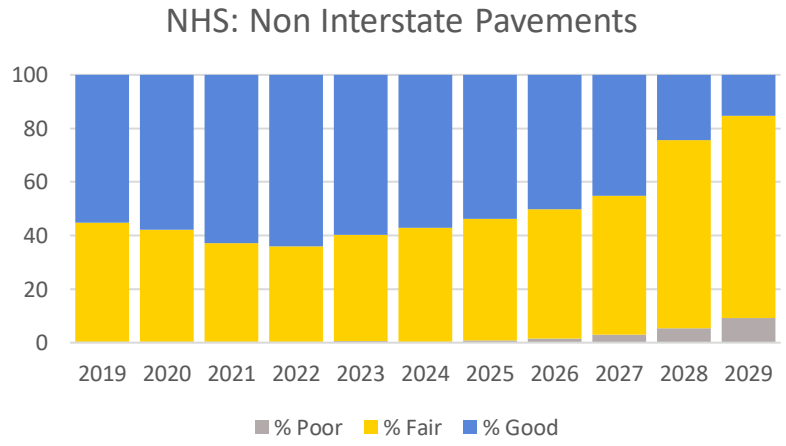


FIGURE 42: SCENARIO 1 - PROJECTED FHWA CONDITION METRICS FOR BASELINE FUNDING SCENARIO ON NON-INTERSTATE NHS PAVEMENTS



The projections from the Baseline funding scenario show an initial increase in the percent of Good pavement until 2022. In the case of Interstates, the percent of Good pavement decreases again with a very slight increase in percent Poor. For Non-Interstate NHS pavement, the percent Good remains high, but the percent Poor shows a projected increase towards the end of the analysis period. These projections show that it would be problematic to reduce funding for pavements and funding needs to remain at least at the Baseline level.

FIGURE 43: SCENARIO 2 - PROJECTED FHWA CONDITION METRICS FOR BASELINE FUNDING PLUS 10% SCENARIO ON INTERSTATE PAVEMENTS

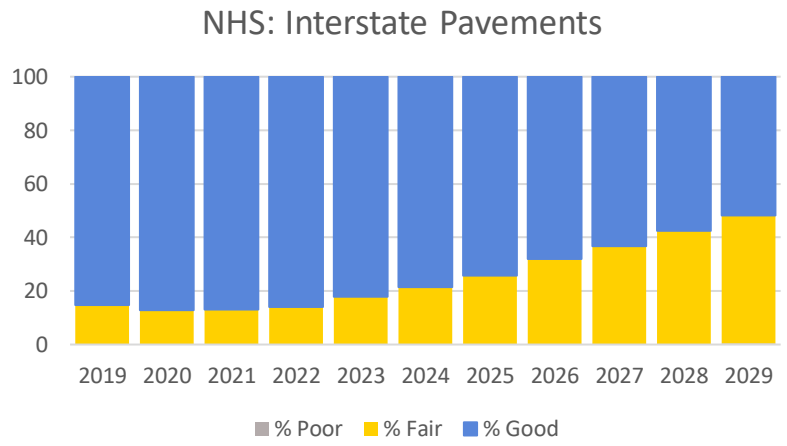
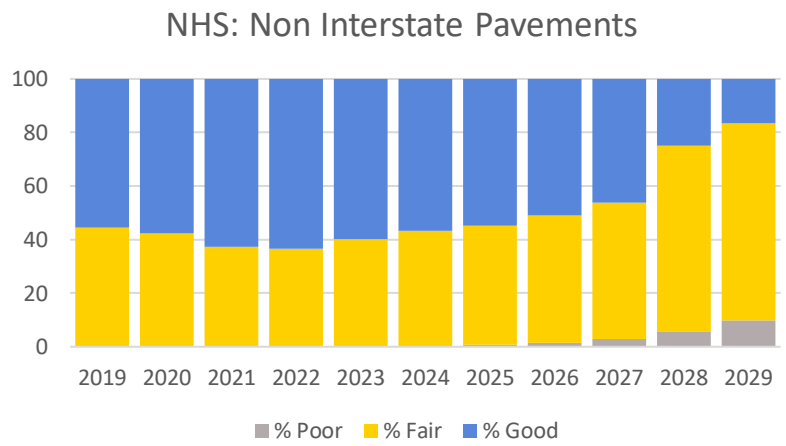


FIGURE 44: SCENARIO 2 - PROJECTED FHWA CONDITION METRICS FOR BASELINE FUNDING PLUS 10% SCENARIO ON NON-INTERSTATE NHS PAVEMENTS



In can be seen from Figure 43 and Figure 44 that increasing the funding by 10% does not make an appreciable difference and the projections from this scenario are similar to those from the Baseline funding scenario.

A summary of the condition projections for the analyzed scenarios is shown in Figure 45.

FIGURE 45: SUMMARY PROJECTED STATISTICS FOR NHS PAVEMENTS

	Interstate		Non-Interstate NHS	
Scenario	**% Lane Miles Good**	**% Lane Miles Poor**	**% Lane Miles Good**	**% Lane Miles Poor**
Baseline Funding Scenario	2019: 85.26% 2029: 52.07%	2019: 0.04% 2029: 0.31%	2019: 55.25% 2029: 15.38%	2019: 0.32% 2029: 9.24%
Baseline plus 10% Increased Funding	2019: 85.26% 2029: 51.77%	2019: 0.04% 2029: 0.30%	2019: 55.47% 2029: 16.65%	2019: 0.33% 2029: 9.83%

Because the lifecycle benefit cost optimization generates not just projected condition but also a simulated workplan of specific projects, these workplans can also be summarized to give an investment strategy in terms of anticipated funding per work type per year (see the mapping of treatment to work type in Figure 46) in each year of the analysis period. As was noted in the analysis results from bridge funding scenarios, an increased funding level was planned for the bridge program. Nonetheless, it was recommended to WV leadership that given the projected drop-off on percent Good pavement in the later years of the 10-year planning period, even for the 10% increased funding, the funding should not be reduced for pavements. The chosen investment strategy is discussed in Chapter 6 Investing Wisely.

Process for Selecting Scenarios

At the beginning of the performance period, the targets from the previous performance period will be re-adopted or new targets will be set. During the performance period, a gap analysis will be conducted. In both cases, the Asset Management Coordinator will work with the Executive Leadership and the Planning and Programming Division to decide on a set of scenarios for analysis by the different asset management groups.

Process for Performing Lifecycle Optimization Analysis

Analyzing a specific scenario involves following these basic steps:

1. **Update or confirm available treatment actions** – The treatments currently included in the pavement management system are shown in Figure 46.

FIGURE 46: TREATMENT ACTIONS

Treatment	Work Type	Description
Crack Seal	Preservation	
Chip Seal	Preservation	
Fog Seal	Preservation	
Microsurfacing	Preservation	May include Cape Seal.
Preservation	Preservation	
Saw Seal Joints	Preservation	
Ultra-Thin Overlay	Preservation	
Thin Overlay	Preservation	Thin overlays are 2" or less. May include milling.
Major Concrete Pavement Restoration (CPR) Diamond Grind	Rehabilitation	Major Concrete Pavement Restoration activities include DBR, slab replacement, partial or full depth patching, slab stabilization, etc.
Minor CPR Diamond Grind	Preservation	Minor Concrete Pavement Restoration activities assumes no major repair other than joint reseal.
Thick Overlay	Rehabilitation	Thick overlays are assumed to be more than 2". May include milling.
Reconstruction	Reconstruction	

2. **Update or confirm deterioration models** – Deterioration models for the following key performance indices (KPI's) are currently used:
   - PSI = Present Serviceability Index
   - NCI = Net Cracking Index
   - SCI = Structural Cracking Index
   - ECI = Environmental Cracking Index
   - RDI = Rut Depth Index
   - JCI = Joint Condition Index
   - CSI = Concrete Slab Index
   - CCI = Composite Condition Index

   These indices are on a 0-5 scale with 0 being the worst and 5 being perfect.

3. **Update or confirm benefit calculations** – The benefit will be calculated as the area between the 'do nothing' projection of the objective function (e.g. CCI condition rating) and the projection for the proposed treatment, multiplied by various priority factors as discussed in the previous section, Objectives and Targets on page 32.
4. **Update construction history** – Projects that have been completed in the last year will be updated by obtaining the Construction History File and STIP Project Listing in October and importing these into the pavement management system.
5. **Update Committed Projects (including STIP)** – The list of committed projects will be updated by obtaining the Construction History File and STIP Project Listing in October and importing these into the pavement management system.
6. **Identify Objectives and Constraints for Scenarios** – The objective function for the particular scenario will be confirmed. The objective function defines what the optimization will attempt to maximize or minimize. In addition to the objective function, the constraints for each scenario will be confirmed. For example, if the scenario is 'maintain current funding levels', the analysis may be to maximize the average CCI index rating (objective function), subject to an annual budget equal to the current or latest budget (constraint). If

the scenario was 'meet target' the analysis may be to minimize cost (objective function) subject to the target metric value for the scenario being no worse than the set target value (constraint).

7. **Run scenarios** – Once all the inputs for the scenarios have been confirmed, multiple long-term alternative strategies for the scenarios are generated and evaluated.
8. **Review and Adjust Scenario Results** – At this point, the user has the option to review and adjust scenario strategies, to accept, or override them.
9. **Run optimization** – After candidate strategies have been evaluated, the optimization analysis for each scenario will be run. This will result in an optimum strategy being recommended for each Pavement Management Section included in the analysis. These strategies result in an overall workplan for the scenario detailing treatments for each year (including 'do nothing' treatments) for each Pavement Management Section.
10. **Analyze effect of scenarios on metrics** – Because each scenario analysis results in a workplan strategy for each Pavement Management Section, this allows the values of all metrics to be predicted for the analysis period (e.g. 10 years).
11. **Predict gap at end of performance period for each scenario** – The predicted values over the analysis period can then be used to see if, for any particular scenario, these values meet, exceed, or fall short of target values that have been set for any particular year.
12. **Submit results of analyses to Asset Management Coordinator** – The results, including the predicted metrics over time for each scenario, will be given by the Pavement Management Lead to the Asset Management Coordinator. As part of this submission there will be a discussion of any gaps between scenarios and current/future targets, including explanations and possible reasons and solutions. In addition, if it is a year in which targets are to be adjusted, or new targets are to be set, the submission may also include discussion of possible target values. However, targets can only be finalized once the financial analysis to analyze funding trade-offs between pavement and bridges has been conducted with the Executive Leadership. Once that analysis is complete, a specific scenario and funding strategy will be adopted and used for allocating a budget. This budget (and subsequent funding scenario) is communicated back to the Pavement Management Section for use in Lifecycle Planning Analysis for Work Planning and Programming as described in the following section.

Lifecycle Planning Analysis for Work Planning and Programming

Once a budget has been set for the current year, it is communicated to the Pavement Management Section along with a funding scenario to be used for analysis for work planning and programming near term (over the next two to three years) projects. Once already committed projects are updated, the analysis will identify specific short term recommended projects based on long term deterioration projections and benefit cost ratio calculations and optimization.

The funding scenario is analyzed to generate a recommended optimum work plan over the next 10 years. From this analysis, recommended projects for the near term are generated based on optimization and benefit-cost considerations. The complete one-year work plan cycle is shown in Figure 47.

Process for Selecting Scenarios

The funding scenario is determined when the Pavement Management group receives a directive (Memo) from Executive Leadership giving Budgets for Interstates and ADHS in October for the following year. The funding scenario used as the input for the pavement optimization analyses assumes this budget remains constant for future years in the analysis (level budget analysis).

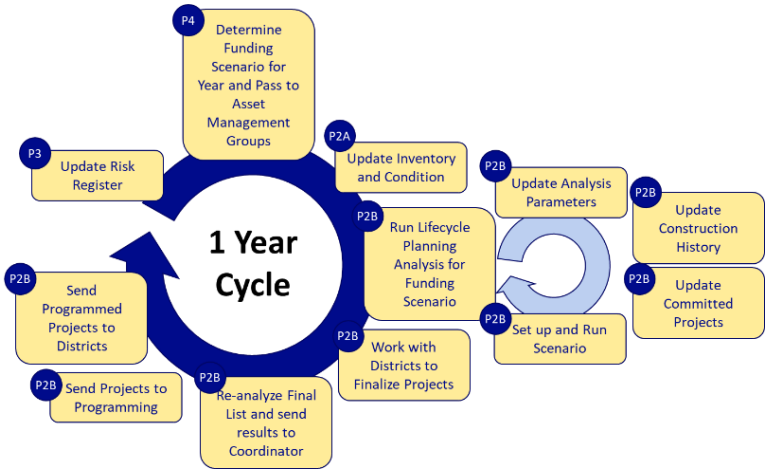
The Pavement Management group may also perform additional scenario analyses to test different mixes of work types and objective functions other than the Composite Condition Index (CCI). It should be noted however, that when unconstrained by forcing certain proportions of work types, the pavement management system will generate workplans containing an optimum mix of work types for the specific funding scenario being analyzed.

Process for Performing Lifecycle Optimization Analysis

This process involves many of the same basic steps as described above for the Lifecycle Planning Analysis for Gap Analysis and Target Setting except that the results will be used for short term work planning and programming:

1. **Update or confirm available treatment actions**
2. **Update or confirm deterioration models**
3. **Update or confirm benefit calculations**
4. **Update construction history**
5. **Update committed projects (including STIP)**
6. **Identify Objectives and Constraints for Scenarios** – The objective function will be as described in the section on Objectives and Targets: to maximize the CCI. The constraint will be the budget for the year (assumed to remain constant for future years).
7. **Run scenario** – The objective of this step will be to run the designated budget and funding scenario, but other scenarios involving different work types etc. may also be run informally.
8. **Analyze resulting workplan** – The list of recommended projects that is the result of the scenario optimization analysis will be analyzed to ensure the resulting projects are reasonable and practical.
9. **Send recommended projects list to Districts for review** – After running the budget scenario and checking the resulting recommended workplan, 5-year project lists will be sent by the Pavement Management group to the Districts for review.
10. **Receive District project lists** – Districts will compile their own lists based on District priorities, budget etc. Each District's list will be finalized with justifications of why they are different from the Pavement Management list and returned to the Pavement Management group.

FIGURE 47: WORKPLAN ONE YEAR CYCLE



11. **Validate treatment selections** – The recommended projects from the analysis run will be validated by the Pavement Management group against the District recommendations and the project list finalized. During this process, the Pavement Management group and Districts will discuss the results and comments to show how the system will be impacted by adjusting different mixes or treatment types. This serves to ensure Districts understand the effects of different scenarios. It also serves as feedback to continue to improve the modeling in the management system.
12. **Send Project List to Planning and Programming Division** – The Pavement Management group will send the final list of projects to the Planning and Programming Division to initiate the project development processes. This list will also be sent to the Districts.
13. **Send Final Programmed Projects to Districts** – The Pavement Management group will then send final programmed projects to the Districts.

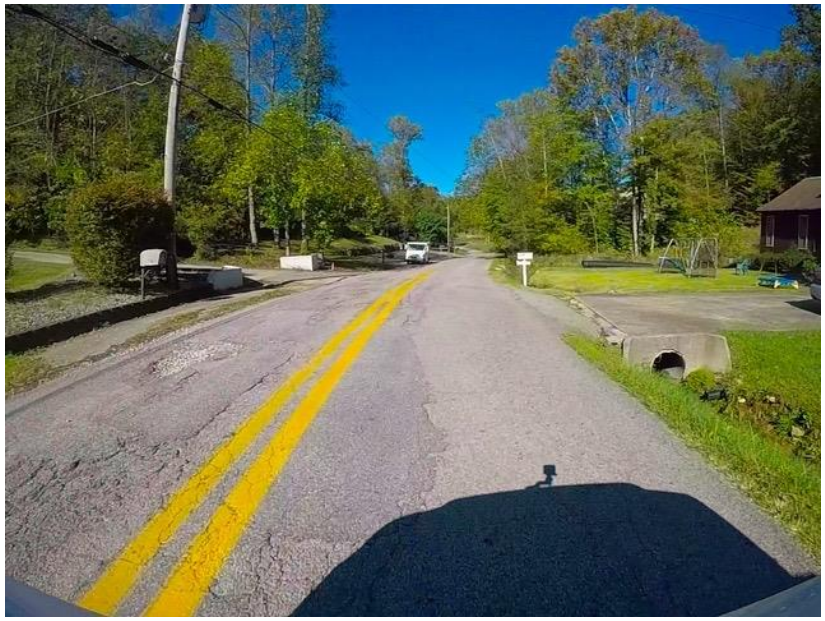
Ensuring Use of Best Available Data and Use of Management Systems

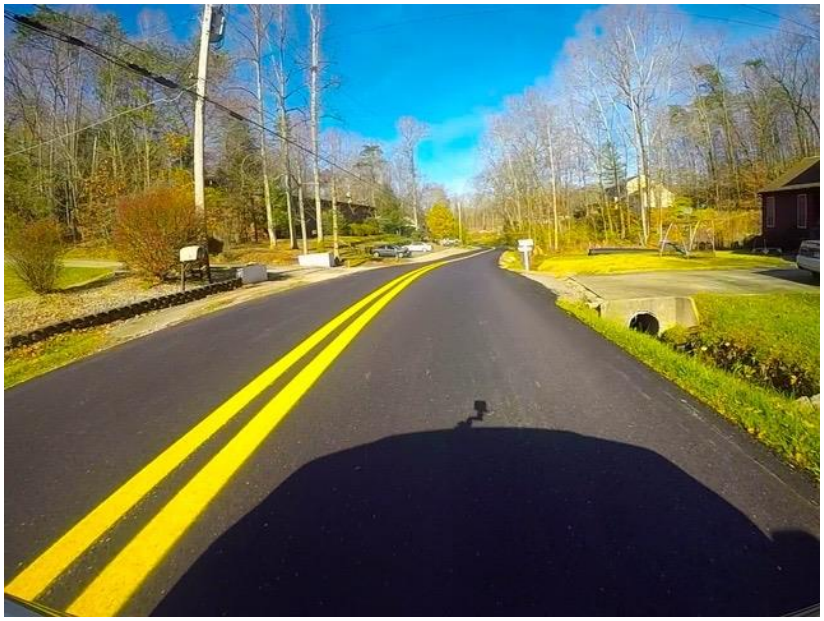
As part of the Gap Analysis process and the Lifecycle Planning Analysis process described above, the most recent inventory and condition data are used as input to the Gap Analysis process as described in that section above. This updated inventory and condition data is then the starting point for the Lifecycle Planning process also described above. The Lifecycle Planning process includes use of a commercial pavement management system (Deighton dTIMS) to perform optimization analyses of various scenarios. This software and associated processes will enable:

- Collecting, processing, storing, and updating inventory and condition data;
- Forecasting deterioration;
- Determining the benefit-cost over the lifecycle of assets to evaluate alternative actions (including no action decisions);
- Identifying short- and long-term budget needs; and
- Recommending workplans and project implementation schedules.

The process will also involve using the STIP as part of the input for maintaining a list of committed projects that is used in the scenario analyses. The procedures for using the management system for short and long-term planning are described previously in the sections on Lifecycle Planning Analysis for Gap Analysis and Target Setting and Lifecycle Planning Analysis for Work Planning and Programming respectively. An example of a typical pavement treatment is shown in Figure 48.

FIGURE 48: EXAMPLE ROADWAY CONDITIONS BEFORE AND AFTER TREATMENT





Source: WVDOH

Source: WVDOH

Chapter 4

Consideration of Risk

Risk Management Assessment

As part of the development process for the initial TAMP, a risk workshop was conducted with representatives from various WVDOH Divisions and Districts on December 12 and 13, 2017 to compile an initial Risk Register. This was updated in a risk workshop conducted May 7-8, 2019 by the Asset Management Coordinator following the processes described within this chapter to review and update the Risk Register on a regular basis.

Agency and Program Level Risk Register

The top priority agency and program level risks identified during the latest Risk Workshop are shown in the prioritized Risk Register in Appendix A. The scoring with regard to likelihood and consequence of these risks was updated during the risk workshop conducted May 7-8, 2019. The likelihood and consequence scales were also revisited and revised slightly. These scales are shown, along with the scoring process, in the Risk Management Process section.

Asset Level Risk Evaluations of NHS Pavements and Bridges pursuant to 23 CFR part 667

Prior to the risk workshop, projects were reported out of the project tracking/financial authorization system based on emergency

authorizations. During the risk workshop conducted May 7-8, 2019 by the Asset Management Coordinator, it was determined from the list of projects that no facilities could be reliably identified as having been repeatedly damaged as the data did not support being able to match any project locations exactly. Although no specific facilities were identified, the process for evaluating mitigation options and calculating a benefit/cost ratio for each mitigation option relative to the Do-Nothing option was refined and run against test examples. This process is described under Process for Evaluating NHS Pavements and Bridges Repeatedly Damaged by Emergency Events in the Risk Management Process section. In the future, the list of emergency projects will be maintained with a GIS location by the Asset Management Coordinator and any sites with more than one project will be able to be identified.

Risk Management Process

Risk Identification and Assessment Workshop

While certain aspects of risk have traditionally been factored into highway design and operational processes, it has only been in recent years that broader applications of risk consideration and strategies for mitigation have become integrated into Executive Leadership decision making. MAP -21 and FAST Act legislation requires state DOT's to develop risk-based Asset Management Plans. As part of the risk assessment update process for the TAMP, the Asset Management Coordinator will follow the processes described within this chapter to review and update the Risk Register on a regular basis.

Frequency and Attendees

The Asset Management Coordinator will arrange for a Risk Assessment Workshop to be conducted annually to update the Risk Register. The workshop will be attended by a diverse group of representatives both from the Districts and Central Office including Planning, Bridge, and Pavement sections. It is assumed that participants in the workshop may change from year to year, therefore a refresher on Risk Fundamentals will typically be incorporated into the agenda. Rotating the Risk Workshops around the Districts will allow opportunities for field site visits that may be beneficial with respect to applying the consideration of risk to real world situations and developing effective and practical mitigation strategies. When it comes to risk identification and evaluation, there is no substitute for local, tacit knowledge and understanding.

Agenda

The workshop will begin with an introduction to risk assessment that includes training for the group on:

- Definitions and Terminology
  - What is "Risk"?
  - Why manage risk?
  - Risk Management – overall process
- Risk Register Components
  - Types of risk
  - Impacts of uncertainty
  - Scoring of risk impacts
  - Proposed "remedies" for increasing resilience and reducing vulnerability
- Previous lessons learned – getting the most from the Risk Register effort

Thereafter the group will participate in a facilitated exercise to identify/confirm the major risks to the agency's goals and vision.

Scope

Risks covering a wide range of risk types are assessed, including:

- Natural Hazards – Geo-hazards, flooding
- Man-made or induced hazards – utility mishaps, barge/bridge strikes, etc.
- Materials (e.g. Asphalt) price variability – due to statewide monopoly, market anomalies
- Personnel and hiring issues – some of these issues have significant uncertainties associated with them
- Bad/ineffective processes/practices causing wrong treatments to be applied
- Program and project delivery uncertainties affecting performance and safety

As instructed, the group limited risk identification strictly to those risks that would affect Pavement and Bridge assets on the NHS to align with the current scope of the TAMP. However, while only considering the asset classes of pavement and bridges, the levels of risk include Agency, Programmatic, and Project/Network levels and thus span the vertical dimension of the organization. A representative set of "risk types" were therefore posed and explored/scored and the "scores" reflect risks of significant importance to the organization.

Scoring

The scoring framework and methods used are shown in Figure 49 and Figure 50. These include the dollar ranges for each consequence scoring level, as well as the frequency ranges used for the likelihood/probability ratings.

During the development/confirmation of the Risk Register, the group should continuously refer to handouts that are distributed at the start of the workshop giving the scoring method (using Figure 49 and Figure 50) throughout the workshop. An important thing to note is that the ranges of "consequence", and associated costs, are important for an agency to reflect in the scales they use for rating various risks. The group focused attention on this and updated the rating scale for consequence "costs" as shown in the table.

To simplify scoring the overall consequence in terms of an anticipated dollar value, the consequences are divided into the following areas:

- Safety
- Mobility
- Asset Damage
- Other Financial Impact

It is imperative that the group is attentive and engaged, and understands the concepts of risk in general, including the methods used, and the objectives of the workshop.

FIGURE 49: CONSEQUENCE TERMINOLOGY

		Consequence to Public			Corridor / Region / Department	
Level	Descriptor	Safety	Conveyance	Asset	Financial Impact	Other Impacts
1	Negligible	Negligible safety hazard	Minimal delay	Minimal or cosmetic damage	Cost < $200K	Consider negative impacts to: future funding, insurance costs, regulatory compliance, political issues, and public reputation
2	Minor	Minimal safety hazard	Minor delay	Minor damage requiring repair	Cost $200K to $1M	
3	Major	Likely minor injuries	Major delay	Moderate damage requiring repair	Cost $1M to $10M	
4	Critical	Likely major injuries	Critical delay	Extensive damage requiring significant repair or replacement	Cost $10M to $25M	
5	Catastrophic	Likely fatalities and major injuries	Catastrophic delay	Destroyed or large-scale damage requiring replacement	Cost > $25M	

FIGURE 50: LIKELIHOOD TERMINOLOGY

Level	Descriptor	Description	Annual Probability Range	Probability
1	Low	50 years or more between events	<2%	1.0%
2	Medium Low	20 to 50 years between events	2% to 5%	3.5%
3	Medium Low	5 to 20 years between events	5% to 20%	12.5%
4	Medium High	1 to 5 years between events	20% to 100%	40.0%
5	High	One to several events per year	100%	99.0%

A question which commonly arises is whether an issue involves a business decision, indicates a capability "gap", or whether it is truly a "risk". At times, it can be difficult to determine what part of the problem involves just making a management decision, or needs capability development, and which part of the problem warrants on-going risk management due to the inherent uncertainties/variability of the situation. Although several risks may be identified with a very high likelihood score (indicating that the likelihood is at or close to 100%), these may still be valuable risks to identify and score. Therefore, risk analysis for these should be viewed as a useful prioritization tool. Even if they are occurring with near 100% likelihood, it should be noted that the consequences of not managing these risks can be severe.

It is also important to note that bad, or deficient, processes and practices can introduce "uncertainties". For instance, non-repeatable project development processes can lead to inconsistencies in achieving

targets, and the inability to manage performance effectively. Thus, uncertainties (and resulting consequences) are sometimes derived or propagated from the variability or ineffectiveness of current processes. Hence, these situations may be worth analyzing as opportunities for reducing variability and uncertainty in business processes.

Methodology

After the initial introductory training session, and before discussing the current Risk Register, the group is challenged to identify a few new risks. The new risks identified are then discussed and compared to the current Risk Register to check whether these risks are already present in the register in some form and need to be modified, or if they are new risks. The methodology for scoring the likelihood and consequences across the high-level areas of safety, mobility, asset damage, and other financial impacts are discussed, and it is clear the group fully understands the process. If a workshop ever extends over two days, the participants are typically challenged to think of other risks overnight prior to resuming the workshop on the morning of the second day.

The following process is used to identify risks:

- Aided by the facilitator, a risk is identified by someone in the group and discussed to distill it to a meaningful item and captured in the spreadsheet template (see Risk Register in Appendix A) projected on the screen and therefore visible to everyone in the workshop for discussion.
- Some notes and comments to further detail the risk are captured by the note taker in the spreadsheet displayed on the screen.
- Once the risk has been sufficiently discussed, the group decides on likelihood and consequence scores based on their scoring handouts. These scores are also captured on the screen and therefore again visible to everyone in the workshop for discussion.

As the individual 'raw' scores are filled in for each risk, the total score for the risk was calculated as follows:

$$Risk\ score = \left(\sum_{i=1}^{4} consequence\ scores\right) \times likelihood\ score$$

Where:

- Risk score is the combined effect of likelihood of the event occurring and the consequence of the event should it occur. It thus represents the overall potential impact to the agency. The maximum score is 100.
- Consequence scores are the individual scores for safety, mobility, asset damage, and other financial impacts between 1 and 5 based on the scoring guidelines (See Figure 49 and Figure 50).
- Likelihood score is the score between 1 and 5 based on the scoring guidelines (See Figure 49 and Figure 50)

Risk Register

The top priority risks identified during the latest Risk Workshop are shown in the prioritized Risk Register in Appendix A.

Risk Mitigation

Once the Risk Register has been revised and updated, the next part of the process is to identify, implement and monitor specific initiatives to address the highest priority risks where appropriate.

The process will typically be a continuation of the Risk Register development or revision workshop, but may also be conducted as a

future session. As such, it is important that the attendees be the same or similar to those for the Risk Register sessions.

The goal is to start with the top ten risks based on the Risk Register scores, and identify options to address each risk.

For each of the high-scoring risks in the Risk Register, the following steps are undertaken to assure consideration of risk mitigation opportunities.

1. **Identify strategy options** - Consider at least one strategy option for managing the risk. The following options[4] should be considered:
   a. **Tolerate** – For high scoring risks this is typically not a desirable option unless it is already being mitigated to the extent possible, in which case the only option for the remaining risk may be to monitor it.
   b. **Treat** – This is typically a desirable option if large benefits can be attained at relatively low cost.
   c. **Transfer** – This is sometimes possible and should certainly be considered. The most common method of transferring risk is through insurance. However, spreading risk between groups in an organization is also possible.
   d. **Terminate** – Where possible, this is the most desirable option. If the risk can be removed altogether, for instance by reconstructing an asset in a different location (for example raising or relocating a bridge), then this option should be considered but will need to be weighed against cost.
   e. **Take Advantage** – In some cases, risks may be identified for a new process or policy but if the probability of considerable benefits significantly outweighs the probability of negative outcomes, it may still be desirable to adopt the process or policy.
2. **Estimate the benefits and costs** – Estimate the benefits and costs of the candidate strategies by defining the benefits and costs of each strategy in terms of High/Medium/Low. The "benefits" are the reductions in risk scores, and the "costs" are the annualized costs of implementing each candidate strategy. Use these indicators to rank them from strategies with high benefit/low cost to low benefit/high cost.
3. **Implement high ranked strategies** – Pick high ranked strategies for implementation. Continue to monitor the implementation of these strategy initiatives in future Risk Mitigation workshops to gauge their status and how well they are working.

Because of the interactive session, candidate strategies can be ranked, and high value initiatives can be identified and planned. The outcome of this effort should be a set of initiatives that can be justified because they address the top-ranking risks faced by the agency and provide strategies to manage them.

Process for Evaluating NHS Pavements and Bridges Repeatedly Damaged by Emergency Events

In a separate effort, WVDOH conducts statewide evaluations in accordance with 23 CFR 667 to determine if there are reasonable alternatives to roads, highways, and bridges that have required repair and reconstruction activities on two or more occasions due to emergency events.

[4] The Five T's: AASHTO Guide for Enterprise Risk Management

The process of evaluating and identifying high value alternatives is to conduct an interactive session either in conjunction with the Risk Register and Risk Mitigation sessions or through a separate effort with stakeholders directly involved or affected by the evaluation and decision-making process.

The following methodology describes the process that is used to incorporate the results of the evaluation into risk management.

1. **Create an Emergency Event Risk Register** – Use the list of assets, and associated alternative strategies identified in 23 CFR 667 statewide evaluation effort, to create a risk list similar to the Risk Register described above.
2. **Prioritize the risks** – For each item in the list follow the same process used to evaluate consequence and probability and thereby the associated risk score. Use this score to prioritize the assets.
3. **Prioritize the strategy options** – For each alternative identified in the 23 CFR 667 effort, use the process described within this section to prioritize the alternatives.
4. **Implement high ranked strategies** - Pick high ranked alternatives for implementation and add these projects into the programming process. Continue to monitor the implementation of these projects in future risk workshops.

The goal and outcome of this effort will be to connect the identification of possible options for assets repeatedly damaged in emergency events, with the evaluation of these mitigation strategies as part of risk management, and to include these projects as part of the programming process.

The process for evaluating asset level risks is to evaluate possible mitigation actions or strategies, including the Do Nothing alternative.

First, each repeatedly damaged location is listed. This location could be a specific bridge or culvert, but could also be the location of a recurring slip. Each location has at least the following information:

Facility Name: A unique description of the facility (e.g. Bridge ID) if available.

Location: Latitude and Longitude of location, including linear reference (Route, Begin Milepoint, End Milepoint) if available.

NHS (Y/N): A flag noting whether the facility is on the National Highway System.

Repeated Damage (Y/N): A flag noting whether the facility has been damaged more than once.

Most Recent Damage Project Description: Description of the project to repair the facility from the most recent damage.

Work Start and End: The start and end dates of the work.

Total Authorized and Expended: The authorized and expended dollar amount for the project.

For each repeatedly damaged location, list a number of possible mitigation actions. Each possible mitigation action is evaluated as follows:

Action – First evaluate a Do-Nothing action. Then define at least one other possible mitigation action to alleviate the consequence of a similar event to the latest event which damaged the asset. These actions are essentially mitigation projects that could be undertaken now to mitigate risk in the future. Each action is evaluated separately.

Cost of Action – Estimate the agency cost of the mitigation action. In the case of the Do Nothing alternative, this can be assumed to be zero.

Duration of Fix – Estimate the duration before the asset will need to be repaired or replaced in years.

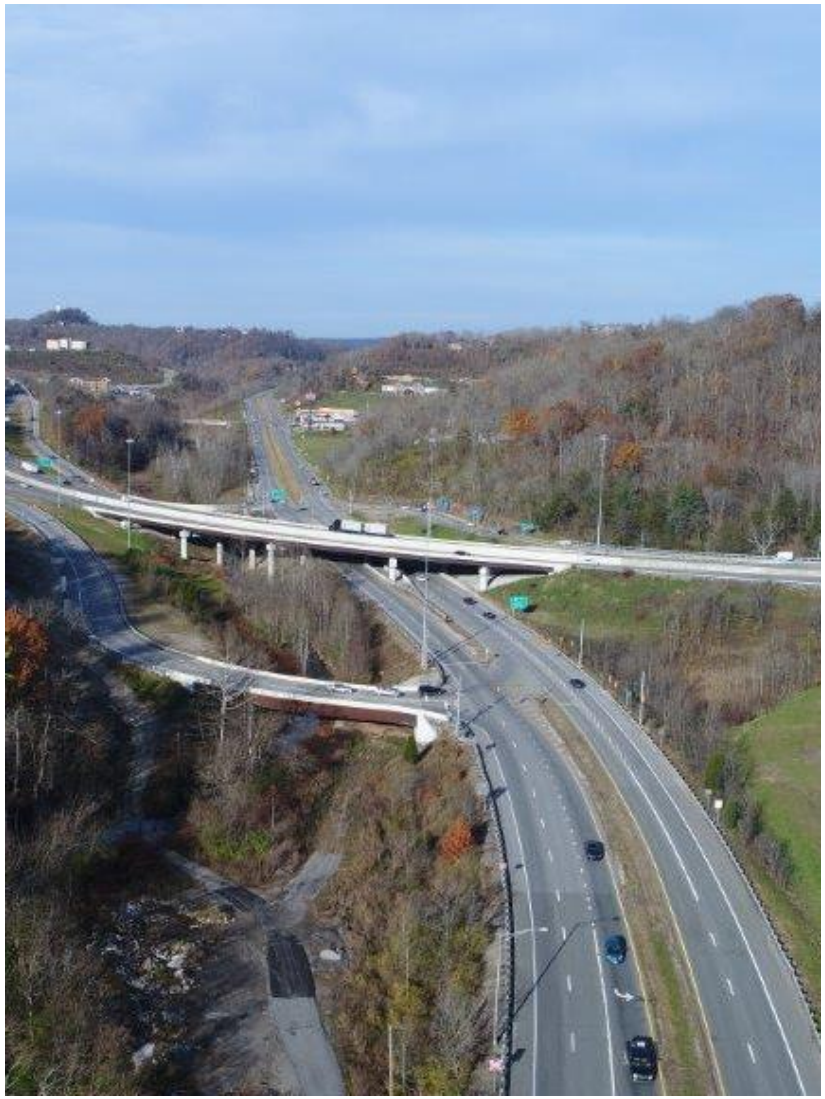
Annualized Cost of Action – The cost of the action is divided by the duration of the fix to obtain an annualized cost.

Event Frequency (Likelihood) – Estimate the frequency of the future event being evaluated.

Cost Exposure after Action (Consequence) – Estimate the User Costs, Repair Costs, Safety Costs and Other costs and sum these as the consequence of the event assuming the mitigation action had been implemented. The consequence is then annualized based on the event frequency to give the annualized expected consequence.

Risk reduction – Calculate the percent risk reduction as the expected consequence under the Do Nothing alternative minus the remaining expected consequence if the mitigation action was implemented.

Benefit Cost Ratio – Calculate the benefit to cost ratio (B/C Ratio) by dividing the expected annualized consequence reduction (see Risk Reduction) by the annualized cost of the action (described above). If this B/C ratio is greater than one, the mitigation action could be considered. If the ratio is less than one, the risk could be tolerated.



Source: WVDOH

Chapter 5

Managing Finances

Financial Plan

The FAST Act legislation stipulates that a Financial Plan is a part of the Transportation Asset Management Plan (TAMP). According to the FHWA Asset Management Financial Report Series, Report 2, Components of a Financial Plan[5], a comprehensive financial plan that supports long-term transportation asset management (TAM) will at a minimum include the following primary components:

- The various uses of funds based on forecasted system conditions and performance targets. It will include assumptions related to future projections.
- Projected revenues from all available and anticipated sources of funds including related assumptions.
- Projected gaps or surpluses based on the above.
- Scenarios reflecting adjustments necessary to address gaps, if any, along with related consequences.
- Final proposed financial plan to support the agency's asset management plan.

[5] https://www.fhwa.dot.gov/asset/plans/financial/hif15017.pdf

By expanding on each of these areas in the financial plan, a realistic picture of WVDOH's projected future financial health will come into focus.

Revenue and Expenditures

This section presents the processes, documentation, and analysis that are required in an asset management financial plan. The financial plan discusses historic funding levels and presents the level of funding expected to be allocated to WVDOH's pavement and bridge assets over the next 10 years. The financial plan relies on outputs from the annual budget process, the program distribution process and the TAMP processes discussed in other chapters of this document.

Financial data for the figures in this chapter were provided by WVDOH in March of 2018 and updated with input from the draft 2020-2025 STIP in March of 2019.

WVDOH Revenue Sources

The WVDOH primary sources of revenue for funding of general maintenance and construction of the WVDOH roadway network and for providing resources to match available Federal funds are derived from fuel taxes, automobile privilege taxes, motor vehicle registration and license fees, less the costs incurred by the Division of Motor Vehicles in collecting funds for deposit into the State Road Fund.

Motor Fuel Tax:

The State of West Virginia levies excise taxes on gasoline, diesel fuel, and special fuels used by motor vehicles that use public highways. Likewise, the Federal government levies excise taxes on gasoline, diesel fuel, and special fuels used by motor vehicles on public highways. The West Virginia motor fuel tax rate is composed of two components: a fixed rate per gallon and a variable rate per gallon that is indexed to the wholesale price of fuel and calculated annually. The motor fuel tax rate for 2017 was 20.5 cents for the flat rate and 11.7 cents for the variable rate for a total of 32.2 cents per gallon of gasoline or diesel. The Federal government rate is 18.4 cents per gallon for gasoline and 24.4 cents per gallon for diesel. WVDOH receives most of this revenue back in the form of Federal-aid reimbursable grants.

Registration Fees:

Registration fees include not only vehicle registration fees but also driver's licenses, permits, and litter control fees. Vehicle registration fees are based on a vehicle's classification and are renewed annually or on a multi-year basis. Driver's licenses and learner's permit fees are paid by persons licensed to operate a motor vehicle.

Privilege Tax:

The privilege tax, imposed when a vehicle certificate of title is issued, was first enacted in 1935 at a rate of 2% of the vehicle value. The rate was increased to 5% in 1971 and was increased to 6% in 2017.

Miscellaneous Fees:

Miscellaneous revenue sources include revenue from interest on investments, map sales, permits, and special revenue funds such as the A. James Manchin Fund (title fees) and the Coal Resource Transportation System (CRTS) fund (permit tonnage fees). It also has included a yearly transfer of revenue from the State's general fund to the State Road Fund that is intended to offset costs incurred by the WVDOH when its contractors pay state sales tax on construction materials. The amount of the transfer varies yearly depending on the size and scope of the WVDOH's construction program, but typically adds several million dollars to the State Road Fund annually.

Federal Aid:

The WVDOH also relies on Federal funds as a source of revenue for the transportation program. Federal-aid is obtained in the form of reimbursable grants. Federal transportation legislation provides funds that are available for obligation for eligible projects on the Federal-aid system. WVDOH, like most other State DOTs, expects to continue obligating all available Federal funds, otherwise these funds are withdrawn at the end of the Federal fiscal year. On December 4, 2015, the President signed into law the "Fixing America's Surface Transportation Act," or FAST Act which is a five-year surface transportation program authorizing funding for highway and public transportation investments. The FAST Act is the first long-term transportation legislation to pass Congress in ten years and thus, provides needed stability for planning transportation investments.

WVDOH Historical Revenues

The WVDOH is dependent on State and Federal revenues generated from the purchase and use of motor fuel, motor vehicle fees and privilege tax on purchases of motor vehicles. Figure 52, and Figure 53 summarize historical tax and fee collections. Some key highlights are:

- Total WVDOH revenue averaged approximately $1.15 billion each year over the last ten years with FY 2009 total revenue approximately $1.13 billion and FY 2018 total revenue approximately $1.24 billion. This represents an average annual growth of approximately 1% per year.
- State fuel tax made up 34% of the total revenue and has seen an increase on the average of 1% per year while Federal-aid made up 32% of total revenue and experienced an average annual decrease of 1.7% per year.
- The third largest revenue stream, automobile privilege tax made up 18% of the total revenue and increased by an average annual rate of 5.6% per year mostly due to the increase in the tax rate and the increase in the price of vehicles.

FIGURE 51: WVDOH HISTORICAL REVENUE (NOT INCLUDING BONDS)

(Millions $)	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016	FY 2017	FY 2018	10-yr Annual Average	Average Annual Increase/ Decrease FY 09-18
Revenues						**Historical**						
Motor Fuel Tax	$385	$391	$398	$387	$409	$441	$435	$396	$381	$420	$404	1.0%
Privilege Tax	$151	$148	$172	$186	$187	$194	$206	$206	$204	$227	$188	5.6%
Registration Fees	$91	$89	$93	$92	$92	$99	$101	$87	$104	$150	$100	7.2%
Miscellaneous Fees + CRTS	$47	$58	$31	$50	$36	$18	$21	$23	$26	$52	$36	1.1%
Federal Funds	$460	$496	$503	$449	$433	$405	$350	$396	$442	$391	$433	-1.7%
Combined DOH Fund Revenues	$1,134	$1,182	$1,197	$1,164	$1,157	$1,157	$1,113	$1,108	$1,157	$1,240	$1,152	1.0%

Note: Data includes State Road Fund, Coal Resource Transportation System (CRTS) Fund, A. James Manchin Fund (title fee to DOH). Data does not include WV Turnpike. Data does not include proceeds from GO or GARVEE bonds. Historical revenue is in year of occurrence dollars.

FIGURE 52: WVDOH FY 2018 REVENUE (NOT INCLUDING BONDS)

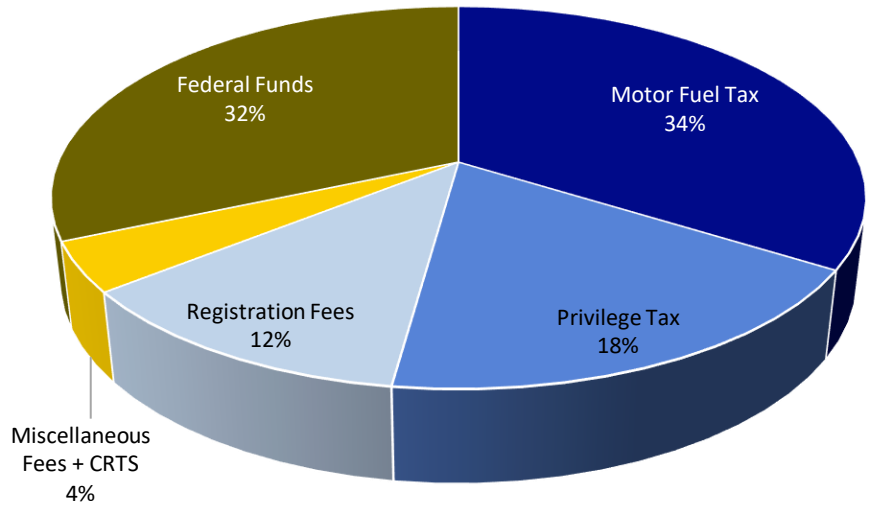
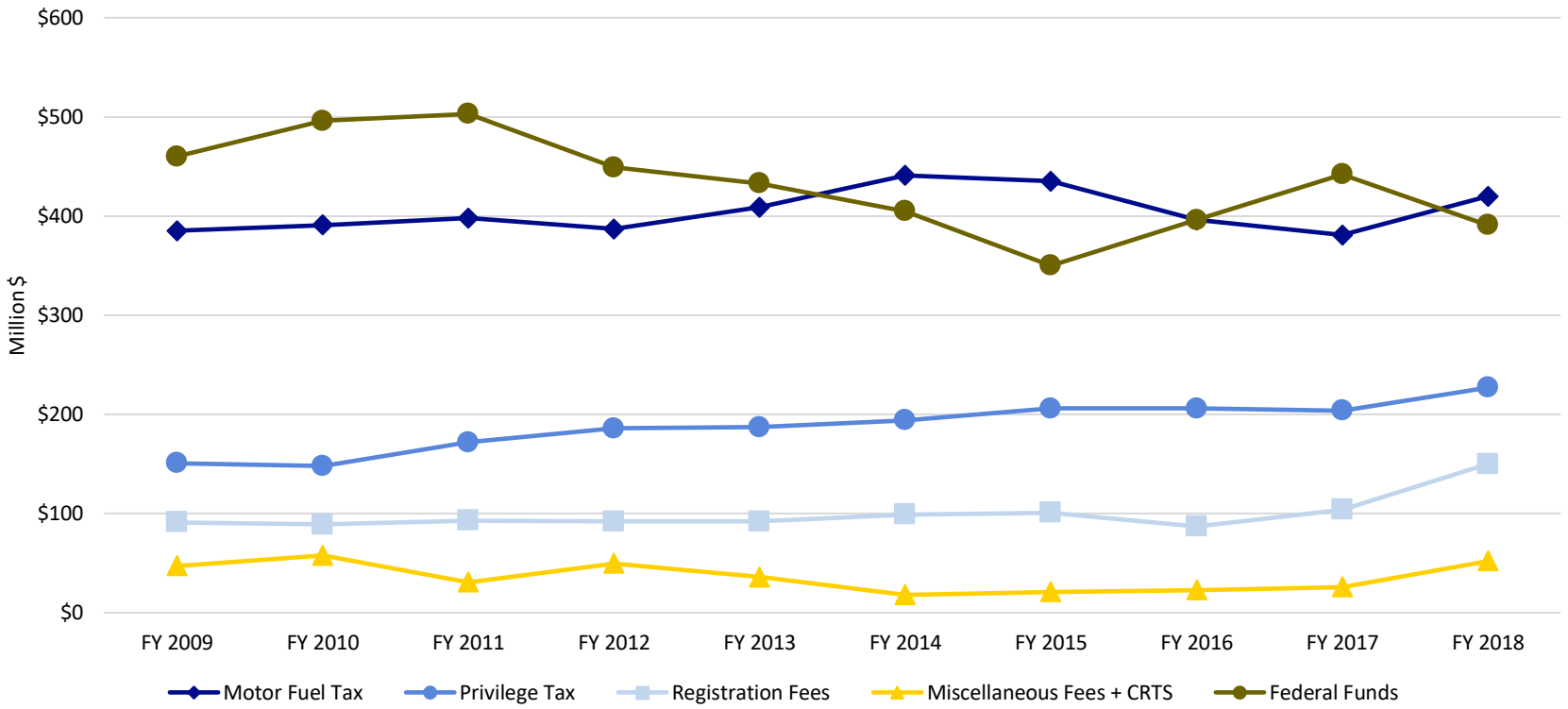


FIGURE 53: WVDOH HISTORICAL REVENUE (NOT INCLUDING BONDS)



WVDOH Historical Expenditures

WVDOH has statutory responsibility for construction, operation, and maintenance of all Federal-aid highways, except for the WV Turnpike, as well as all other state highways and county roads. Municipalities are generally responsible for maintenance of non-primary roadways within their corporate limits. A description of the expenditure categories across divisions are as follows:

- Capital Improvements – State and Federal construction projects, equipment, vehicles, etc.
- Routine Maintenance – Operations costs, maintenance projects, etc.
- Administrative Support – Staff salaries and general expenses to include Department of Motor Vehicles as well as contractual costs and studies.
- Debt Service – Cost to repay bond issuances and interest.

The budget allocation is based on processes that consider available funding, basic administrative costs such as salaries and operating expenses, maintenance and capital project needs and debt service. Overall, the budget allocations have been level over the past ten years. Figure 54, Figure 55, and Figure 56 show the breakdown of expenditures into major subcategories for FY 2009 through FY 2018. Some key observations are:

- The overall annual expenditures for the past ten years fluctuated between $1.22 billion (FY 2009) and $1.26 billion (FY 2018), resulting in an average annual increase of 0.4%. Expenditures essentially mirror revenue over this period.
- The largest recipient of funding was the Federal Capital Program, which received on average $583 million annually during FY 2009-2018. This program represents 46% of the total expenditures.
- While the State capital program has declined by an annual average rate of 0.2%, the Federal capital program has increased by an average annual rate of 0.4%.
- Administrative support, which is composed primarily of salaries, increased by an average annual rate of 0.8% during the period of FY 2009 – 2018.

FIGURE 54: WVDOH HISTORICAL EXPENDITURES (NOT INCLUDING BONDS)

(Millions $)	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016	FY 2017	FY 2018	10-yr Annual Average	Average Annual Increase/ Decrease FY 09-18
EXPENDITURES							**Historical**					
Debt Service (gen ob. bonds only)	$50	$50	$48	$50	$38	$37	$37	$15	$24	$25	$37	-5.6%
Administrative Support	$56	$41	$66	$60	$44	$51	$54	$34	$34	$60	$50	0.8%
Routine Maintenance	$274	$270	$301	$299	$295	$310	$304	$336	$319	$315	$302	1.7%
Set-Asides Required	$39	$41	$42	$48	$49	$48	$48	$43	$45	$44	$45	1.4%
State Capital Program (INCLUDES CRTS)	$234	$163	$157	$200	$147	$134	$147	$127	$109	$231	$165	-0.2%
Federal Capital Program (EXCL GARVEE)	$563	$595	$618	$592	$548	$592	$465	$627	$647	$582	$583	0.4%
Combined WVDOH Fund Expenditures	$1,216	$1,160	$1,232	$1,249	$1,121	$1,172	$1,055	$1,182	$1,178	$1,257	$1,182	0.4%

Note: Data includes State Road Fund, Coal Resource Transportation System (CRTS) Fund, A. James Manchin Fund (title fee to DOH). Data does not include WV Turnpike. Data does not include proceeds from GO or GARVEE bonds. Historic expenditures are in year of occurrence dollars.

FIGURE 55: WVDOH FY 2018 EXPENDITURES (NOT INCLUDING BONDS)

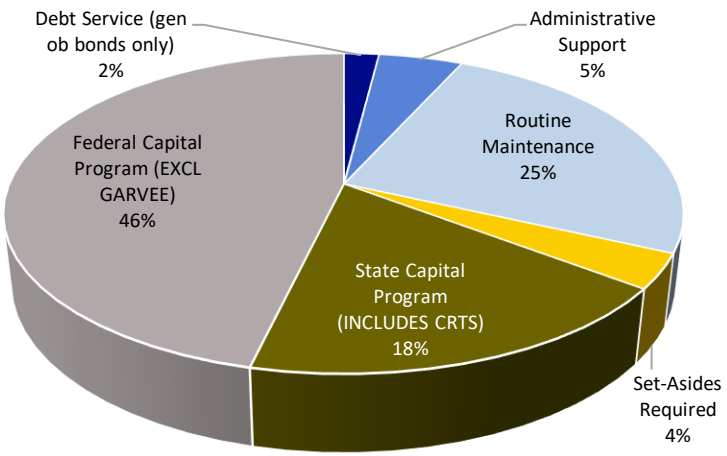
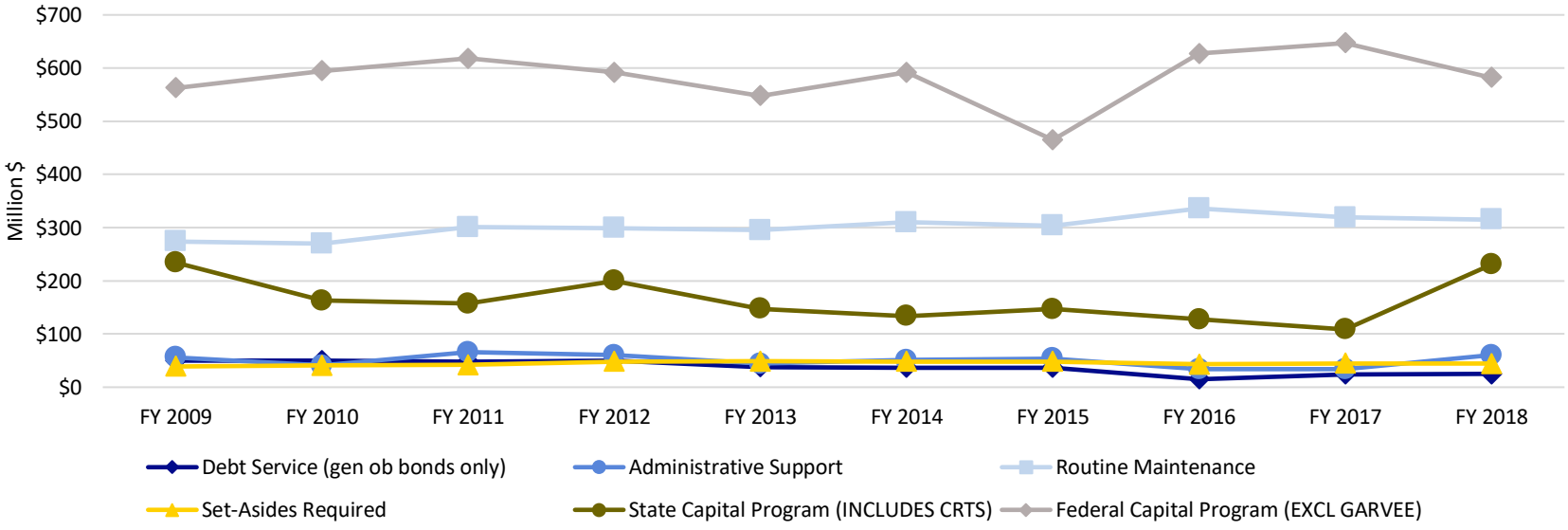


FIGURE 56: WVDOH HISTORICAL EXPENDITURES (NOT INCLUDING BONDS)



WVDOH Budget Allocation Process

The WVDOH annual budget process begins with an estimate of the revenues expected for the upcoming fiscal year. The State Revenue Department forecasts motor fuel taxes. Vehicle registrations and privilege taxes are forecasted by the Division of Motor Vehicles (DMV). Other funds are forecasted internally by WVDOH. The Programming Division forecasts Federal reimbursements.

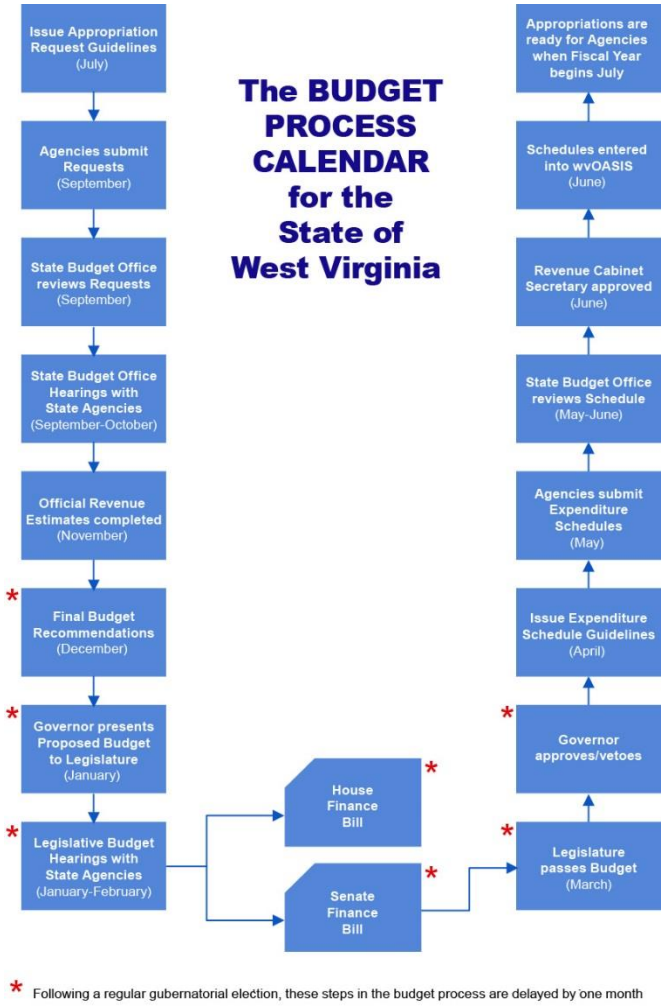
Many factors affect revenues including state and national economic conditions, world events affecting availability and pricing of motor fuel, and fuel consumption rates for motor vehicles. Nationally, the forecast for fuel consumption is anticipated to trend downward as vehicles continue to become more fuel efficient. The 2017 WVDOH Annual Financial Report stated the state legislation that raised the average wholesale price for motor fuel will enhance revenue collections in the short term. The same legislation also provides for increased rates of both privilege tax collections and registration fee collections which are forecasted to increase revenues in FY 2018 and beyond.

WVDOH budget allocations are mostly determined by historical trends, available funding, and projects in the delivery pipeline. High-level funding allocation areas in order of priority are:

- Debt service,
- General operations and administration costs (including equipment),
- Routine maintenance, and
- Capital programming.

Once the WVDOH proposed budget is developed, it is then submitted to the State Budget Office and then to the Legislature. Figure 57 shows this process.

FIGURE 57: WVDOH BUDGET PROCESS



Source: WV State Budget Office

WVDOH Revenue Projections

The WVDOH departmental budget has traditionally been projected four years beyond the current fiscal year. The analysis conducted for the TAMP includes a 10-year forecast horizon. The TAMP budget begins with the departmental budget forecast and uses historical trends to develop the forecast for the remaining six years. These budget forecasts are reasonable estimates typically using a straight-line projection based on historical data and known funding initiatives and anticipated trends. The budget forecast then becomes the baseline budget forecast scenario on which resulting pavement and bridge conditions are analyzed by the bridge and pavement management systems.

The results of the baseline budget forecast as well as additional investment scenarios are discussed in more detail within the Investing Wisely chapter. The funding levels from each scenario is used to inform the analysis performed by the pavement and bridge management systems. This iterative process is used to refine the budget allocation levels that will lead to scenarios that best utilize available resources to meet target condition levels on the NHS pavements and bridges.

Figure 58 and Figure 59 show the breakdown of the baseline revenue forecast for FY 2019 through FY 2029. Some key observations are:

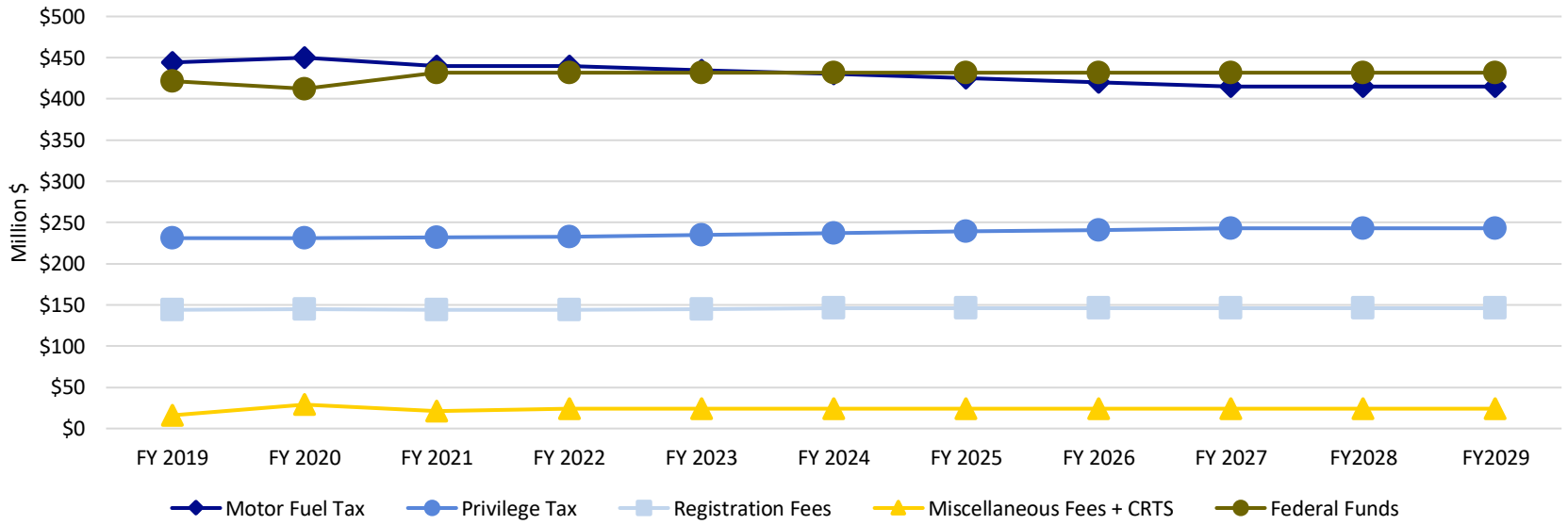
- Overall, the total revenue over the forecast period is forecasted to be essentially flat.
- Motor fuel tax is forecasted to decline by approximately 2% per year partially driven by vehicle fuel efficiency.
- Available Federal funds are forecasted to be essentially flat.
- Forecasted revenue is show in 2019 dollars.

FIGURE 58: WVDOH FORECASTED REVENUE BASELINE SCENARIO (NOT INCLUDING BONDS)

(Millions $)	FY 2019	FY 2020	FY 2021	FY 2022	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	FY 2028	FY 2029	Average Annual Increase/ Decrease FY 19-29
REVENUES						**Forecasted**						
Motor Fuel Tax	$444	$450	$440	$440	$435	$430	$425	$420	$415	$415	$415	-1.6%
Privilege Tax	$231	$231	$232	$233	$235	$237	$239	$241	$243	$243	$243	1.3%
Registration Fees	$144	$145	$144	$144	$145	$146	$146	$146	$146	$146	$146	0.3%
Miscellaneous Fees + CRTS	$16	$29	$21	$24	$24	$24	$24	$24	$24	$24	$24	12.5%
Federal Funds	$422	$412	$432	$432	$432	$432	$432	$432	$432	$432	$432	0.6%
Combined DOH Fund Revenues	$1,257	$1,267	$1,269	$1,273	$1,271	$1,269	$1,266	$1,263	$1,260	$1,260	$1,260	0.1%

Note: Data includes State Road Fund, Coal Resource Transportation System (CRTS) Fund, A. James Manchin Fund (title fee to DOH). Data does not include WV Turnpike. Data does not include proceeds from GO or GARVEE bonds. Forecasted revenue data is in 2019 dollars.

FIGURE 59: WVDOH FORECASTED REVENUE BASELINE SCENARIO (NOT INCLUDING BONDS)



WVDOH Forecasted Budget Allocation

As previously stated, budget allocation is based on processes that consider available funding, basic administrative costs such as salaries and operating expenses, maintenance and capital project needs and debt service. Figure 60 and Figure 61 show the breakdown of expenditures (not including GO and GARVEE bonds) into major high-level subcategories for FY 2019 through FY 2029. Some key observations are:

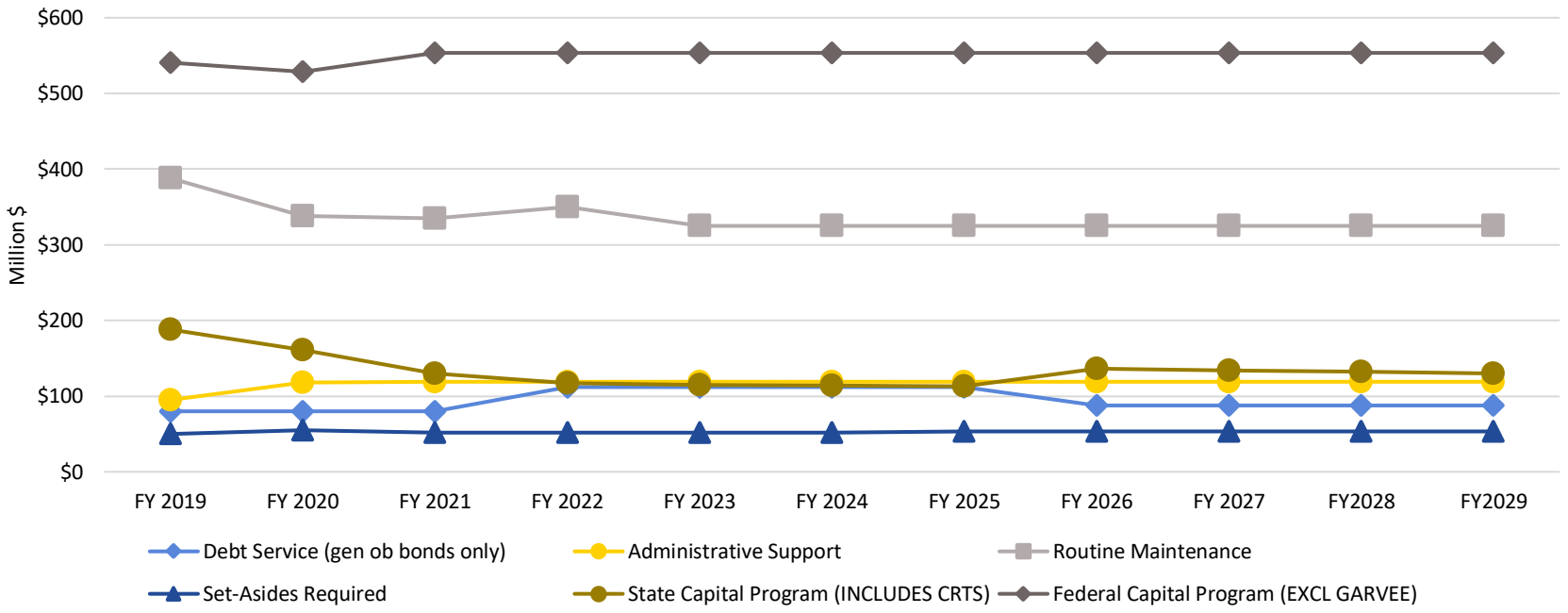
- FY 2019 through FY 2029 represent forecasted expenditures in the in the TAMP financial plan. Overall, this period is forecasted to be relatively flat which matches the revenue forecast.
- Debt service is forecasted to decrease by an average annual rate of 7.1% reflecting the defeasance of some old bonds.
- Forecasted data is shown in 2019 dollars

FIGURE 60:WVDOH FORECASTED EXPENDITURES BASELINE SCENARIO (NOT INCLUDING BONDS)

Expenditures	FY 2019	FY 2020	FY 2021	FY 2022	FY 2023	FY 2024	FY 2025	FY2026	FY 2027	FY 2028	FY 2029	Average Annual Increase/Decrease FY 19-29
(Millions $)	Forecasted											
Debt Service (gen ob. bonds only)	$80	$80	$80	$112	$112	$112	$112	$88	$88	$88	$88	-7.1%
Administrative Support	$95	$118	$119	$119	$119	$119	$119	$119	$119	$119	$119	0.0%
Routine Maintenance	$388	$338	$335	$350	$325	$325	$325	$325	$325	$325	$325	0.0%
Set-Asides Required	$50	$55	$52	$52	$52	$52	$53	$53	$53	$53	$53	0.0%
State Capital Program (INCLUDES CRTS)	$188	$161	$130	$117	$115	$114	$113	$136	$134	$132	$130	5.6%
Federal Capital Program (EXCL GARVEE)	$541	$529	$554	$554	$554	$554	$554	$554	$554	$554	$554	0.0%
Combined DOH Fund Expenditures	$1,342	$1,281	$1,270	$1,304	$1,277	$1,276	$1,276	$1,275	$1,273	$1,271	$1,269	-0.1%

Note: Data includes State Road Fund, Coal Resource Transportation System (CRTS) Fund, A. James Manchin Fund (title fee to DOH). Data does not include WV Turnpike. Data does not include proceeds from GO or GARVEE bonds. Forecasted expenditures data are in 2019 dollars.

FIGURE 61: WVDOH FORECASTED EXPENDITURES BASELINE SCENARIO (NOT INCLUDING BONDS)



WVDOH Forecasted Budget Allocation for NHS Pavements and Bridges

To aid in the development of funding allocation scenarios for NHS pavements and bridges, the high-level WVDOH budget summaries previously shown have been broken down into funding allocated to the Capital Outlay program.

The WVDOH does not presently have an easy way of breaking out the funding for NHS pavements and bridges, nor does it have an easy way to break out funding into work types such as initial construction, reconstruction, rehabilitation, and preservation treatments. However, the full implementation of the new ERP financial and project management system (wvOASIS) will provide this capability. In the meantime, for this Complete TAMP, a methodology was used to approximate the funding available under the base case scenario for NHS pavements and bridges. This methodology uses the FHWA 534 reports entitled "State Highway Capital Outlay and Maintenance

Expenditures"[6] that are submitted to FHWA on an annual basis to approximate a percentage of total capital funding that goes to NHS pavements and bridges. One advantage of using this methodology is that it is repeatable and is based on existing reports provided to FHWA.

Figure 62 and Figure 63 show the breakdown of historical and forecasted revenue and expenditures (including GO and GARVEE bonds[7]) for the WVDOH overall budget. Figure 64 shows the breakdown of historical and forecasted expenditures for the capital program for the bridge and pavement systems. Figure 65 shows the historical and forecasted expenditures for NHS and Non-NHS pavements and bridges only.

Some key observations are:

- Overall revenue is forecasted to drop an average of 0.7% per year over the TAMP forecast period from FY 2019 to FY 2029. This is due to the GO and GARVEE bond issuances being completed.
- The State Capital program without general obligation bonds is forecasted to decline an average 3.1% per year over the TAMP forecast period from FY 2019 to FY 2029.
- The WVDOH sold $913 million in GO bonds in 2018 and is scheduled to sell $800 million in 2021 for the WVDOH Roads to Prosperity Program.
- The Federal program, without GARVEE bond revenue increases slightly by an average annual rate of 0.2%.
- A total of $485 million GARVEE bonds have sold or are scheduled to be sold between 2018 and 2020 providing additional funding for the Federal program and the WVDOH Roads to Prosperity Program.
- The historical data in the tables represent year of occurrence dollars. The forecasted data is in 2019 dollars.
- The forecast represents the baseline funding scenario. Additional scenarios are discussed in the Investing Wisely chapter.

[6] https://www.fhwa.dot.gov/policyinformation/hss/guide/ch12.cfm

[7] A GO bond is a municipal bond issued by the WVDOH and repaid over time from revenues that flow into the state road fund. GARVEE stands for Grant Anticipation Revenue Vehicle which is a type of bond issued by the WVDOH under the guidelines of the FHWA and repaid over time using future FHWA funding.

FIGURE 62: WVDOH REVENUE FORECAST BASELINE SCENARIO (INCLUDING BONDS)

Revenues	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016	FY 2017	FY 2018	Average Annual Increase/Decrease FY 09-18
(millions $)	Historical										
WVDOH Combined State Funds (SRF, CRTS, AJ MANCHIN)	$674	$686	$694	$715	$724	$752	$763	$712	$715	$849	2.9%
Federal Reimbursement to WVDOH	$460	$496	$503	$449	$433	$405	$350	$396	$442	$391	-1.7%
Federal Reimbursement to Others (for GARVEE Debt Service)	$15	$28	$28	$28	$28	$28	$28	$28	$10	-$5	-15.2%
Federal Reimbursement Total	$475	$524	$531	$477	$461	$433	$378	$424	$452	$386	-2.1%
General Obligation Bonds	$0	$0	$0	$0	$0	$0	$0	$0	$0	$913	N/A
GARVEE Bonds	$82	$0	$0	$0	$0	$0	$0	$0	$58	$261	N/A
Total WVDOH Revenue	$1,231	$1,209	$1,224	$1,191	$1,185	$1,185	$1,141	$1,136	$1,225	$2,409	-0.1%

Revenues	FY 2019	FY 2020	FY 2021	FY 2022	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	FY 2028	FY 2029	Average Annual Increase/Decrease FY 19-29
(millions $)	Forecasted											
WVDOH Combined State Funds (SRF, CRTS, AJ MANCHIN)	$835	$855	$837	$841	$839	$837	$834	$831	$828	$828	$828	-0.1%
Federal Reimbursement to WVDOH	$422	$412	$432	$432	$432	$432	$432	$432	$432	$432	$432	0.2%
Federal Reimbursement to Others (for GARVEE Debt Service)	$32	$44	$44	$44	$44	$44	$44	$44	$44	$44	$44	3.8%
Federal Reimbursement Total	$454	$457	$476	$476	$476	$476	$476	$476	$476	$476	$476	0.5%
General Obligation Bonds	$14	$0	$800	$0	$0	$0	$0	$0	$0	$0	$0	-10.0%
GARVEE Bonds	$94	$130	$0	$0	$0	$0	$0	$0	$0	$0	$0	-10.0%
Total WVDOH Revenue	$1,397	$1,442	$2,113	$1,317	$1,315	$1,313	$1,310	$1,307	$1,304	$1,304	$1,304	-0.7%

Note: Data includes State Road Fund, Coal Resource Transportation System (CRTS) Fund, A. James Manchin Fund (title fee to DOH). Data does not include WV Turnpike. Historical data is in year of occurrence dollars. Forecasted data is in 2019 dollars.

FIGURE 63: WVDOH EXPENDITURE FORECAST BASELINE SCENARIO (INCLUDING BONDS)

Expenditures	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016	FY 2017	FY 2018	Average Annual Increase/Decrease FY 09-18
(millions $)	Historical										
Debt Service (gen ob. bonds only)	$50	$50	$48	$50	$38	$37	$37	$15	$24	$25	-5.6%
Debt Service (GARVEE Bonds only)	$15	$28	$28	$28	$28	$28	$28	$28	$10	-$5	-15.2%
Administrative Support	$56	$41	$66	$60	$44	$51	$54	$34	$34	$60	0.8%
Routine Maintenance	$274	$270	$301	$299	$295	$310	$304	$336	$319	$315	1.7%
Set-Asides Required	$39	$41	$42	$48	$49	$48	$48	$43	$45	$44	1.4%
State Capital Program (Includes CRTS)	$234	$163	$157	$200	$147	$134	$147	$127	$109	$231	-0.2%
State Capital Program (GO Bonds)	$0	$0	$0	$0	$0	$0	$0	$0	$0	$913	N/A
Federal Capital Program (w/o GARVEE)	$563	$595	$618	$592	$548	$592	$465	$627	$647	$582	0.4%
Federal Capital Program (GARVEE)	$82	$0	$0	$0	$0	$0	$0	$0	$58	$261	24.4%
Total WVDOH Expenditures	$1,313	$1,188	$1,260	$1,277	$1,149	$1,199	$1,082	$1,210	$1,246	$2,426	9.4%
WVDOH Capital Program	$879	$758	$775	$792	$695	$726	$612	$754	$756	$1,726	-1.8%

Expenditures	FY 2019	FY 2020	FY 2021	FY 2022	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	FY 2028	FY 2029	Average Annual Increase/Decrease FY 19-29
(millions $)	Forecasted											
Debt Service (gen ob. bonds only)	$80	$80	$80	$112	$112	$112	$112	$88	$88	$88	$88	1.0%
Debt Service (GARVEE Bonds only)	$32	$44	$44	$44	$44	$44	$44	$44	$44	$44	$44	3.8%
Administrative Support	$95	$118	$119	$119	$119	$119	$119	$119	$119	$119	$119	2.5%
Routine Maintenance	$388	$338	$335	$350	$325	$325	$325	$325	$325	$325	$325	-1.6%
Set-Asides Required	$50	$55	$52	$52	$52	$52	$53	$53	$53	$53	$53	0.6%
State Capital Program (Includes CRTS)	$188	$161	$130	$117	$115	$114	$113	$136	$134	$132	$130	-3.1%
State Capital Program (GO Bonds)	$14	$0	$800	$0	$0	$0	$0	$0	$0	$0	$0	-10.0%
Federal Capital Program (w/o GARVEE)	$541	$529	$554	$554	$554	$554	$554	$554	$554	$554	$554	0.2%
Federal Capital Program (GARVEE)	$94	$130	$0	$0	$0	$0	$0	$0	$0	$0	$0	-10.0%
Total WVDOH Expenditures	$1,482	$1,455	$2,114	$1,348	$1,321	$1,320	$1,320	$1,319	$1,317	$1,315	$1,313	-1.1%
WVDOH Capital Program	$742	$690	$1,484	$671	$669	$668	$667	$690	$688	$686	$684	-0.8%

Note: Data includes State Road Fund, Coal Resource Transportation System (CRTS) Fund, A. James Manchin Fund (title fee to DOH). Data does not include WV Turnpike. Historical data is in year of occurrence dollars. Forecasted data is in 2019 dollars.

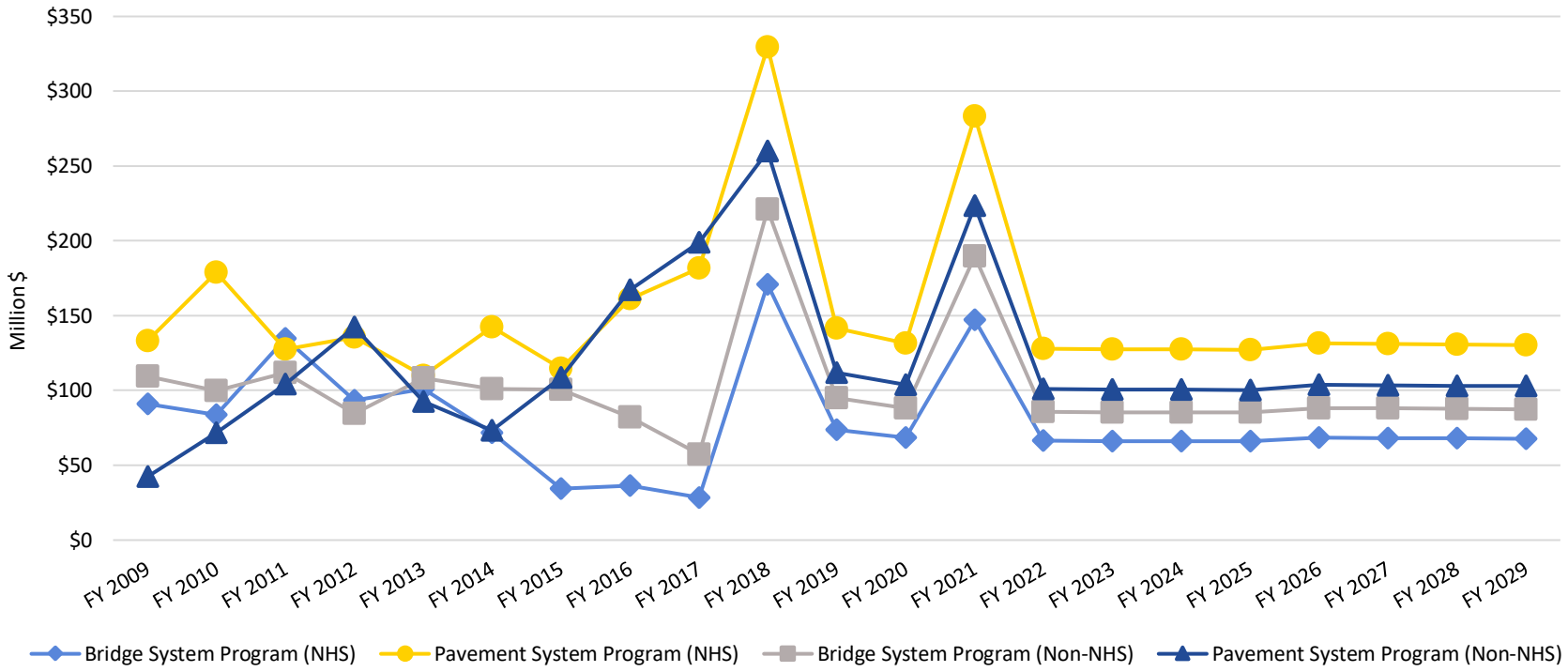
FIGURE 64: WVDOH CAPITAL PROGRAM BASELINE SCENARIO

Capital Program NHS and Non-NHS	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016	FY 2017	FY 2018	Average Annual Increase/Decrease FY 09-18
(millions $)	Historical										
Bridge System Program (NHS)	$91	$84	$135	$93	$101	$72	$34	$36	$28	$171	9.8%
Bridge System Program (Non-NHS)	$110	$100	$112	$85	$108	$101	$100	$82	$57	$221	11.3%
Pavement System Program (NHS)	$133	$179	$127	$135	$110	$143	$115	$161	$182	$330	16.4%
Pavement System Program (Non-NHS)	$42	$72	$104	$142	$93	$73	$109	$167	$199	$260	57.0%
Other Capital Initiative (NHS)	$408	$216	$153	$223	$227	$306	$229	$273	$218	$576	4.6%
Other Capital Initiative (Non-NHS)	$95	$108	$144	$113	$56	$31	$25	$34	$71	$169	8.7%

Capital Program NHS and Non-NHS	FY 2019	FY 2020	FY 2021	FY 2022	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	FY 2028	FY 2029	Average Annual Increase/Decrease FY 19-29
(millions $)	Forecasted											
Bridge System Program (NHS)	$74	$68	$147	$66	$66	$66	$66	$68	$68	$68	$68	-0.8%
Bridge System Program (Non-NHS)	$95	$88	$190	$86	$86	$85	$85	$88	$88	$88	$87	-0.8%
Pavement System Program (NHS)	$142	$132	$283	$128	$128	$127	$127	$132	$131	$131	$131	-0.8%
Pavement System Program (Non-NHS)	$112	$104	$223	$101	$101	$100	$100	$104	$103	$103	$103	-0.8%
Other Capital Initiative (NHS)	$248	$230	$495	$224	$223	$223	$222	$230	$229	$229	$228	-0.8%
Other Capital Initiative (Non-NHS)	$73	$68	$146	$66	$66	$66	$65	$68	$67	$67	$67	-0.8%

Note: This data encompasses all bridge and pavement systems managed by WVDOH. Data includes State Road Fund, Coal Resource Transportation System (CRTS) Fund, A. James Manchin Fund (title fee to DOH). Data does not include WV Turnpike. Historical data is in year of occurrence dollars. Forecasted data is in 2019 dollars.

FIGURE 65: WVDOH CAPITAL PROGRAM FOR PAVEMENTS AND BRIDGES BASELINE SCENARIO



West Virginia Turnpike

The West Virginia Parkways Authority operates and maintains the WV Turnpike, an 87-mile toll facility which includes 97 bridges. The West Virginia Department of Transportation owns the WV Turnpike and it is part of the NHS. The funding for operation and maintenance is supported by tolls and toll revenue bonds. The funding does not flow through the WVDOH and is not included in the revenue and expenditure figures previously discussed. However, the WV Turnpike revenue and expenditures will be combined with that of the WVDOH in the investment scenario analysis discussed in the Investing Wisely chapter. The data in the following figures is a close approximation of the historical and forecasted revenue and expenditures on the WV Turnpike. Some key observations are as follows:

- Data includes only the WV Turnpike.
- Tolls increased January 1, 2019.
- Toll revenue bonds in the amount of $174 million are assumed to be issued in FY 2019.
- FY 2019 – 2029 revenue without toll revenue bonds is forecasted to increase at an average annual rate of 1.2%.

FIGURE 66: WV TURNPIKE HISTORICAL AND FORECAST REVENUES - BASELINE SCENARIO

Revenues	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016	FY 2017	FY 2018	Average Annual Increase/Decrease FY 09-18
(millions $)	Historical										
WV Turnpike Tolls and Misc.	$60	$89	$92	$91	$91	$92	$96	$101	$100	$102	7.6%
Turnpike Revenue Bonds	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	0.0%
Total WV Turnpike Revenue	$60	$89	$92	$91	$91	$92	$96	$101	$100	$102	7.6%

Revenues	FY 2019	FY 2020	FY 2021	FY 2022	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	FY 2028	FY 2029	Average Annual Increase/Decrease FY 19-29
(millions $)	Forecasted											
WV Turnpike Tolls and Misc.	$138	$140	$141	$143	$144	$146	$148	$149	$151	$153	$155	1.2%
Turnpike Revenue Bonds	$174	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	-10.0%
Total WV Turnpike Revenue	$312	$140	$141	$143	$144	$146	$148	$149	$151	$153	$155	5.0%

Note: Data includes that applicable to the WV Turnpike. Historical data is in year of occurrence dollars. Forecasted data is in 2019 dollars.

FIGURE 67: WV TURNPIKE HISTORICAL AND FORECAST EXPENDITURES – BASELINE SCENARIO

Expenditures	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016	FY 2017	FY 2018	Average Annual Increase/Decrease FY 09-18
(millions $)	Historical										
Debt Service (REVENUE Bonds only)	$15	$18	$11	$11	$10	$8	$8	$7	$8	$8	-4.9%
Administrative Support	$9	$14	$19	$21	$21	$24	$25	$25	$28	$28	23.9%
Routine Maintenance	$18	$21	$24	$22	$23	$23	$26	$25	$25	$25	4.7%
WVTPK Regular Capital Program	$19	$37	$38	$37	$37	$38	$38	$44	$40	$40	12.2%
WVTPK Capital Program (Revenue Bonds)	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	0.0%
TOTAL WV Turnpike Expenditures	$60	$89	$92	$91	$91	$92	$96	$101	$100	$102	8.2%
WV Turnpike Capital Program	$19	$37	$38	$37	$37	$38	$38	$44	$40	$40	12.2%

Expenditures	FY 2019	FY 2020	FY 2021	FY 2022	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	FY 2028	FY 2029	Average Annual Increase/Decrease FY 19-29
(millions $)	Forecasted											
Debt Service (REVENUE Bonds only)	$12	$12	$12	$12	$12	$12	$12	$12	$12	$12	$12	0.0%
Administrative Support	$29	$29	$30	$30	$31	$31	$31	$32	$32	$33	$33	1.6%
Routine Maintenance	$26	$26	$27	$27	$28	$29	$29	$30	$30	$31	$32	2.4%
WVTPK Regular Capital Program	$72	$60	$50	$51	$51	$52	$52	$53	$53	$54	$55	-2.3%
WVTPK Capital Program (Revenue Bonds)	$174	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	-10.0%
TOTAL WV TURNPIKE EXPENDITURES	$312	$127	$118	$120	$122	$123	$125	$127	$128	$130	$132	-5.8%
WV Turnpike Capital Program	$245	$60	$50	$51	$51	$52	$52	$53	$53	$54	$55	-7.8%

Note: Data includes that applicable to the WV Turnpike. Historical data is in year of occurrence dollars. Forecasted data is in 2019 dollars.

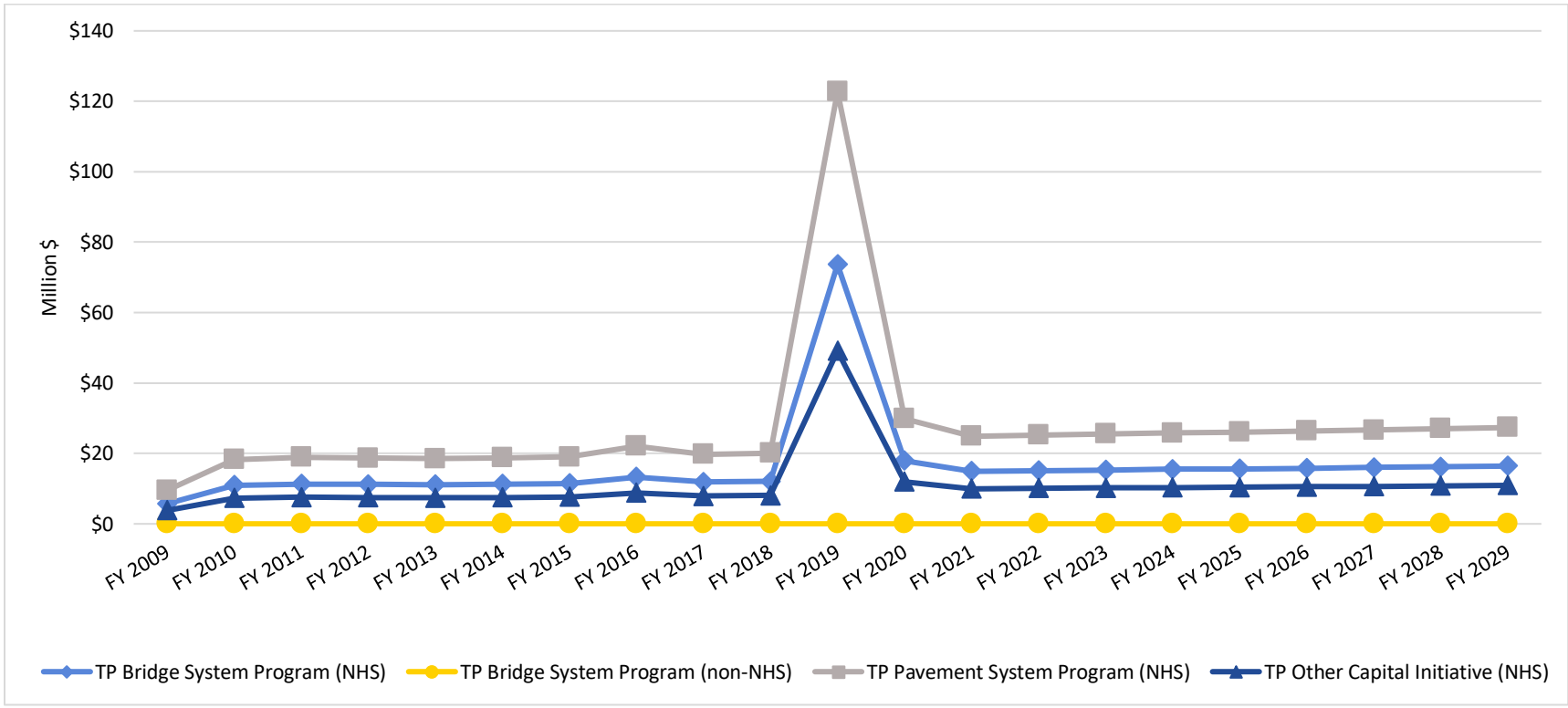
FIGURE 68: WV TURNPIKE HISTORICAL AND FORECASTED NHS FUNDING – BASELINE SCENARIO

Expenditures	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016	FY 2017	FY 2018	Average Annual Increase/Decrease FY 09-18
(millions $)	Historical										
TP Bridge System Program (NHS)	$6	$11	$11	$11	$11	$11	$11	$13	$12	$12	12.2%
TP Bridge System Program (Non-NHS)	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	0.0%
TP Pavement System Program (NHS)	$10	$18	$19	$19	$19	$19	$19	$22	$20	$20	12.2%
TP Pavement System Program (Non-NHS)	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	0.0%
TP Other Capital Initiative (NHS)	$4	$7	$8	$7	$7	$8	$8	$9	$8	$8	12.2%
TP Other Capital Initiative (Non-NHS)	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	0.0%

Expenditures	FY 2019	FY 2020	FY 2021	FY 2022	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	FY 2028	FY 2029	Average Annual Increase/ Decrease FY 19-29
(millions $)	Forecasted											
TP Bridge System Program (NHS)	$74	$18	$15	$15	$15	$15	$16	$16	$16	$16	$16	-7.8%
TP Bridge System Program (Non-NHS)	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	0.0%
TP Pavement System Program (NHS)	$123	$30	$25	$25	$26	$26	$26	$26	$27	$27	$27	-7.8%
TP Pavement System Program (Non-NHS)	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	0.0%
TP Other Capital Initiative (NHS)	$49	$12	$10	$10	$10	$10	$10	$11	$11	$11	$11	-7.8%
TP Other Capital Initiative (Non-NHS)	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	0.0%

Note: Data includes only that applicable to the WV Turnpike. Data in table is calculated by using an approximation of the breakdown of pavement, bridge and other capital initiatives of the total WV Turnpike capital budget. The WV Turnpike pavement and bridge network is all included in the National Highway System. Historical data is in year of occurrence dollars. Forecasted data is in 2019 dollars.

FIGURE 69: WV TURNPIKE NHS FUNDING FORECAST



Asset Valuation

Asset valuation is a required element of annual financial reporting by government agencies. The details of these requirements are included in the Government Accounting Standards Board Statement 34 (GASB 34). Asset valuation can be used to establish asset value, track asset depreciation, and estimate the asset service life. There are different approaches to meeting GASB 34, including straight-line depreciation and the "modified approach", which relies on data analysis to confirm that asset conditions are sustained over time by employing appropriate investment strategies. The data required to estimate the asset value will depend upon the approach used.

WVDOH Asset Valuation

WVDOH, like most state DOT's, uses the GASB 34 depreciation method to determine the value of transportation assets on an annual basis. This information is included in its annual financial report. In this method, the collective original construction cost of all road and bridge assets is determined, then each year the value of all new construction is added, and the depreciation is subtracted. The valuation for roads includes the cost of pavement and bridge construction and all other assets necessary for the operation of the highway, such as signs, striping and drainage. Capital assets are depreciated on the straight-line method over the assets' estimated useful lives. There is no depreciation recorded for land and construction-in-progress. Generally, estimated useful lives are as follows:

- Infrastructure: roads - 30 years.
- Infrastructure: bridges - 50 years.

It should be noted that asset valuation is not reported in subcategories such as NHS, state-owned and non-state-owned. Although breaking out NHS pavements and bridges is desirable for tracking and communicating the value of the NHS pavements and bridges; the present method for reporting asset value can still be used to communicate the value of the infrastructure and consequences of under-investing to the transportation stakeholders. Using the best available data, a reasonable approximation of the NHS asset value can be calculated using the percentage of the NHS roads in lane-miles as compared to the total state-maintained roads in lane miles and the percentage of the NHS bridges in deck area as compared to the total state-maintained bridge deck area. The results can then be multiplied by the total state-owned asset values in Figure 70. Based on this calculation, NHS roads represent 8.8% of the total state-maintained lane-miles. NHS bridges represent 60% of the total state-maintained bridges as a function of deck area.

Figure 70, Figure 71, and Figure 72 show the historical value of the WVDOH transportation land, pavement, and bridge assets over the FY 2008 through FY 2018 timeframe. Some key observations are:

- Infrastructure Land – $1.2 billion (17% of total);
- All State-owned Roads - $3.5 billion (48% of total);
- NHS Roads - $305 million (8.8% of total roads);
- All State-owned Bridges - $2.47 billion (35% of total);
- NHS Bridges - $1.5 billion (60% of total bridges); and
- Overall value has increased by an average of 2.1% per year reflecting more value added through capital projects than subtracted through depreciation.

FIGURE 70: WVDOH ASSET VALUE

($1,000)	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	Average Annual Increase / Decrease
Land	$876,642	$898,613	$928,577	$956,518	$986,302	$1,039,165	$1,071,733	$1,097,423	$1,124,458	$1,187,099	$1,204,877	3.7%
Roads	$3,611,424	$3,794,524	$3,745,318	$3,900,873	$3,957,162	$3,938,068	$3,841,535	$3,638,959	$3,574,749	$3,630,308	$3,465,639	-0.4%
Bridges	$1,403,038	$1,745,392	$1,893,013	$2,101,528	$2,181,556	$2,266,793	$2,433,040	$2,442,434	$2,496,309	$2,473,187	$2,476,229	7.6%
Total	$5,891,104	$6,438,529	$6,566,908	$6,958,919	$7,125,020	$7,244,026	$7,346,308	$7,178,816	$7,195,516	$7,290,594	$7,146,745	2.1%

Note: Data taken from WVDOH Annual Financial Statements - Statement of Net Assets

FIGURE 71: WVDOH FY 2019 ASSET VALUE

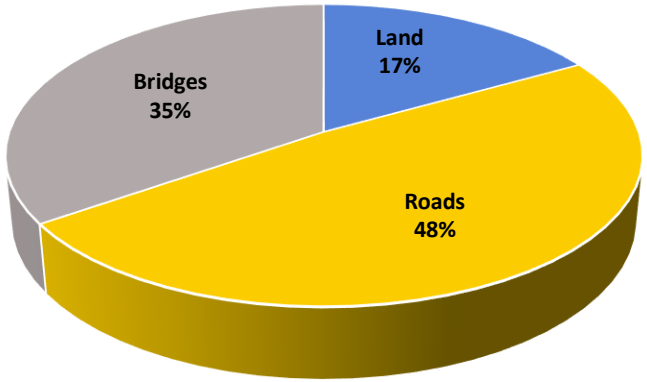
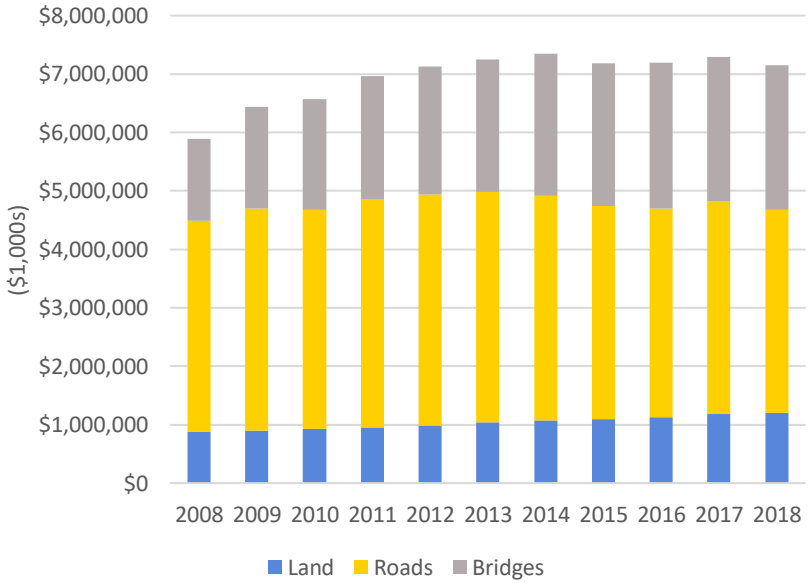


FIGURE 72: WVDOH HISTORICAL ASSET VALUE



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Source: WVDOH

Chapter 6

Investing Wisely

Investment Strategies

FHWA defines Investment Strategies as a set of strategies that result from evaluating various levels of funding to achieve State DOT targets for asset condition and system performance at a minimum practicable cost while managing risks.

Going forward, the investment strategies outlined in this TAMP document will be the result of the policies, goals, and measures identified within the context of asset data, forecasted demand, available funding, and other factors which have been detailed in preceding chapters. Ultimately, this results in a well-defined plan that specifies how funds will be allocated across pavement and bridge assets on the NHS by work types such as construction, reconstruction, rehabilitation, and preservation treatments by fiscal year in both the short and long-term.

The investment strategies in this chapter will support progress in achieving the national goals in 23 USC 150(b). These strategies are shown in Figure 73

FIGURE 73: NATIONAL PERFORMANCE GOALS AND TAMP INTEGRATION STRATEGIES

National Performance Goal	Strategy
(1) Safety – To achieve a significant reduction in traffic fatalities and serious injuries on all public roads.	Project selection through the TAMP will be integrated with the West Virginia Highway Safety Improvement Program (HSIP), and the West Virginia Strategic Highway Safety Plan.
(2) Infrastructure condition – To maintain the highway infrastructure asset system in a state of good repair.	The TAMP will be integrated with the project selection and STIP process as documented in this plan.
(3) Congestion reduction – To achieve a significant reduction in congestion on the National Highway System.	The TAMP will be integrated with the Congestion Mitigation and Air Quality Improvement Program (CMAQ), National Highway Performance Program (NHPP), and Surface Transportation Program (STP) as part of the project selection and STIP development process.
(4) System reliability – To improve the efficiency of the surface transportation system.	Projects to enhance system performance will be integrated with projects resulting from the TAMP as part of the project selection and STIP process.
(5) Freight movement and economic vitality – To improve the National Highway Freight Network, strengthen the ability of rural communities to access national and international trade markets, and support regional economic development.	Projects identified as part of the TAMP will be coordinated where applicable with projects identified in the West Virginia State Freight Plan.
(6) Environmental sustainability – To enhance the performance of the transportation system while protecting and enhancing the natural environment.	Projects identified as part of the TAMP will continue to be designed and implemented within the established environmental permitting process. In addition, projects will be integrated with the CMAQ Program as noted previously.
(7) Reduced project delivery delays – To reduce project costs, promote jobs and the economy, and expedite the movement of people and goods by accelerating project completion through eliminating delays in the project development and delivery process, including reducing regulatory burdens and improving agencies' work practices.	With increased funding from the West Virginia Roads to Prosperity program, projects resulting from the TAMP will need to be efficiently delivered with minimal project delays.

The Investment Strategy process outlined in this TAMP follows these steps:

- Translation of agency goals and objectives into levels of service and performance targets;
- Forecast available revenue that can be used on the NHS;
- Analyze assets to determine short-term and long-term needs using the PMS and BMS;
- Determine performance gaps based on targets;
- Assess gaps and recommendations contained in the safety, mobility, congestion, and freight plans for possible integration to improve effectiveness of the NHS and other critical infrastructure;
- Consider how investment strategies are influenced by lifecycle planning, risk analysis and anticipated levels of funding;
- Create investment plans that detail short-term and long-term work by work types such as construction, reconstruction, rehabilitation, and preservation treatments by fiscal year;

- Repeat the process to develop multiple investment scenarios for consideration by Executive Leadership; and
- Document and communicate the investment scenario chosen by Executive Leadership.

Because of this process, several investment scenarios can be developed and incorporated into pavement and bridge management analysis to forecast asset condition. Some of these scenarios may include:

- Projected condition performance based on current funding levels with conservative assumptions for modest growth (baseline scenario);
- Condition levels resulting from decreased funding levels (Decreased revenue scenario);
- Condition levels resulting from increased funding levels (Increased revenue scenario);
- Funding amount needed to meet condition targets and goals (Funding needed scenario); and
- Pavement and Bridge funding trade-off analysis (Trade-off Scenarios).

The goal of the strategies is to develop a program that will:

- Achieve and sustain a desired state of good repair over the life cycle of the assets;
- Improve or preserve the condition of pavement and bridge assets and the overall performance of the NHS with respect to these critical physical assets;
- Make progress toward achievement of the established targets for asset condition of the NHS; and
- Support progress toward the achievement of national goals.

It should be noted that work recently has been completed to enhance the existing PMS and to implement a new BMS so that future pavement and bridge conditions can be forecasted assuming various funding scenarios. Continued refinements of the PMS and BMS will enable robust analysis capabilities for forecasting pavement and bridge performance. Prior to the completion of the BMS and PMS, several generalized strategies were utilized in the short term to make the best use of resources programmed for pavement and bridge projects, including:

Pavements:

- Design and schedule pavement projects to align with a roadway's lifecycle needs whenever possible utilizing the recommendations from the Deighton dTIMS pavement management system (PMS);
- Continue the use of pavement preservation strategies, such as thin-lift treatments to cost-effectively extend pavement life; and
- Evaluate innovative contracting methods and potential advantages of bundling projects to lower costs.

Bridges:

- Continue to conduct frequent and regular inspections;
- Continue to expand the use of preservation strategies that extend the service life of bridge components;
- Invest in rehabilitation at appropriate times in a bridge's lifecycle by utilizing the recommendations from the Deighton bridge management system (BMS); and
- Have more bridge projects "on the shelf".

As discussed in the pavement and bridge chapters, various funding scenarios were analyzed using the lifecycle planning analysis processes described in the section Process for Performing Lifecycle Optimization

Analysis in Chapter 2 for bridges, and in the equivalent section Process for Performing Lifecycle Optimization Analysis in Chapter 3 for pavements. After various iterations, the funding scenarios are as follows:

Bridges

1. Baseline Funding Scenario – the projected funding for bridges over the 10-year analysis period
2. Baseline Scenario with increased funding from 2024 – a funding scenario where the funding for NHS bridges was increased by $50 million from 2024 onwards

Pavements

1. Baseline Funding Scenario – the projected funding for bridges over the 10-year analysis period
2. Baseline Scenario with 10% increased funding – additional 10% funding

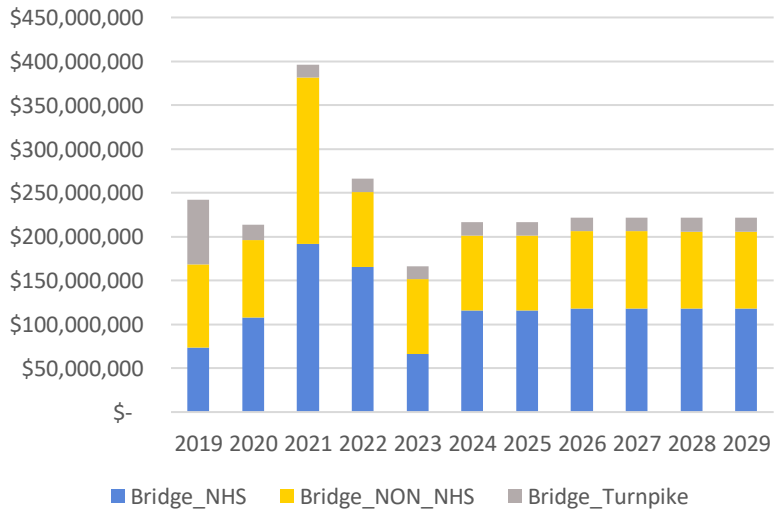
The projected condition for these funding scenarios is discussed under the section Scenario Analysis Results in Chapter 2 for bridges, and in the equivalent section Scenario Analysis Results in Chapter 3 for pavements.

The Baseline funding scenarios for pavement and bridge are discussed below. Thereafter, the specific investment strategies chosen for the bridge and pavement programs are discussed in the following sections of this chapter.

Planned Investment Strategy for Bridges

As discussed in Chapter 2 Scenario Analysis Results, a number of funding scenarios were analyzed and it was determined that the second bridge scenario, 'Baseline Scenario with increased funding' was the best practical plan to handle the wave of older bridges that were projected to become poor during the analysis period. As a result, this was the recommended plan that was approved by WVDOT Leadership. The resulting investment strategy is shown in Figure 74 with the split between NHS and Non-NHS bridges being shown, as well as the budgeted amount for the West Virginia Turnpike. The figure includes projected investments for projects that are already committed (e.g. from the STIP). It should be noted that the totals for 2020, 2021 and 2022 are higher than the budgets used from the funding scenario because these totals represent the total project cost of the committed projects on the NHS projected to be completed in those years. As a result, even though in reality these costs may have been disbursed over a period of multiple years, they are being shown in the year the project will be completed and thus when the benefit in terms of condition of the network will be realized.

FIGURE 74: BASELINE PLUS INCREASED FUNDING SCENARIO ON WV BRIDGES



The general investments shown in Figure 75 are broken down for the NHS bridges (excluding Turnpike bridges) into work types and this detailed investment strategy is shown for the NHS. Note that this investment strategy for NHS bridges excludes Turnpike bridges.

FIGURE 75: DETAILED INVESTMENT STRATEGY FOR BASELINE PLUS INCREASED FUNDING SCENARIO ON NHS BRIDGES

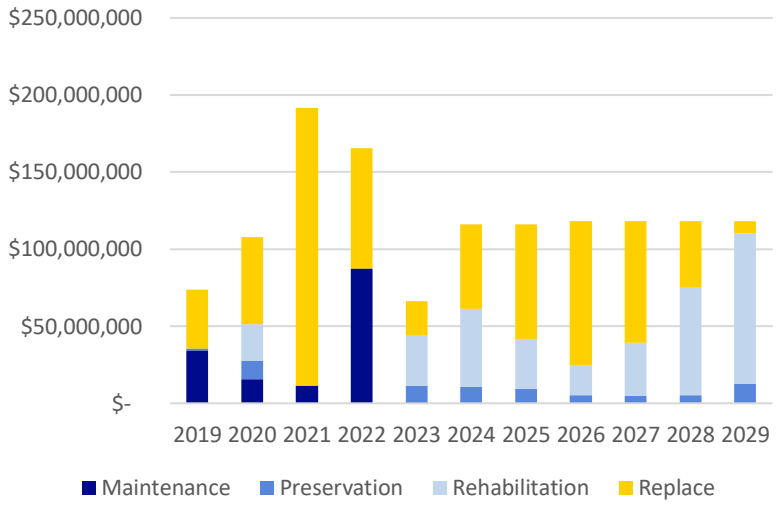


FIGURE 76: SUMMARIZED INVESTMENT STRATEGY FOR BASELINE PLUS INCREASED FUNDING SCENARIO ON NHS BRIDGES

Investment by Work Type in $ Millions	Maintenance	Preservation	Rehabilitation	Replace	Total
2019	$34.4	$1.1	$0.0	$38.1	$73.6
2020	$15.5	$12.0	$23.7	$56.7	$107.9
2021	$11.6	$0.0	$0.0	$180.1	$191.8
2022	$87.6	$0.0	$0.0	$77.9	$165.5
2023	$0.7	$10.7	$32.7	$22.2	$66.2
2024	$0.0	$10.6	$50.8	$54.8	$116.1
2025	$0.0	$9.6	$32.1	$74.3	$116.0
2026	$0.0	$5.2	$19.7	$93.3	$118.2
2027	$0.0	$4.8	$34.4	$78.9	$118.1
2028	$0.2	$5.1	$69.8	$43.0	$118.0
2029	$0.0	$12.7	$97.5	$7.8	$118.0

The investment strategy shown for NHS bridges results in the projected federal performance measures shown in Figure 23 in the section Scenario Analysis Results in Chapter 2. As noted earlier, although the percent of poor bridges by deck area does increase considerably in 2023 because of the wave of older bridges projected to cross into the poor category in that timeframe, the projected percent of poor bridge deck area is projected to begin to decline after this due to the increased funding being injected into the bridge program.

It should be noted that no funding is being removed from the Non-NHS bridges and the funding levels for these remains at the levels from the Baseline Funding Scenario. As discussed in the section Scenario Analysis Results in Chapter 2, the Non-NHS bridges also have a wave of older bridges that were built in the 1970's that are projected to cross

into the poor category in the same timeframe. However, this percentage begins to reduce almost immediately showing that the funding is sufficient to continue to reduce the percent of poor bridges over time. The projections for Non-NHS bridges under the investment strategy shown in Figure 74 is also shown in Figure 22 in the section Scenario Analysis Results in Chapter 2.

Planned Investment Strategy for Pavements

Two funding scenarios were analyzed for pavements: a Baseline Scenario discussed early in this chapter, and a Baseline plus 10% scenario. The condition projections for these scenarios are discussed in Chapter 3 Scenario Analysis Results. These condition projections show that although an initial increase in percent of pavement in Good condition is projected, the percent of pavement in a Poor condition is projected to increase slightly towards the end of the analysis period. As a result, it was recommended that funding for pavements should not be decreased, and the Baseline Funding Scenario was recommended and approved for adoption by WVDOT leadership.

The detailed lifecycle benefit cost optimization analysis conducted in the pavement management system allows projection of the condition of the pavement network over the analysis period. However, because the analysis also generates a work program consisting of simulated projects over the analysis period, these projects can be used to define the planned investment strategy in terms of anticipated spending per work type in each year using the mapping of treatment to work type given in Figure 46. The anticipated investment strategies for the approved baseline funding scenario for pavements are shown in the following figures. Figure 77 shows the anticipated investment strategy for NHS pavements.

These anticipated investment strategies are summarized in Figure 78. Note that this is the investment strategy for NHS pavements excluding Turnpike pavements.

FIGURE 77: DETAILED INVESTMENT STRATEGY FOR BASELINE FUNDING SCENARIO ON NHS PAVEMENTS (EXCLUDING TURNPIKE)

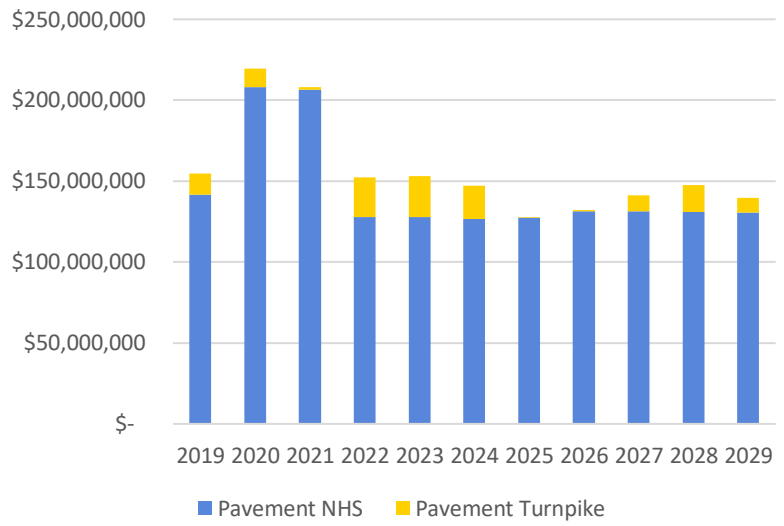


FIGURE 78: SUMMARIZED INVESTMENT STRATEGY FOR BASELINE FUNDING SCENARIO ON NHS PAVEMENTS (EXCLUDING TURNPIKE)

Investment by Work Type ($ Millions)	Preservation	Rehabilitation	Reconstruction	Total
2019	$0.2	$57.0	$84.5	$141.7
2020	$46.7	$75.3	$86.0	$208.0
2021	$32.2	$108.8	$65.3	$206.3
2022	$0.0	$79.6	$48.3	$127.9
2023	$3.8	$91.5	$32.2	$127.6
2024	$3.7	$117.9	$4.8	$126.5
2025	$15.6	$90.4	$21.2	$127.2
2026	$48.9	$52.0	$30.4	$131.2
2027	$23.1	$65.3	$42.8	$131.2
2028	$0.0	$45.1	$85.8	$130.9
2029	$0.0	$20.3	$110.3	$130.6

The investment strategies for NHS pavements result in the projected federal performance measures as shown in Figure 41 and Figure 42 in the section Scenario Analysis Results in Chapter 3. These condition projections show an initial increase in the percent of Good pavement until 2022, however, both Interstates and the Non-Interstate NHS system show slight increases in the projected percent Poor indicating that it would be problematic to reduce funding for pavements and funding needs to remain at least at the Baseline level.

Similar to bridges, although this plan is focused on the NHS network, it should be noted that no funding is being removed from the Non-NHS pavements and the funding levels for this part of the network remain at the levels anticipated from the Baseline funding scenario.

Glossary

AASHTO	American Association of State Highway and Transportation Officials
ADHS	Appalachian Development Highway System
AMS	Asset Management System
BMS	Bridge Management System
CCI	Condition Composite Index
CFR	Code of Federal Regulations
CMAQ	Congestion Mitigation and Air Quality Improvement Program
CRTS	Coal Resource Transportation System
CSI	Concrete Slab Index
dTIMS	Deighton Total Infrastructure Management System; asset management software
DMV	Department of Motor Vehicles
DOT	Department of Transportation
ECI	Environmental Cracking Index
FAST Act	2015 Federal Transportation Bill: Fixing America's Surface Transportation Act
ERP	Enterprise Resource Planning
FHWA	Federal Highway Administration
GARVEE Bonds	Grant Anticipation Revenue Vehicle Bonds
GASB	Governmental Accounting Standards Board
GO Bonds	General Obligation Bonds
HPMS	Highway Performance Monitoring System
HSIP	Highway Safety Improvement Program
IHS	Interstate Highway System
IRI	International Roughness Index
JCI	Joint Condition Index
KPI	Key Performance Indices
LCCA	Life Cycle Cost Analysis
LOS	Level of Service
LRS	Linear Referencing System
LRTP	Long Range Transportation Plan
MAP-21	2012 Federal Transportation Bill: Moving Ahead for Progress in the 21st Century Act
NBI	National Bridge Inventory
NBIS	National Bridge Inspection Standards
NCI	Net Cracking Index
NHPP	National Highway Performance Program
NHS	National Highway System
PMS	Pavement Management System
PSI	Present Serviceability Index

PTS	Project Tracking System
R&H	Roads and Highways: ESRI proprietary software for managing the Linear Referencing System
RDI	Rut Depth Index
ROI	Return on Investment
SCI	Structural Cracking Index
STIP	Statewide Transportation Improvement Program
STP	Surface Transportation Program
TAM	Transportation Asset Management
TAMP	Transportation Asset Management Plan
VMT	Vehicle Miles Travelled
WVDOH	West Virginia Division of Highways
wvOASIS	West Virginia Our Advanced Solution with Integrated Systems

Appendix A

Risk Register

Risk Level	Asset Class	Event/Occurrence	Likelihood	Safety	Mobility	Asset Damage	Other Financial Impact	Risk Score	Comments / Notes	"Risk Management Options (Treat, Tolerate, Transfer, Terminate)"
			Consequence Score							
Agency	Pavement/ Bridge	Lack of personnel, vacant positions and uncertainty in being able to backfill employees who leave	5	3	2	5	5	75.0	Problem with time it takes to process paperwork. Other problem is not getting qualified candidates (at wages offered, also drug testing). Impacts program delivery (e.g. bridges plans), as well as maintenance. Also results in lack of redundancy in personnel job skills/responsibilities. Costs in damage due to premature failure e.g. bridge projects no longer being done at the right time, premature pavement failure due to lack of drainage maintenance. Resulting bad state of infrastructure results in companies not investing in state.	Various studies have been conducted to analyze this issue. Follow through with recommendations from these studies. 1. Change compensation structure to add more tiers per level. 2. Insurance stability 3. Respond to offers/HR communication 4. Flexible schedule (e.g. part time, trial retirement) 5. Public service recognition 6. Culture 7. Enhance recruiting.
Program	Bridge	Not delivering programmed bridge projects on time	5	2	3	5	3	65.0	Problems include environmental, ROW, utilities, historical (SHPO), manpower. Average delay 3-5 years from date in the	Review of project delivery process to identify pain points, measure and

Risk Level	Asset Class	Event/Occurrence	Likelihood	Safety	Mobility	Asset Damage	Other Financial Impact	Risk Score	Comments / Notes	"Risk Management Options (Treat, Tolerate, Transfer, Terminate)"
		(even when budget is available)							STIP. One of the costs of delay is inflation at 5% a year.	enforce. Increase use of consultants to develop plans to add capacity.
Program	Bridge/ Pavement	Minor (50-year events) flooding events	5	3	2	3	3	55.0	25 disaster declarations in 20 years across multiple types of event (> $750,000)	Currently tolerating this risk. Maintain current standards for design and improve resilience when reconstructed.
Agency	Pavement	Variability in materials costs based on uncertainty in competition	5	1	1	4	5	55.0	Only one major supplier of asphalt over two thirds of state. $90-$125 per ton in single bidder areas; $80-$90 in multiple bidder areas.	Continue to monitor problems and take legal action where necessary.
Program	Bridge	Not performing routine maintenance	5	1	3	5	1	50.0	Similar to pavement. Problems can result from lack of funding, or not enough resources, even if there were enough money.	Review maintenance allocation formulas. Monitor and track maintenance being performed.
Program	Pavement	Not doing the right maintenance, preservation and rehabilitation at the right time in the right location.	5	2	1	4	3	50.0	This is not really doing the right things like not sealing a longitudinal joint. Not the right priorities for the maintenance dollars. Failure to set and meet performance standards.	Education of management, project selectors and field staff including annual Pavement Preservation conference. Introduced pavement preservation technician certification. Need to dedicate funding specifically for preservation and rehab projects, and ensure projects are undertaken on the right locations. Using pavement management systems to

Risk Level	Asset Class	Event/Occurrence	Likelihood	Safety	Mobility	Asset Damage	Other Financial Impact	Risk Score	Comments / Notes	"Risk Management Options (Treat, Tolerate, Transfer, Terminate)"
										identify recommended work types per year.
Program	Pavement	Minor geohazards such as rockfalls, slippage	5	2	2	4	2	50.0		Identify high risk locations and monitor and maintain (e.g. drainage).
Program	Pavement	Major geohazards such as rockfalls, slippage	4	3	3	3	3	48.0		Identify high risk locations and monitor and maintain (e.g. drainage).
Program	Pavement/ Bridge	Poor workmanship reduces quality of work. Lack of performance standards and lack of measurement against standards.	5	2	2	3	2	45.0	Accountability to meet performance standards is needed. Eventually may open a new bridge at a 7 out of 9. On pavements it is possible that bidders are not fully invested in project success. WVDOH is trying to go to a performance-based pre-qualification. Spec enforcement regarding temperature etc. not followed if a need to get in before end of season. Safety a problem because may produce slick asphalt, mobility affected because on the road more often, asset damage because not lasting as long as it should. Internally would benefit by better certification process enforcement. This applies to bridges as well.	For pavements, WVDOH is trying to use more performance-based specifications. (e.g. PWL specifications with bonus and penalty over multiple years). For bridges, construction inspection is currently not doing full NBE inspection but may be an option.
Program	Bridge	Not doing the right maintenance, preservation and rehabilitation at the right time in the right location.	5	1	2	5	1	45.0	Most of the problem is that lack of funding results in only reactive maintenance.	Adding codes to maintenance management system to track maintenance and preservation work. Full paint and overlay programs with specific budget. Need

Risk Level	Asset Class	Event/Occurrence	Likelihood	Safety	Mobility	Asset Damage	Other Financial Impact	Risk Score	Comments / Notes	"Risk Management Options (Treat, Tolerate, Transfer, Terminate)"
										to dedicate funding specifically for preservation, and rehab projects and ensure projects are undertaken on the right locations. Beginning to use bridge management systems to identify recommended work types per year.
Program	Bridge/ Pavement	Major (500+ year events) flooding events	2	5	5	5	5	40.0		Currently tolerating this risk. Maintain current standards for design.
Agency	Bridge/ Pavement	Political influence changes allocations late in the process where allocations increase in one area without expectation of reductions in others.	5	2	1	4	1	40.0	Capital budgets for bridge often reduced because too many pavement projects are requested. Result is that existing safety, mobility, etc. problems may not get corrected. This typically affects the bridge program more than the pavement program. (Money taken from bridge to fund pavement.)	Use bridge and pavement management systems to better predict impact of decisions regarding increased and decreased funding changes.
Program	Pavement	Short term and long term increases in traffic loading causing unexpected damage to pavement	5	1	2	4	1	40.0	Examples such as coal price going up causing increase in haul traffic, similar with gas prices. May become a bigger problem due to Mountain Valley pipeline.	Tolerate risk due to economic benefits and explore bonding similar to local roads.
Program	Pavement	Not performing routine maintenance	5	2	2	3	1	40.0	There is a possibility that funding is cut (or increased) in a particular year. Pothole patching may be done but drainage may suffer. Budget variability also based on	Review maintenance allocation formulas. Monitor and track maintenance being performed.

Risk Level	Asset Class	Event/Occurrence	Likelihood	Safety	Mobility	Asset Damage	Other Financial Impact	Risk Score	Comments / Notes	"Risk Management Options (Treat, Tolerate, Transfer, Terminate)"
									snow and ice/how good was the winter. But agree that it is a net deficit.	
Program	Bridge	Minor bridge hits	4	2	3	3	1	36.0		Need to track bridge hits to be able to analyze problem areas and investigate mitigation strategies.
Agency	Pavement	Not delivering programmed pavement projects on time.	4	1	1	5	2	36.0	Once project is let, getting it constructed in the planned year is a problem because of contractor availability and other uncertainties. Project selection/STIP processes are a problem since get on the program too easily but getting into STIP more of a problem. E.g. a thin OL project was change ordered into mill and fill.	Review and improve process to better encourage on-time delivery of pre-construction phases and set more realistic dates.
Program	Pavement	Not using the right repair method for the problem in resurfacing projects (Non-Expressway NHS)	4	2	1	4	1	32.0	Lack of training is main cause. Consequence is that the pavement fails prematurely. What drives this is folks just doing whatever is the quickest and easiest. E.g. a Purchase Order project. May also be a funding issue.	same risk as previous - recommend remove
Agency	Pavement	Mines causing damage to NHS through subsidence etc.	3	3	3	3	1	30.0	A mine is seeking a permit to mine under I-70	Require permits. Review mineral acquisition policy.
Program	Pavement	Utility cuts take place in newer pavement (more on Non-IS NHS)	5	1	1	2	1	25.0	Better communication and availability of information regarding planned utility and pavement projects. Monthly coordination meeting worked well in past experience.	Better communication and availability of information regarding planned utility and pavement projects. Monthly coordination meeting.

Risk Level	Asset Class	Event/Occurrence	Likelihood	Safety	Mobility	Asset Damage	Other Financial Impact	Risk Score	Comments / Notes	"Risk Management Options (Treat, Tolerate, Transfer, Terminate)"
Program	Pavement	Not using the right repair method for the problem in resurfacing projects (Expressway NHS)	3	2	1	4	1	24.0	Lack of training is main cause. Consequence is that the pavement fails prematurely. What drives this is folks just doing whatever is the quickest and easiest. E.g. a Purchase Order project. May also be a funding issue.	same risk as previous - recommend remove
Program	Pavement/ Bridge	Gas lines causing fires that damage pavement and bridge infrastructure.	2	2	3	3	3	22.0	42" and 36" lines under many highways and across bridges. About to have more of these. Problems in specific case was short circuit of Cathodic Protection. Older lines have higher chance of failing. Previous event shut down IS for two days.	Create GIS layer to show location information. Coordinate with gas companies to obtain inspection records. Mostly tolerate risk.
Program	Bridge	Catastrophic bridge failure due to condition	1	5	5	5	5	20.0	Mitigation is federal bridge inspection program.	Mitigation is federal bridge inspection program.
Program	Bridge	Catastrophic bridge hits	1	5	5	5	5	20.0	Possible from both traffic and barges (in the case of river bridges)	Analyze vulnerability and prepare response plans.

Appendix B

Plan Development and Content Checklist

Required Elements	Indicators the TAMP Meets Element Requirements in 23 U.S.C. 119(e) and 23 CFR part 515	Location Addressed in TAMP
TAMP approved by head of State DOT (23 CFR 515.9(k))		
	Does the TAMP bear the signature of the head of the State DOT?	Signed by the West Virginia Secretary of Transportation.
State DOT has developed its TAMP using certified processes (23 CFR 515.13(b))		
	Do the process descriptions align with the FHWA-certified processes for the State DOT? [If the process descriptions do not align with the FHWA-certified processes, the State DOT must request recertification of the new processes as amendments unless the changes are minor technical corrections or revisions with no foreseeable material impact on the accuracy and validity of the processes, analyses, or investment strategies. State DOTs must request recertification of TAMP development processes at least 30 days prior to the deadline for the next FHWA TAMP consistency determination as provided in 23 CFR 515.13(c).]	The processes used for bridge analysis are the FHWA-certified processes for WVDOH from the Initial TAMP and include the use of the newly implemented bridge management system as described in the subsections Process for Selecting Scenarios and Process for Performing Lifecycle Optimization Analysis of Chapter 2, Managing Bridge Assets. The processes used for pavement analysis are the FHWA-certified processes for WVDOH from the Initial TAMP. These processes are described in the subsections Process for Selecting Scenarios and Process for Performing Lifecycle Optimization Analysis of Chapter 3, Managing Pavement Assets. The processes used for risk analysis are the FHWA-certified processes for the State DOT from the Initial TAMP. These processes are described in Risk Management Process in Chapter 4 Consideration of Risk. The processes used for financial analysis and investment strategy development are the FHWA-certified processes for the State DOT from the Initial TAMP. These processes are described in the Financial Plan section in Chapter 5

Required Elements	Indicators the TAMP Meets Element Requirements in 23 U.S.C. 119(e) and 23 CFR part 515	Location Addressed in TAMP
		Managing Finances and in Investment Strategies in Chapter 6 Investing Wisely.
	Do the TAMP analyses appear to have been prepared using the certified processes?	The analyses are discussed in the Chapters noted above and follow the processes as described above. The main lifecycle benefit cost optimization analyses are described in Scenario Analysis Results under Lifecycle Planning Analysis for Gap Analysis and Target Setting in Chapter 2 Managing Bridge Assets for bridges, and in Scenario Analysis Results under Lifecycle Planning Analysis for Gap Analysis and Target Setting in Chapter 3 Managing Pavement Assets for pavements. The resulting investment strategies from these analyses are reported on under Investment Strategies in Chapter 6 Investing Wisely. Risk analyses are described under Risk Management Assessment in Chapter 4 Consideration of Risk.
TAMP includes the required content as described in 23 CFR 515.9(a)-(g) (23 CFR 515.13(b))		
	Does the TAMP include a summary listing of NHS pavement and bridge assets, regardless of ownership?	This is contained in Inventory and Condition in Chapter 2 for bridges, and under Inventory and Condition in Chapter 3.
	Does the TAMP include a discussion of State DOT asset management objectives that meets requirements?	This is contained in Objectives and Targets in Chapter 2 for bridges, and under Objectives and Targets in Chapter 3 for pavements.
	Does the TAMP include a discussion of State DOT measures and targets for asset condition, including those established pursuant to 23 U.S.C. 150, for NHS pavements and bridges, that meets requirements?	This is contained in Objectives and Targets in Chapter 2 for bridges, and under Objectives and Targets in Chapter 3 for pavements.
	Does the TAMP include a summary description of the condition of NHS pavements and bridges, regardless of ownership, that meets requirements?	This is contained in Inventory and Condition in Chapter 2 for bridges, and under Inventory and Condition in Chapter 3 for pavements.
	Does the TAMP identify and discuss performance gaps?	A discussion of performance gaps is contained in Gap Identification and Strategies for Attaining Targets in Chapter 2 for bridges, and under Gap Identification and

Required Elements	Indicators the TAMP Meets Element Requirements in 23 U.S.C. 119(e) and 23 CFR part 515	Location Addressed in TAMP
		Strategies for Attaining Targets in Chapter 3 for pavements.
	Does the TAMP include a discussion of the lifecycle planning that meets requirements, including results?	A description of the lifecycle planning process and results is contained in Scenario Analysis Results under Lifecycle Planning Analysis for Gap Analysis and Target Setting in Chapter 2 for bridges, and under Scenario Analysis Results under Lifecycle Planning Analysis for Gap Analysis and Target Setting in Chapter 3 for pavements.
	Does the TAMP include a discussion of the risk management analysis that meets requirements?	Discussion of the risk management process and results is contained in Risk Management Process and Risk Management Assessment respectively in Chapter 4 Consideration of Risk.
	Does the TAMP include the results of the evaluations of NHS pavements and bridges pursuant to 23 CFR part 667?	Discussion of evaluations of NHS pavements and bridges pursuant to 23 CFR part 667 are contained in Asset Level Risk Evaluations of NHS Pavements and Bridges pursuant to 23 CFR part 667 in Chapter 4 Consideration of Risk. The process is described in Process for Evaluating NHS Pavements and Bridges Repeatedly Damaged by Emergency Events.
	Does the TAMP include a discussion of a 10-year Financial Plan to fund improvements to NHS pavements and bridges?	A discussion of a 10-year Financial Plan to fund improvements to NHS pavements and bridges is contained in Chapter 5 Managing Finances.
	Does the TAMP identify and discuss investment strategies the State intends to use for their NHS pavements and bridges?	The TAMP identifies and discusses investment strategies the State intends to use for their NHS pavements and bridges in Investment Strategies in Chapter 6 Investing Wisely.
	Does the TAMP include a discussion as to how the investment strategies make or support progress toward achieving and sustaining a desired state of good repair over the lifecycle of the assets?	Discussion on how the planned investment strategy supports progress toward achieving and sustaining a desired state of good repair over the lifecycle of the assets is included in Scenario Analysis Results in Chapter 2 Managing Bridge Assets, in Scenario Analysis Results in Chapter 3 Managing Pavement Assets and in Investment Strategies in Chapter 6 Investing Wisely.

Required Elements	Indicators the TAMP Meets Element Requirements in 23 U.S.C. 119(e) and 23 CFR part 515	Location Addressed in TAMP
	Does the TAMP include a discussion as to how the investment strategies make or support progress toward improving or preserving the condition of the assets and the performance of the NHS related to physical assets?	Discussion as to how the planned investment strategy supports progress toward improving or preserving the condition of the assets and the performance of the NHS related to physical assets is contained in Scenario Analysis Results in Chapter 2 Managing Bridge Assets, in Scenario Analysis Results in Chapter 3 Managing Pavement Assets and in Investment Strategies in Chapter 6 Investing Wisely.
	Does the TAMP include a discussion as to how the investment strategies make or support progress toward achieving the State's targets for asset condition and performance of the NHS in accordance with 23 USC 150(d)?	Discussion as to how the planned investment strategy supports progress toward achieving the State's targets for asset condition and performance of the NHS in accordance with 23 USC 150(d) is included in Scenario Analysis Results in Chapter 2 Managing Bridge Assets, Scenario Analysis Results in Chapter 3 Managing Pavement Assets and in Investment Strategies in Chapter 6 Investing Wisely.
	Does the TAMP include a discussion as to how the investment strategies make or support progress toward achieving the national goals identified in 23 USC 150(b)?	Discussion as to how the planned investment strategy supports progress toward achieving the national goals identified in 23 USC 150(b) is included in Investment Strategies in Chapter 6 Investing Wisely.
	Does the TAMP include a discussion as to how the TAMP's lifecycle planning, performance gap analysis, and risk analysis support the State DOT's TAMP investment strategies?	Discussion as to how the TAMP's lifecycle planning, performance gap analysis, and risk analysis support the State DOT's TAMP investment strategy is included in in Investment Strategies in Chapter 6 Investing Wisely. More detailed discussion is included in Scenario Analysis Results in Chapter 2 Managing Bridge Assets, in Scenario Analysis Results in Chapter 3 Managing Pavement Assets.
Inclusion of Other Assets in the TAMP in 23 CFR 515.9 (l):		Not applicable.
Integration of TAMP into transportation planning processes that lead to the Statewide Transportation Improvement Program (STIP) (23 CFR 515.9(h))		

Required Elements	Indicators the TAMP Meets Element Requirements in 23 U.S.C. 119(e) and 23 CFR part 515	Location Addressed in TAMP
	Do State DOT planning documents or records of planning activities show that the TAMP was integrated into its transportation planning processes that lead to the STIP?	Discussion of how the TAMP was integrated into its transportation planning processes that lead to the STIP will be contained in the annual Consistency submission letter to FHWA.
TAMP available to the public (23 CFR 515.9(i))		
	Has the State DOT made its TAMP available to the public by posting on its website, or distributing in public meetings, or by some other means?	The TAMP will be posted on the WVDOT website: https://transportation.wv.gov/highways/Pages/default.aspx
State DOT demonstrates through current and verifiable documentation that it has implemented a TAMP meeting requirements of 23 U.S.C. 119 and 23 CFR part 515 and that the State DOT is following the investment strategies in the TAMP (23 CFR 515.13(b)(2)).		
	Has the State DOT documented evidence that the State DOT is using the TAMP investment strategies? (23 CFR 515.13(b)(2)). The best evidence is that, for the 12 months preceding the consistency determination, there was alignment between the actual and planned levels of investment (in the TAMP) for various work types as defined in 23 CFR 515.5 (i.e., initial construction, maintenance, preservation, rehabilitation and reconstruction) (23 CFR 515.13(b)(2)(i))?	Documented evidence of alignment between the actual and planned levels of investment in the TAMP for various work types as defined in 23 CFR 515.5 will be contained in annual Consistency submissions to FHWA with the exception of 2019 consistency. For this 2019 consistency review, based on the FHWA guidance in Question 27 of the Frequently Asked Questions, please note that WVDOT opted to exclude the life-cycle planning, risk management, and financial plan analyses from the 2018 Initial TAMP, as permitted by 23 CFR 515.11(b). Due to this extenuating circumstance, no investment plans are available for the 12 months preceding the 2019 Complete TAMP and as a result no documentation can be provided at this time to show alignment between actual and planned levels of investment.
	If the State DOT deviated from the TAMP investment strategies, did they document reasons the deviation(s) were necessary due to extenuating circumstances beyond	Documented evidence of alignment between the actual and planned levels of investment in the TAMP for various work types as defined in 23 CFR 515.5 will be contained in annual Consistency submissions to FHWA with the exception of 2019 consistency. For this 2019 consistency review, based

Required Elements	Indicators the TAMP Meets Element Requirements in 23 U.S.C. 119(e) and 23 CFR part 515	Location Addressed in TAMP
	the State DOT's reasonable control [1] (23 CFR 515.13(b)(2)(ii)).	on the FHWA guidance in Question 27 of the Frequently Asked Questions, please note that WVDOT opted to exclude the life-cycle planning, risk management, and financial plan analyses from the 2018 Initial TAMP, as permitted by 23 CFR 515.11(b). Due to this extenuating circumstance, no investment plans are available for the 12 months preceding the 2019 Complete TAMP and as a result no documentation can be provided at this time to show alignment between actual and planned levels of investment.

[1] The determination of whether there are extenuating circumstances is a case-by-case decision that is highly dependent on the facts. The State DOT must show the deviation from its TAMP investment strategies was the result of circumstances beyond its reasonable control. In cases where the State DOT believes extenuating circumstances have caused it to deviate from the investment strategies in its TAMP, the State DOT should provide an explanation of the extenuating circumstances, the impacts, the State DOT's efforts to avoid or offset the changes and impacts, and program

West Virginia Division of Highways

Transportation Asset Management Plan

August 2019 Complete Plan

MOTT MACDONALD

THE KERCHER GROUP