U.S. Department of Transportation
Federal Highway Administration

Virginia Division

400 North 8th Street, Suite 750
Richmond, Virginia 23219-4825
Phone: 804-775-3320
Fax: 804-775-3356
Virginia.FHWA@dot.gov

August 8, 2022

In Reply Refer To:
HDA/VA

Kevin Gregg
Chief of Maintenance and Operations
Virginia Department of Transportation
1401 East Broad Street
Richmond, Virginia 23219-2000

SUBJECT: Virginia Transportation Asset Management Plan Certification

Dear Mr. Gregg,

The Federal Highway Administration (FHWA) has reviewed the Virginia Department of Transportation's (VDOT) January 20, 2022, formal submittal of the Virginia Transportation Asset Management Plan (TAMP) to determine if the processes identified in the TAMP comply with the minimum requirements of 23 CFR 515.13(a). Based on FHWA's review of the TAMP and additional documentation provided, FHWA certifies that VDOT's asset management processes and analyses meet the plan development requirements set forth in 23 CFR 515.13. This includes the requirement to consider extreme weather and resilience as part of life-cycle planning and risk management analyses resulting from the Bipartisan Infrastructure Law (BIL).

Background

Below is a timeline of FHWA's review:

- VDOT informally shared drafts of the TAMP with FHWA in the summer of 2021 which reflected changes to the State's asset management processes, and FHWA provided some initial comments at that time.
- Following the January 2022 submittal of the TAMP, FHWA developed additional comments for VDOT.
- After sharing those comments with VDOT, we met in April to discuss them and give VDOT the opportunity to address them.
- Following the meeting, VDOT provided written responses to the priority comments, which have been considered.
- On May 27, 2022, FHWA provided a follow-up to VDOT's responses by identifying a few areas requiring additional information. FHWA also informed VDOT that it was receptive to using the annual consistency determination submittal as a vehicle to provide additional information to support the TAMP submission.
- On June 29, 2022, VDOT submitted their annual consistency determination and provided additional documentation related to the TAMP submission and BIL requirements.

VDOT's January 2022 submittal of the TAMP did not address extreme weather and resilience as part of the life-cycle planning and risk management analyses as required by Section 11105 of the BIL and the changes to 23 USC, Section 119(e)(4) that took effect October 1, 2021. FHWA's May 27th letter offered VDOT the

option to take until December 31, 2022, to address the BIL requirements, but VDOT declined to take advantage of that option when the annual consistency determination documentation was submitted on June 29, 2022. Instead, VDOT provided additional documentation demonstrating that through the Commonwealth Transportation Board (CTB), significant steps had been taken to review and enhance asset management processes that reflect the BIL requirements. Specifically, in December 2021, the CTB, in support of the statewide transportation plan (i.e., VTrans) process, approved strategic actions to address long-term risks and opportunities covering at least a 20-year planning horizon while formalizing certain elements related to resiliency and sustainability. Those strategic actions included:

1. Data collection to accurately assess flooding risks from sea level rise, storm surge, and inland/riverine flooding for state and locally maintained roadways that can be used to identify funding needs and prioritize investments;

2. Policy development to ensure flooding risks are reflected in transportation asset life cycle and transportation project planning processes; and

3. Collaboration with state/regional agencies to identify solutions that facilitate prioritization and support the allocation of resources to address future flooding risks.

In 2021, VDOT established an internal working group from different departments to prepare a resiliency plan which is being completed. The plan will provide high-level guidance to then develop and implement enhancements to existing resiliency and sustainability processes. Recently, VDOT added a project to their State Planning and Research Work Program to further develop and implement the plan which, consistent with the CTB's approved strategic actions, will identify key metrics and data, inventory existing efforts, engage external stakeholders, develop strategies, and initiate tracking and report progress. This development and implementation work is anticipated to take one to two years to complete and become part of updated processes across VDOT. These efforts, once completely developed and implemented, would fully address the BIL requirement to consider both extreme weather and resilience as part of the asset management process.

We commend VDOT on their efforts to update the TAMP with the changes to their processes and analyses. Please keep FHWA apprised of your resiliency plan developments. Should you need any further assistance from FHWA or have any questions, please contact Ms. Iris Vaughan at (804) 775-3340 or Iris.Vaughan@dot.gov.

Sincerely,

Thomas L. Nelson, Jr., P.E.
Division Administrator

cc: Jennifer Ahlin, VDOT

U.S. Department of Transportation
Federal Highway Administration

Virginia Division

400 North 8th Street, Suite 750
Richmond, Virginia 23219-4825
Phone: 804-775-3320
Fax: 804-775-3356
Virginia.FHWA@dot.gov

July 14, 2022

In Reply Refer To:
HDA/VA

Kevin Gregg
Chief of Maintenance and Operations
Virginia Department of Transportation
1401 East Broad Street
Richmond, Virginia 23219-2000

Dear Mr. Gregg,

The Federal Highway Administration (FHWA) has received the Virginia Department of Transportation's (VDOT) asset management consistency determination submission dated June 29, 2022. The submission states that VDOT continues to deliver an asset management program consistent with the process reported in the 2019 Transportation Asset Management Plan (TAMP), the new approaches and additional information identified in the updated 2021 TAMP submitted to FHWA for review, and applicable Federal requirements.

The annual consistency determination documentation prepared by VDOT was reviewed by FHWA and based on the review of the documentation, we have determined that VDOT is using the investment strategies in the 2019 TAMP and the process transitioned to in the updated 2021 TAMP as required by 23 CFR 515. l 3(b)(2). There was alignment between the actual and planned levels in the 2021 TAMP for bridge investments for the 12 months preceding the consistency determination and for pavement investments for the calendar year preceding the consistency determination for various work types as defined in 23 CFR 515.5 (i.e., initial construction, maintenance, preservation, rehabilitation, and reconstruction).

FHWA will address the certification of the asset management process documented in the 2021 TAMP and the additional information submitted with the consistency determination documentation in a separate letter. Should you have any questions, please contact Ms. Iris Vaughan at (804) 775-3340 or iris.vaughan@dot.gov.

Sincerely,

Thomas L. Nelson, Jr., P.E.
Division Administrator

cc: Jennifer Ahlin

COMMONWEALTH of VIRGINIA

DEPARTMENT OF TRANSPORTATION

Stephen C. Brich, P.E.
Commissioner

1401 East Broad Street
Richmond, Virginia 23219

June 29, 2022

Thomas L. Nelson, Jr., P.E.
Federal Highway Administration
Virginia Division
400 North 8th Street, Suite 750
Richmond, Virginia 23219-4825

Re: VDOT Transportation Asset Management Plan (TAMP) Consistency Determination 2022

Dear Thomas,

With over 50,000 miles of roadway and over 20,000 bridges, the Virginia Department of Transportation (VDOT) is the third largest state-maintained transportation agency in the nation. Additionally, localities and others operate and maintain over 11,000 miles and over 140 bridges in the National Bridge Inventory. VDOT faces the same issues as other transportation agencies concerning aging infrastructure with limited resources to operate and maintain the overall network.

Introduction

In April 2018, VDOT submitted its initial TAMP to Federal Highway Administration (FHWA). This TAMP was certified by FHWA on July 27, 2018. An updated TAMP was provided in 2019.

In January 2022, VDOT formally submitted the 2021 TAMP (earlier drafts had been provided to FHWA) for recertification. This update was to reflect the 2019 Maintenance and Operations Program Comprehensive Review (the "Comprehensive Review"). The Comprehensive Review is an ongoing effort focused on an investment strategy to achieve long-term (at least 20 years) sustainable performance for existing assets such as pavements, bridges (structures) and Special Structures (25 distinct structures), as well as existing maintenance services such as ditching, drainage repair, and tree removal.

The 2021 TAMP was reviewed by FHWA and, as proposed by FHWA, this Consistency Determination submission will address the following:

1. How VDOT is enhancing processes related to extreme weather and resilience as required by the Bipartisan Infrastructure Law (BIL).
2. Provide additional financial plan data to reflect a 10-year period from 2022.
3. Identify additional funding expected to be available from the BIL.
4. Report on actual expenditure for FY 2021 and how this aligns to the planned funding from the 2021 TAMP to show consistency in implementation of the TAMP.

VDOT is not seeking an extension to the TAMP submission timeframe as offered in FHWA's May 27 letter. The submitted 2021 TAMP as well as this document and referenced information are intended to meet the requirement of the BIL.

Enhancement of Extreme Weather and Resilience Processes

VDOT has taken significant steps to review and enhance processes and to reflect on the requirements of the BIL – Section 11105 - 23 USC 119(e)(4) – Extreme Weather and Resilience.

As stated in Section 7 of VDOT's TAMP, resiliency and sustainability are integrated in the normal processes performed (e.g., planning, estimating, life cycle cost analysis). While the processes are integrated, the Commonwealth Transportation Board (the Board) approved VDOT's statewide transportation plan (VTRANs) strategic actions in December 2021. The VTRANs strategic actions formalized certain elements related to resiliency and sustainability. The top three strategic actions are as follows (see link - https://www.ctb.virginia.gov/resources/2021/dec/res/9.pdf):

1. Collect data (e.g., right-of-way mapping, precipitation, roadway elevation, etc.) to accurately assess flooding (resilience) risks for state- and locally-maintained roadways that can be used to identify funding needs and prioritize investment;

2. Develop policies, based on robust data collection and analysis, to ensure flooding (resilience) risks are reflected in transportation asset life cycle and/or transportation project planning processes; and

3. Collaborate with state/regional agencies to systematically identify solutions that facilitate consistent and systematic prioritization and support the allocation of state resources to address flooding (resilience) risks.

In 2021, VDOT established an internal working group from different disciplines (e.g., design, environmental, financial, etc.) to prepare a resiliency plan. The final approved resiliency plan is expected in July/August 2022 and will be shared with VDOT's FHWA partners. This plan will provide high-level guidance to then develop and implement enhancements to existing resiliency and sustainability processes. This development and implementation work is anticipated to take 1-2 years to complete and become part of updated processes across VDOT. This action, once fully implemented, would be in keeping with the requirement of BIL effective on October 1, 2021 to consider both extreme weather and resilience as part of the asset management process.

Additions to the Financial Plan (and Investment Strategies)

VDOT's strategic investment for long-term performance of assets and services (at least 20 years) through the Comprehensive Review set VDOT's path for assets such as pavements, bridges and Special Structures. The Board approved the Comprehensive Review and in turn approved the preservation approach for conventional structures. The preservation approach focuses VDOT's work on 75% preservation and 25% replacement.

The BIL, effective as of October 1, 2021, provides additional federal funds for bridges. VDOT is estimated to receive over $115M annually for five years or an estimated $575M. It also provides an opportunity to invest this funding in alignment with the preservation approach outlined through the Comprehensive Review. The proposed investment levels and work to be accomplished with BIL funding was presented to the Board by VDOT in December 2021. (See link - https://www.ctb.virginia.gov/resources/2021/dec/pres/16_infrastructureinvestmentact-bridge_ctb_presentation_11302021.pdf)

The presentation indicates the focus on work such as preservation (e.g., painting, deck overlays, resurfacing, and joint elimination) and major component replacements.

VDOT has not currently increased investment in pavement due to BIL but may consider such action in the future. The Comprehensive Review set forth the long-term performance and investment strategy for VDOT's statewide pavement inventory. If a need arises, VDOT will reassess at that time.

Tables 1, 2 and 3 on the following pages include a financial plan and investment strategies that reflect the additional investment associated with the BIL. These tables also include anticipated funding/investments for 2031.

Consistency Determination 2022

VDOT continues to deliver an asset management program consistent with the process reported in the 2019 TAMP as well as the updated 2021 TAMP. The implementation is consistent with the 2019 TAMP and reflect the new approaches in the updated 2021 TAMP as well as the requirements established by 23 U.S.C 119 and 23 CFR 515. In 2019 and prior, VDOT's investment in assets was not sustainable as investments each year fluctuated. However, the Comprehensive Review created a sustainable investment or level funding (entire pavement inventory – over $463M statewide investment and entire structure inventory – over $440M statewide investment without BIL) over at least a 20-year period to ensure long-term performance of assets. The sustainable approach has created predictability in modeling performance and budgeting processes.

In answering the following question, the information provided is consistent with the TAMP submissions.

> *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))?*

Tables 1, 2 and 3 on the following page provide actual 2021 NHS expenditure compared to anticipated expenditure (from the 2021 TAMP) and also provide additional anticipated expenditure for 2031 (to update the financial plan and investment strategy).

At this time, VDOT is delivering the processes and investments consistent with the prior VDOT's TAMP submissions and the Comprehensive Review. Please contact me with any questions or concerns at (804) 786-6581 or at Jennifer.Ahlin@VDOT.Virginia.gov.

Sincerely,

Jennifer Ahlin

Jennifer Ahlin
Asset Management Division Administrator
Virginia Department of Transportation

Cc: E. Kevin Gregg, VDOT, Chief of Maintenance and Operations
Angela Quinn, VDOT, Asset Management Assistant Division Administrator
Robert Prezioso, P.E., VDOT, State Maintenance Engineer
Kendal Walus, P.E., VDOT, State Bridge Engineer
Margit Ray, Office of Intermodal Planning and Investment
Ed Sundra, FHWA
Daniel Mott, FHWA
Iris Vaughan, FHWA

Table 1. Actual (2021) and Proposed NHS Pavement Financial Plan and Investment Strategy ($M)

		Actual CY 21 Expenditure	Anticipated Investment for Pavements by Work Type*										
Interstate NHS	**Work Type**		**CY 21**	**CY 22**	**CY 23**	**CY 24**	**CY 25**	**CY 26**	**CY 27**	**CY 28**	**CY 29**	**CY 30**	**CY 31**
	Initial Construction	$60	$85	$251	$20	$3	$42	$28	$47	--	--	$57	$57
	Reconstruction	$3	$4	$4	$4	$4	$4	$6	$6	$6	$6	$6	$6
	Rehabilitation	$69	$63	$63	$63	$63	$63	$79	$79	$79	$79	$79	$79
	Preservation and Maintenance	$20	$21	$21	$21	$21	$21	$26	$26	$26	$26	$26	$26
	TOTAL	*$152*	*$173*	*$339*	*$108*	*$91*	*$130*	*$139*	*$158*	*$111*	*$111*	*$168*	*$168*

Non-Interstate NHS	**Work Type**	**Actual CY 21 Expenditure**	**CY 21**	**CY 22**	**CY 23**	**CY 24**	**CY 25**	**CY 26**	**CY 27**	**CY 28**	**CY 29**	**CY 30**	**CY 31**
	Initial Construction	$32	$34	$44	$69	$29	$44	$6	$24	$77	$7	-	-
	Reconstruction	$0	$5	$5	$5	$5	$5	$6	$6	$6	$6	$6	$6
	Rehabilitation	$72	$57	$57	$57	$57	$57	$70	$70	$70	$70	$70	$70
	Preservation and Maintenance	$44	$30	$30	$30	$30	$30	$37	$37	$37	$37	$37	$37
	TOTAL	*$148*	*$126*	*$136*	*$161*	*$121*	*$136*	*$119*	*$137*	*$190*	*$113M*	*$113*	*$113*

*****VDOT Pavement asset investments are managed on a calendar year (CY) basis to align with paving season contracts. This data is reconciled with financial year budgets. For this reason CY is used in the 2021 TAMP and is reported here in this manner to provide consistency. From a pavement perspective, the data provided here is the last completes calendar year, CY 2021 (January 1 – December 31, 2021). VDOT's fiscal year 2022 or FY 2022 (July 1 – June 30) data will not be available for reporting purposes until after July 1st (or the middle of July 2022).

Table 2. Actual (2021) and Proposed NHS Bridge Financial Plan and Investment Strategy *($M, Excluding Special Structures)*

		Actual FY 21 Expenditure	Anticipated Investment for NBI Bridges by Work Type										
	Work Type		**FY 21**	**FY 22**	**FY 23**	**FY 24**	**FY 25**	**FY 26**	**FY 27**	**FY 28**	**FY 29**	**FY 30**	**FY 31**
NHS	**Initial Construction**	$0	$3	$3	$3	$3	$3	$3	$3	$3	$3	$3	$3
	Reconstruction	$57	$100	$113	$111	$168	$138	$110	$101	$101	$101	$101	$101
	Rehabilitation	$54	$37	$42	$73	$67	$75	$73	$51	$57	$55	$67	$67
	Preservation	$25	$13	$15	$15	$15	$15	$15	$14	$14	$14	$14	$14
	Maintenance	$25	$28	$30	$33	$41	$51	$76	$55	$28	$31	$41	$41
	TOTAL	*$161*	*$181*	*$203*	*$235*	*$294*	*$282*	*$277*	*$224*	*$203*	*$204*	*$226*	*$226*

Note: 2021 TAMP numbers have been updated to reflect BIL investment anticipated for the NHS (starting FY 22).

Table 3. Actual (2021) and Proposed NHS Bridge Financial Plan and Investment Strategy for Special Structures ($M)

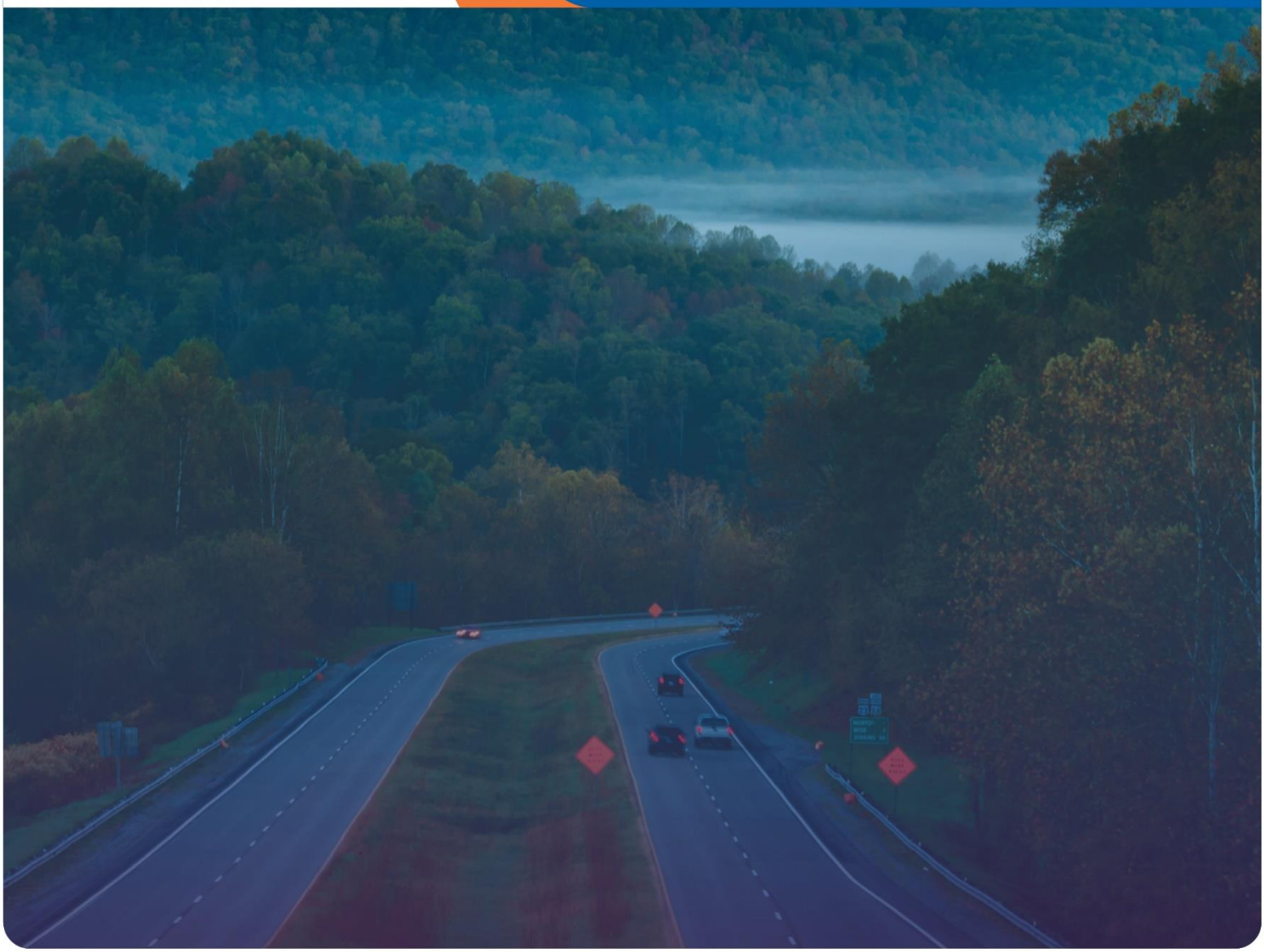
			Actual FY 21 Expenditure	Anticipated Investment for Special Structures by Work Type										
	Work Type	**VDOT Special Structures Work Type**		**FY 21**	**FY 22**	**FY 23**	**FY 24**	**FY 25**	**FY 26**	**FY 27**	**FY 28**	**FY 29**	**FY 30**	**FY 31**
NHS – Special Structures	**Initial Construction**	**New Structure Construction**												
	Reconstruction	**Structure Replacement**												
	Rehabilitation	**Component Replacement**	$0.2	$0.2	$8	$21	$26	$23	$21	$50	$23	$18	$21	$21
	Preservation and Maintenance	**Prioritized Maintenance**	$0.5	$0.5	$1	$9	$7	$15	$27	$9	$8	$5	$1	$1
		Routine Maintenance	$11	$11	$10	$10	$8	$19	$18	$20	$8	$6	$8	$8
	TOTAL		*$11.7*	*$11.7*	*$19*	*$40*	*$41*	*$57*	*$66*	*$79*	*$39*	*$29*	*$30*	*$30*

2021

VDOT
Virginia Department of Transportation

COMMONWEALTH OF VIRGINIA

Transportation Asset Management Plan



January 20, 2022

Mr. Thomas Nelson, Jr P.E.
Federal Highway Administration
Virginia Division
400 North 8th Street, Suite 750
Richmond, Virginia 23219-4825
Attention: Ed Sundra

Subject: Commonwealth of Virginia Transportation Asset Management Plan

Dear Mr. Nelson,

The Virginia Department of Transportation is submitting the Commonwealth of Virginia's updated Transportation Asset Management Plan, which will remain in place for the next four years. Please use this letter as my approval.

If you have any questions or concerns please contact Jennifer Ahlin at (804) 786-6581.

Sincerely,

Stephen C. Brich, P.E.
Commissioner of Highways

TABLE OF CONTENTS

1. INTRODUCTION

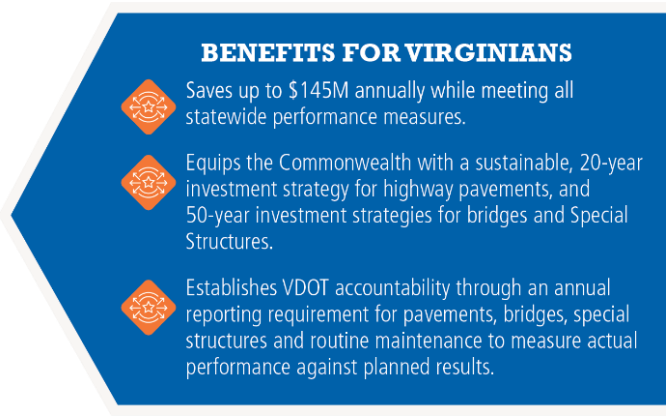
The Commonwealth of Virginia has developed and implemented a risk-based asset management plan in accordance with the federal requirements of 23 U.S.C. 119 for the National Highway System (NHS). This Transportation Asset Management Plan (TAMP) presents current pavement and bridge inventory and conditions; the Commonwealth of Virginia's performance objectives, measures, and associated risks; and the Commonwealth's asset funding and investment strategies, forecasts, goals, and gaps. The Virginia Department of Transportation (VDOT) has updated and is re-certifying the TAMP for the following reasons:

- A new focus on the long-term sustainability of the Commonwealth's program for pavements and bridges and updates to certain targets.
- Implementation of specific funding for special structures with the introduction of the Special Structure Fund.[1]
- Implementation of a new process for monitoring repeatedly damaged facilities.

Maintenance and Operations Comprehensive Review

In 2019, VDOT conducted a comprehensive review of the Commonwealth's investment in transportation assets funded by VDOT's Maintenance and Operations and State of Good Repair Programs (*2019 Maintenance and Operations Comprehensive Review Report*[2] - "*Comprehensive Review*"). The *Comprehensive Review* entailed the development of an investment strategy to achieve long-term, sustainable performance targets for pavements, bridges, and special structures and to satisfy the requirements of the Special Structure Fund legislation (2019 Acts of Assembly, Enactment 2 of Chapters 83 and 349, as amended). As a result of the *Comprehensive Review*, in December 2019, the Commonwealth Transportation Board (the Board):

- Adopted new performance measures and targets for pavements.
- Adopted new performance measures and targets for structures.
- Supported development of a special structure's health index and risk-based prioritization of projects.
- Required an Annual Report that summarizes planned and actual achievement of performance targets.
- Approved the 2019 *Comprehensive Review* report.



Chapter 3 discusses the approach to target setting through the Comprehensive Review. This discussion (and the decision making through the Comprehensive Review) was for the entire VDOT network however the remainder of this TAMP (e.g. inventory, condition, investment strategies and gap analysis) is focused on the NHS.

Alignment with the Commonwealth of Virginia's Mission

The *Code of Virginia* and the VDOT *Business Plan*[3] reflect the efforts the state has taken to promote asset management. Transportation Asset Management (TAM) is integrated into Virginia's short- and long-term

[1] https://lis.virginia.gov/cgi-bin/legp604.exe?191+ful+CHAP0083 and https://lis.virginia.gov/cgi-bin/legp604.exe?191+ful+CHAP0349

[2] https://www.virginiadot.org/projects/resources/legstudies/Maintenance_and_Operations_Comprehensive_Review_%E2%80%93_2019.pdf

[3] https://www.virginiadot.org/about/resources/VDOT_Business_Plan.pdf

transportation plans. **Table 1** provides a summary of the documents that inform and guide the VDOT asset management program and their role relative to this TAMP.

Table 1: Planning and Reporting Documents of the VDOT Asset Management Program

	Document	Description	Outlook
Long-term Vision	VTrans2040[4]	Virginia, through the Office of Intermodal Planning and Investment, has in place its long-range transportation plan (VTrans2040). VTrans2040 provides the vision, goals, and objectives that will guide transportation investment decisions. The objectives include increasing the number of pavement lane miles in Good or Fair condition and improving bridge condition based on deck area. VTrans2040 is based, in principle, on the Fixing America's Surface Transportation Act and on performance-based planning and programming to achieve the vision, goals, and objectives. VTrans2040 is currently being updated, and as part of its process, the Board has reaffirmed its commitment to the vision, goals, objectives, and guiding principles.	25 Years (updated every 4 years)
	Comprehensive Review[5]	Provides an investment strategy to achieve long-term sustainable performance targets for all VDOT managed pavements, bridges, routine maintenance and special structures.	20+ Years
TAMP		Unlike the other documents described in this table the TAMP is specific to the National Highway System (NHS). It provides a summary of, or direction to, the Commonwealth of Virginia's TAM processes and methodology to meet federal requirements.	10 Years (updated every 4 years)
Short Term Planning and Reporting	Statewide Transportation Improvement Plan (STIP)[6]	The STIP is Virginia's federally required four-year program that identifies transportation projects that will utilize federal transportation funding or require approval from either the Federal Highway Administration (FHWA) or Federal Transit Administration (FTA). Virginia updates the STIP every three years to ensure the program never lapses.	4 Years
	VDOT's *Biennial Report*[7]	Describes the allocation process for developing the upcoming fiscal year budget for pavements and bridges through a needs-based, data-driven approach that considers numerous programmatic priorities. Included in these priorities is a focus on pavements and bridges to ensure an alignment of resources to achieve and maintain a State of Good Repair.	2 Years (biennial update)
	Comprehensive Review Annual Report	The *Comprehensive Review* requires the Commissioner of Highways to provide an Annual Report that summarizes planned and actual achievement of performance targets.	Annual (Began 2021)
	State of the Structures and Bridges Report[8]	A summary report of Virginia's bridges, large culverts and ancillary structures (traffic control devices) that covers asset inventory, condition, VDOT's maintenance/ construction/ inspection program for bridges, and accomplishments.	Annual
	State of the Pavement Report[9]	A summary report of Virginia's pavement inventory, condition and ride quality.	Annual

[4] https://www.vtrans.org/archive/vtrans2040
[5] https://www.virginiadot.org/projects/resources/legstudies/Maintenance_and_Operations_Comprehensive_Review_%E2%80%93_2019.pdf
[6] http://www.virginiadot.org/about/stip.asp
[7] https://rga.lis.virginia.gov/Published/2021/RD78/PDF
[8] https://www.virginiadot.org/info/bridges/state-of-structures-and-bridges.asp
[9] https://www.virginiadot.org/info/state_of_the_pavement.asp

VDOT Asset Management Objectives

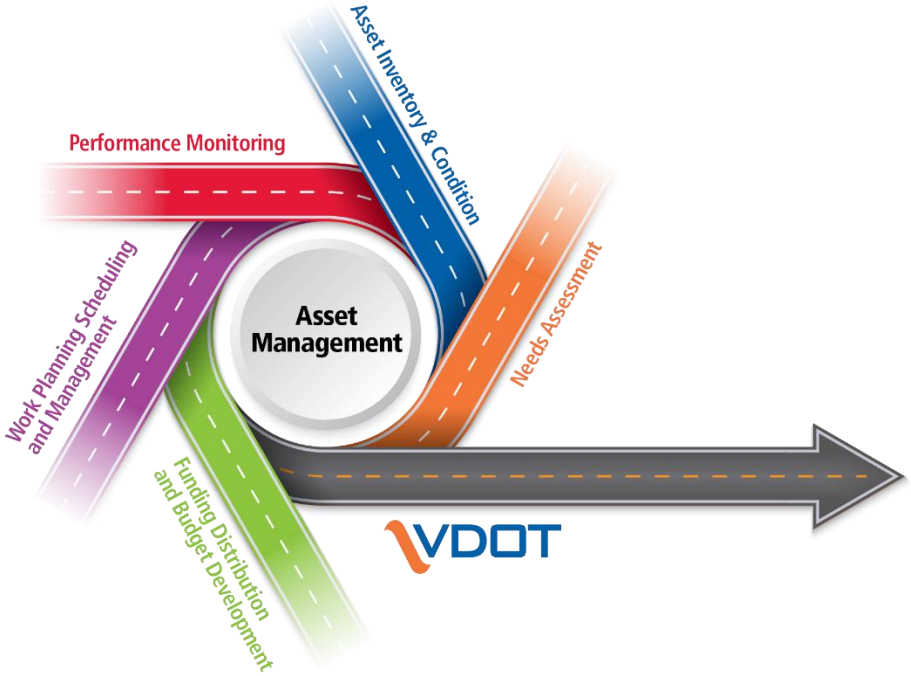
Within its Business Plan VDOT sets the agency goal of maintaining infrastructure:

Maintain Infrastructure	Assess needs, establish goals and keep infrastructure and facilities in a state of good repair.

The *Comprehensive Review* was undertaken to achieve this goal (for pavements, bridges, routine maintenance and special structures). Other parts of the program continue to be assessed. The *Biennial Report* reports on how VDOT is meeting the objective and delivering against its goals and targets.

The methodology used to deliver this goal is part of VDOT's continuous cycle of asset management that begins with assessing asset inventory and condition and ends with performance monitoring, as illustrated in **Figure 1**.

Figure 1. VDOT's Asset Management Cycle.

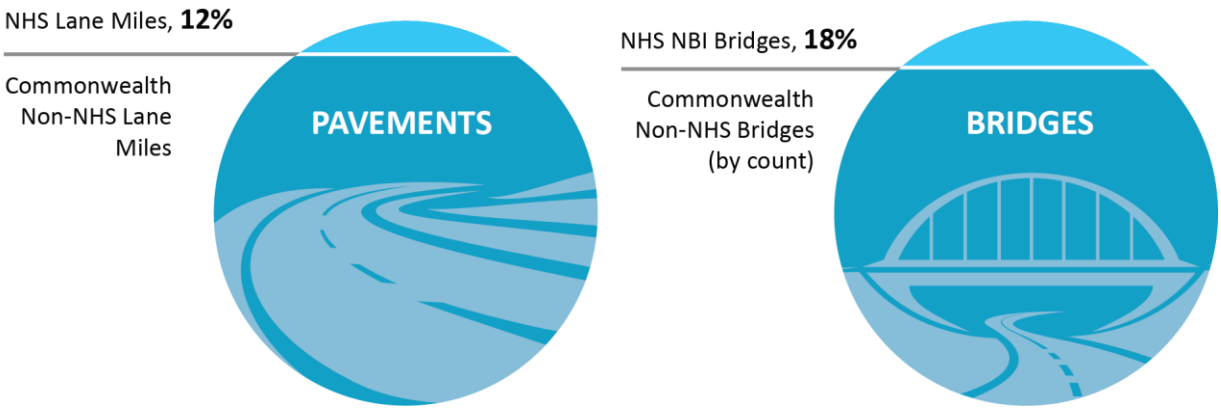


Commonwealth of Virginia Road Network Overview and Scope of the TAMP

VDOT is responsible for the third-largest state-maintained highway system in the country, behind the Texas and North Carolina DOTs. Although VDOT makes risk-based asset management decisions (as described in this TAMP) across the full VDOT network, the scope of this TAMP is only pavements and National Bridge Inventory (NBI) bridges on the NHS. Where necessary, the TAMP describes broader VDOT decision making processes for the entire network but the reporting included here is purely for the NHS assets.

Of the 159,000 lane miles maintained by VDOT and localities, approximately 19,000 lane miles are on the NHS (12% of the roadway inventory). There are over 21,100 bridges in the Commonwealth (maintained by VDOT and localities), of which approximately 13,600 are NBI structures and approximately 3,800 are NBI structures on the NHS (18% of the bridge inventory) (**Figure 2**).

Figure 2. Scope of the TAMP relative to overall VDOT and Locality network.



In order to meet the federal TAMP requirements this TAMP includes the following chapters:

1. **Introduction**. Including a discussion of VDOT's asset management objectives.
2. **Inventory and condition**. A summary listing of the pavement and bridge assets on the NHS in the Commonwealth regardless of ownership, including a description of the condition and valuation of those assets.
3. **Performance targets**. A description of the VDOT target setting process and confirmation of the VDOT State of Good Repair (SGR) definition for pavements and bridges on the NHS.
4. **Life-cycle planning** (LCP). A summary of the LCP process used by VDOT.
5. **Financial plan**. A description of the funding sources available to VDOT and localities and a summary of the 10-year financial projections for pavements and bridges on the NHS.
6. **Investment strategies**. A summary of the investment strategies by work type for the NHS.
7. **Risk management**. A description of the VDOT risk management process, the highest priority risks (including mitigation strategies), a description of the bridge management risk-based decision making and a summary of the 23 CFR Part 667 analysis process and results.
8. **Performance gap analysis**. Predicted NHS pavement and bridge performance based on proposed investment strategies and risk analysis. Discussion of strategies to close performance gaps.

2. INVENTORY AND CONDITION

Accurate inventory and condition information are fundamental to asset management communication and decision-making. VDOT maintains a comprehensive inventory of all pavement and bridges on the state-maintained network. This inventory includes location, maintenance, ownership, and current condition or inspection information and serves as the foundation for LCP, performance forecasting, maintenance, and rehabilitation needs estimation as well as the prioritization of work to maximize asset life and available funding. Condition information is also vitally important for communicating with external stakeholders and the general public.

Lane Mile

A lane mile is the length (in miles) of pavement multiplied by the number of lanes in a road segment.

NBI versus Non-NBI

NBI - Bridges that are over 20 feet in length and large culverts.

Non-NBI - Bridges that are less than 20 feet in length and culverts with openings greater than 36 square feet.

PAVEMENT INVENTORY

Annually, VDOT produces the *State of the Pavement Report*, which includes a description of data collection and quality processes. Results are then published for condition by roadway system (Interstate, Primary, and Secondary). The definition of these systems is as follows:

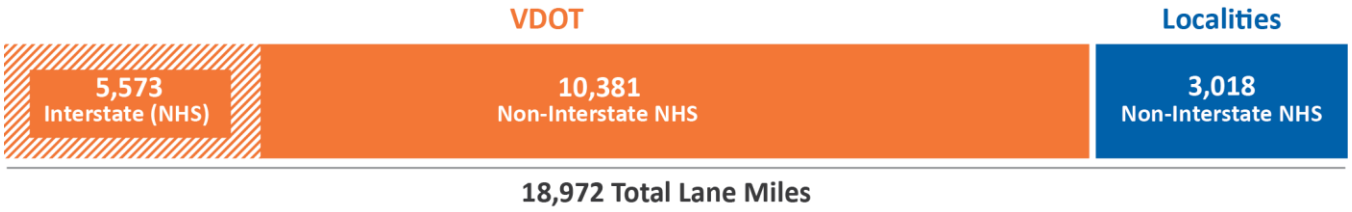
Interstate System	Includes highways or highway segments in the Commonwealth that constitute a part of the Dwight D. Eisenhower National System of Interstate and Defense Highways as authorized and designated in accordance with §7 of the Federal-Aid Highway Act of 1944 and §108(a) of the Federal-Aid Highway Act of 1956 and are declared by resolution of the Commonwealth Transportation Board to be portions of the Interstate System.
Primary state highway system	Consists of all highways and bridges under the jurisdiction and control of the Commonwealth Transportation Board and the Commissioner of Highways and not in the secondary state highway system.
Secondary state highway system	Consists of all public highways, causeways, bridges, landings, and wharves in the counties of the Commonwealth not included in the primary state highway system and that have been accepted by VDOT for supervision and maintenance.

VDOT reporting and asset management decision-making work across all these systems. These are discussed further in the LCP section, but the focus of this report is the NHS. The NHS includes assets from all three VDOT systems.

A summary by NHS designation of the Commonwealth of Virginia's pavement inventory is provided in the *Annual Mileage Table*[10]. The NHS designation, however, is not directly reported within the mileage tables. **Table 2** provides a breakdown by ownership of the NHS and uses data consistent with the 2019 mileage table.

[10] https://www.virginiadot.org/projects/pr-mileagetablepublications.asp

Table 2 : Virginia Pavement Lane Miles by Maintenance Responsibility, December 2019



NHS	Lane Miles by Maintenance Responsibility		Total
	VDOT	Localities	
Interstate (NHS)	5,573	0	5,573
Non-Interstate NHS	10,381	3,018	13,399
Total:	15,954	3,018	18,972

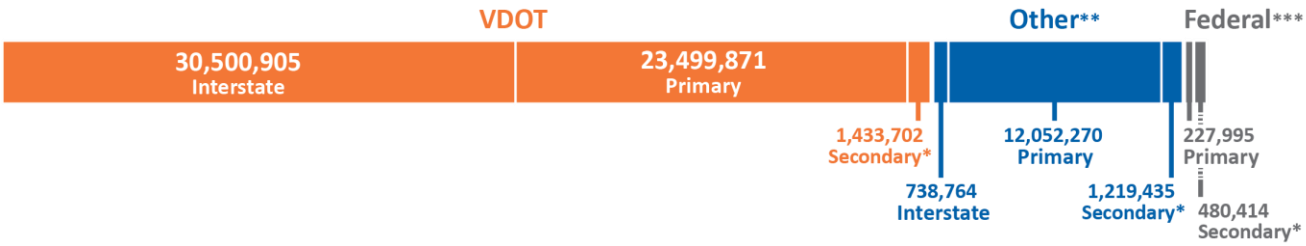
BRIDGE INVENTORY

VDOT maintains an inventory of all NBI structures, regardless of ownership, and reports their condition to FHWA annually, in accordance with the requirements of the National Bridge Inspection Standards (NBIS).

VDOT also summarizes its bridge and condition data in its annual *State of the Structures and Bridges Report*, which documents Virginia's structures by providing both current and historical information. Charts and graphs are provided by structure type, roadway system, count, and deck area for all bridges, including the specific population of bridges addressed in this report: NBI bridges on the NHS, which are those that meet the federal definition for inclusion in the NBI.

A summary of NBI structures on the NHS is provided in **Table 3**, reflecting data as of July 2020, which aligns with VDOT's *State of the Structures and Bridges Report*. The *State of the Structures and Bridges Report* does present data for the NHS but it should be noted that the summary in **Table 3** includes certain NBI bridges that are owned and maintained by other entities. They are included in this report in accordance with FHWA requirements and includes bridges owned by the federal government through its agencies such as the U.S. Army Corps of Engineers and bridges on Virginia's border that cross into and are owned by adjacent states.

Table 3: Virginia NHS/NBI Bridge Inventory as of July 2020, by System and Owner



Count and Area of NBI Bridges on the NHS by Highway System and Owner								
Owner	**VDOT**		**Other****		**Federal*****		**Total**	
	Count	**Area**	**Count**	**Area**	**Count**	**Area**	**Count**	**Area**
Interstate	1,699	30,500,905	8	738,764	0	0	1,707	31,239,670
Primary	1,595	23,499,871	318	12,052,270	13	227,995	1,926	35,780,136
Secondary*	71	1,433,702	85	1,219,435	30	480,414	186	3,133,551
Total	**3,365**	**55,434,478**	**411**	**14,010,470**	**43**	**708,409**	**3,819**	**70,153,357**

*Includes bridges on VDOT's designated "Urban" system

**"Other" includes private bridges, toll bridges, and any other bridges that are required by FHWA requirements to be submitted with the TAMP, including border bridges

***Federal bridges are those owned by any federal agency, such as the Army Corp of Engineers or National Park Service

PAVEMENT CONDITION

The *State of the Pavement Report* describes the inspection process, frequency, and quality assurance/quality control. VDOT meets or exceeds the minimum inspection requirements for the NHS.

Pavement Condition Data Quality Management Plan

VDOT's Pavement Data Quality Management Plan (and its implementation) is consistent with the requirements relating to State DOT Pavement Data Quality Management Programs as set forth in 23 C.F.R. § 490.311, and the data elements discussed in 23 C.F.R. § 490.309 (C).

VDOT Pavement Performance Measures

VDOT has developed pavement condition indices that it uses to summarize detailed pavement condition data collected on Virginia roadways. The condition indices (or Critical Condition Index – CCI) are measured on a 0 to 100 scale, with 100 representing no visible distress and deductions calculated based on observed distresses.

VDOT reports a sufficiency percentage (% sufficient) which is the percentage of lane miles on the network at a CCI of 60 or better (Excellent, Good or Fair) condition (see **Table 4**).

Table 4: Critical Condition Index (CCI) Grading Overview

CCI Score	Rating	
90 – 100	Excellent	▲Sufficient
70 – 89	Good	(CCI≥60)
60 – 69	Fair	▼
50 – 59	Poor	
0 – 49	Very Poor	

These pavement condition indices, developed in 1998, are based on the U.S. Army Corps of Engineers PAVER methodology. They have undergone extensive validation using FHWA Long Term Pavement Performance (LTPP) data and a process of consensus building with VDOT pavement experts. Details of the methodology used to develop these indices are further explained in reports developed by VDOT.[11],[12]

The CCI developed by VDOT is the common index used to summarize the condition of all VDOT pavement types. It is used to assign a general pavement condition designation and to inform state decision-making in combination with detailed distress data.

[11] Development and Implementation of Pavement Condition Indices for the Virginia Department of Transportation, Phase I: Flexible Pavement. Virginia Department of Transportation, McGhee, K H., Maintenance Division, 2002. http://www.virginiadot.org/business/resources/local_assistance/Flexible_Pavements_Development_of_Pavement_Condition_Indices_Phase_I.pdf

[12] Development and Implementation of Pavement Condition Indices for the Virginia Department of Transportation, Phase II: Rigid Pavements. Virginia Department of Transportation, McGhee, K H, Maintenance Division, 2002. http://www.virginiadot.org/business/resources/local_assistance/Rigid_Pavement_Development_of_Pavement_Condition_Indices_Phase_II.pdf

FHWA Pavement Performance Measures

FHWA selected four performance measures to determine the condition level of NHS pavements. The federal data collection metrics used in determining performance measures are shown in **Table 5**.

Table 5: Federal Pavement Performance Measures - Data Collection Metrics

Name	Pavement Type	Measure	Description
Pavement Roughness	Asphalt and Concrete	International Roughness Index (IRI)	Indicator of discomfort experienced by road users traveling over the pavement.
Rutting	Asphalt	Depth of ruts along wheel path	Commonly caused by a combination of high traffic and heavy vehicles.
Faulting	Concrete	Average depth of faulting	Occurs when adjacent pavement slabs are vertically misaligned. It can be caused by slab settlement, curling, and warping.
Cracking	Asphalt and Concrete	% of cracked pavement surface	Can be caused/accelerated by excessive loading, poor drainage, frost heaves or temperature changes, and construction flaws.

FHWA has established Good, Fair, and Poor performance rating thresholds, as described in **Table 6**. An overall condition is assigned based on performance against each of the individual measures for each pavement type: Asphalt Concrete (AC), Jointed Concrete (JC), and Continuously Reinforced Concrete (CRC).

Table 6: Federal Performance Rating Thresholds for Pavement Condition Categories

Measure	Good	Fair	Poor
Ride Quality (IRI)	<95	95 – 170	>170
Rutting (inches)	<0.20	0.20 – 0.40	>0.40
Faulting (inches)	<0.10	0.10 – 0.15	>0.15
Cracking (% area)	<5	5-20 (AC) 5-15 (JC) 5-10 (CRC)	>20 (AC) >15 (JC) >10 (CRC)

An individual pavement section is rated as overall Good condition if all applicable individual metrics are rated as "Good," and Poor when two or more of the applicable metrics are rated as "Poor." In all other cases, the pavement section would be assigned an overall federal condition rating of Fair. For federal performance, 0.10-mile performance is reported, whereas Virginia performance is typically reported by management section (or homogeneous sections).

NHS Pavement Condition Summary

Table 7 provides a summary of Virginia's NHS pavement condition organized by ownership and lane miles. This information is developed through additional analysis to convert CCI (considering 13 different factors) to the four FHWA measures and performance ratings. This conversion process is described in a document developed for FHWA.[13]

Table 7: 2020 NHS Pavement Condition - Based on FHWA Performance Measures

Ownership	Designation	Lane Miles	% Good	% Poor
VDOT	NHS Interstate	5,573	57.9	0.3
	NHS Non-Interstate	10,381	42.9	0.2
Localities	NHS Non-Interstate	3,018	16.6	2.9
Total	NHS	18,972	42.6	0.7

[13] Federal Pavement Performance Measure Modeling, Technical Memorandum in support of Virginia TAMP Development, May 2018

BRIDGE CONDITION

Bridge and large culvert condition data are collected by in-house VDOT inspection staff and through consultant contracts. The *State of the Structures and Bridges Report* describes the inspection process, frequency, and quality assurance/quality control. VDOT meets or exceeds the minimum inspection requirements of the National Bridge Inspection Standards.

VDOT Bridge Performance Measures

VDOT uses a condition rating scale to summarize data collected on each primary structure component that is recorded in the inspection report during each inspection. The rating, known as the General Condition Rating (GCR), is a nationally established numerical grading system measured on a 0-9 scale, where 0 represents failed condition and 9 represents excellent condition. For bridges, the deck, superstructure, and substructure are rated individually, while culverts receive a single rating.

FHWA Bridge Performance Measures

Bridge performance is summarized into three federally defined condition categories: Good, Fair, and Poor/Structurally Deficient (SD) as noted in **Table 8**.

Table 8: Bridge Condition Definitions

Condition Category and Definition		
Poor/SD	**Fair**	**Good**
Minimum GCR ≤ 4	4 < Minimum GCR <7	Minimum GCR ≥ 7

NHS Bridge Condition Summary

Table 9 provides a condition summary of Virginia's NBI bridges on the NHS using the FHWA condition categories by ownership, count, and deck area. Deck area is the federal unit of measure required for the TAMP.

Based on deck area, 31.9% of the NBI/NHS bridges statewide are in good condition, 65.5% are in fair condition, and 2.6% are in poor condition.

As noted previously, these data differ from the *State of the Structures and Bridges Report,* as it includes certain NBI bridges that are owned and maintained by other entities.

Table 9: Performance of NBI Bridges on the NHS as of July 1, 2020

Owner	Good		Fair		Poor		Total	
	Count	Area	Count	Area	Count	Area	Count	Area
VDOT	740	15,137,671	2,554	38,973,489	71	1,323,319	3,365	55,434,478
Other	142	7,183,735	252	6,538,947	17	287,788	411	14,010,470
Federal	5	40,448	37	459,415	1	208,546	43	708,409
Total	887	22,361,854	2,843	45,971,851	89	1,819,653	3,819	70,153,357
% of Total	**23.2%**	**31.9%**	**74.4%**	**65.5%**	**2.3%**	**2.6%**	**100%**	**100%**

ASSET VALUATION

The *2018 Biennial Report* provides VDOT's estimate to fully replace state-maintained assets at approximately $400 billion. This value includes other assets in addition to pavements and bridges on NHS as well as non-NHS roadways. The following section provides the estimated asset value for the NHS pavements and bridges only.

Pavements

VDOT estimated the value of the NHS pavement network by using current condition data, in combination with pavement deterioration modeling to determine a percentage remaining life of the network pavement. The percentage remaining life was used to adjust the replacement cost to establish the current asset value.

VDOT estimates the value of all NHS pavements to be approximately $11 billion as summarized in **Table 10**. This valuation was developed based on an estimate of remaining pavement life that equates to 75% of the replacement cost of the NHS pavement network (approximately $15 billion).

Table 10: Estimated Value of NHS Pavements (millions)

Ownership	System	Replacement Cost ($M)	Asset Value ($M)
NHS Pavements		$15,217	$11,465

Bridges

VDOT estimates the current total valuation of NBI bridges on the NHS to be $53 billion as summarized in **Table 11**. This figure is developed using the health index of each bridge, which provides a numerical percentage of the remaining value of each structure after consideration of depreciation caused by deterioration. The replacement cost and current asset value calculations are as follows:

1. Replacement Cost of Each Bridge = Area of Structure x $1,110/SF (Replacement Cost/SF)
2. Current Asset Value of Each Bridge = Replacement Cost x Health Index

Table 11: Estimated Value of NBI Bridges on the NHS (millions)

Asset	Replacement Cost ($M)	Asset Value ($M)
NHS NBI Bridges	$77,000	$53,000

3. PERFORMANCE TARGETS

The *Comprehensive Review* process included consideration of the performance measures used (resulting in a new measure for bridges) and the long-term targets that VDOT is aiming to achieve. These measures and targets are applied across all parts of the VDOT network and adopted as the VDOT definition of State of Good Repair (per MAP-21 requirements).

The following sections provide an overview of the performance targets and how they translate to the FHWA requirements for federal performance measures. Further details on how these targets were developed based on a range of investment strategies are included within the *Comprehensive Review* report.

A core requirement of the TAMP is that it must demonstrate the impact of performance gap analysis, LCP, risk management, and anticipated funding on the state investment strategy. Each of these elements was a key consideration through the *Comprehensive Review* and informs investment strategies over the coming years.

State of Good Repair

As used in this document the term "state of good repair" refers to the condition of a section of pavement or a bridge that meets the performance targets as approved by the Board. However, VDOT has a State of Good Repair Program as defined in the *Code of Virginia* Section 33.2-369 which dedicates funds for the Commonwealth of Virginia's deteriorated pavements and structurally deficient bridges.

Life Cycle Planning Influence on *Comprehensive Review* Investment Strategy

Pavement and bridge LCP models and strategies were integral to the *Comprehensive Review* process. The process also included a review of the assumptions and district-level implementation of model outputs. For implementation, results of LCP are communicated to District project-level decision-makers. Regular review by Central Office staff ensures adequate compliance with the established network-level strategy.

Performance Gap Analysis Influence on *Comprehensive Review* Investment Strategy

The *Comprehensive Review* considered a range of different investment levels, targets, and associated performance gaps. It also considered how these performance gaps could be closed and alternative investment strategies that could achieve improved results.

Risk Management Influence on *Comprehensive Review* Investment Strategy

This TAMP formally recognizes some of the key risks to delivery of the TAMP. Through the *Comprehensive Review,* risks to mobility, increased likelihood of asset failure, and implementation risk were considered. In cases where the consequences of a risk are so severe as to affect the ability of the state to achieve desired asset performance levels, the consequences of the risk would be formally recognized and addressed within the annual needs assessment and maintenance funding allocation process.

Anticipated Funding Influence on *Comprehensive Review* Investment Strategy

In general, when funding increases, asset management investment optimizations will identify additional projects and increased performance outcomes. The *Comprehensive Review* process considered a range of different funding levels and a trade-off of investment between pavements and bridges as well as other assets and services provided within the Commonwealth.

PAVEMENT PERFORMANCE TARGET SETTING APPROACH

Through the *Comprehensive Review* process VDOT defined performance targets for each VDOT system. The analysis undertaken to define a sustainable, long-term approach included:

- **Considering Historical Performance**: What has VDOT spent? How did that influence performance?
- **Evaluation of Time Periods**: What is the best analysis period to understand the full lifecycle of an asset?
- **Assessment of Varying Maintenance Strategies**: What are the assumptions used in modeling and how is pavement performance affected if assumptions change?
- **Cost to Maintain Performance**: What it would take to sustain our pavement condition as last measured in 2018?
- **Cost to Achieve Current Targets**: What would be the cost difference of lowering sufficiency level (where it exceeds targets) to meet the current performance target?
- **Impact of Different Investment Levels**: What can be achieved with different investment levels, based on 2020 investment levels and increasing or decreasing funding?
- **Impact of Tiered Targets**: What if tiered performance targets were considered for each of the systems?

VDOT modeled and analyzed a series of investment scenarios and evaluated potential outcomes in pavement performance.

Two of the shortlisted investment options are presented in **Figure 3** through **Figure 5** shown on the following pages for interstate, primary, and secondary systems.

The results presented here are shown over a 20-year period. Analysis was also undertaken for a 30- to 50-year period to ensure rehabilitation and the greater cost of associated treatments (i.e., 2 to 5 times the cost of corrective maintenance) were considered.

There are three key elements to the figures:

- The blue bars and line indicate the past expenditure and condition performance.
- The orange bars and lines represent the predicted outcomes based on the FY 2020 level of investment. The outcome is presented as a band of performance to reflect a range of possible solutions based on a variety of assumptions for potential treatment types. Actual performance is expected to fall within this band.
- The green bars and line indicate required funding levels to maintain the pavement condition at the pavement performance targets.

This analysis showed that the new performance targets reduce the required expenditure by $23M per year ($8M per year after 7 years), when compared to achieving the current performance targets.

The Board approved the new performance targets.

Figure 3. 20-Year Outlook for Interstate System: Predicted Performance for alternative Investment Strategies.

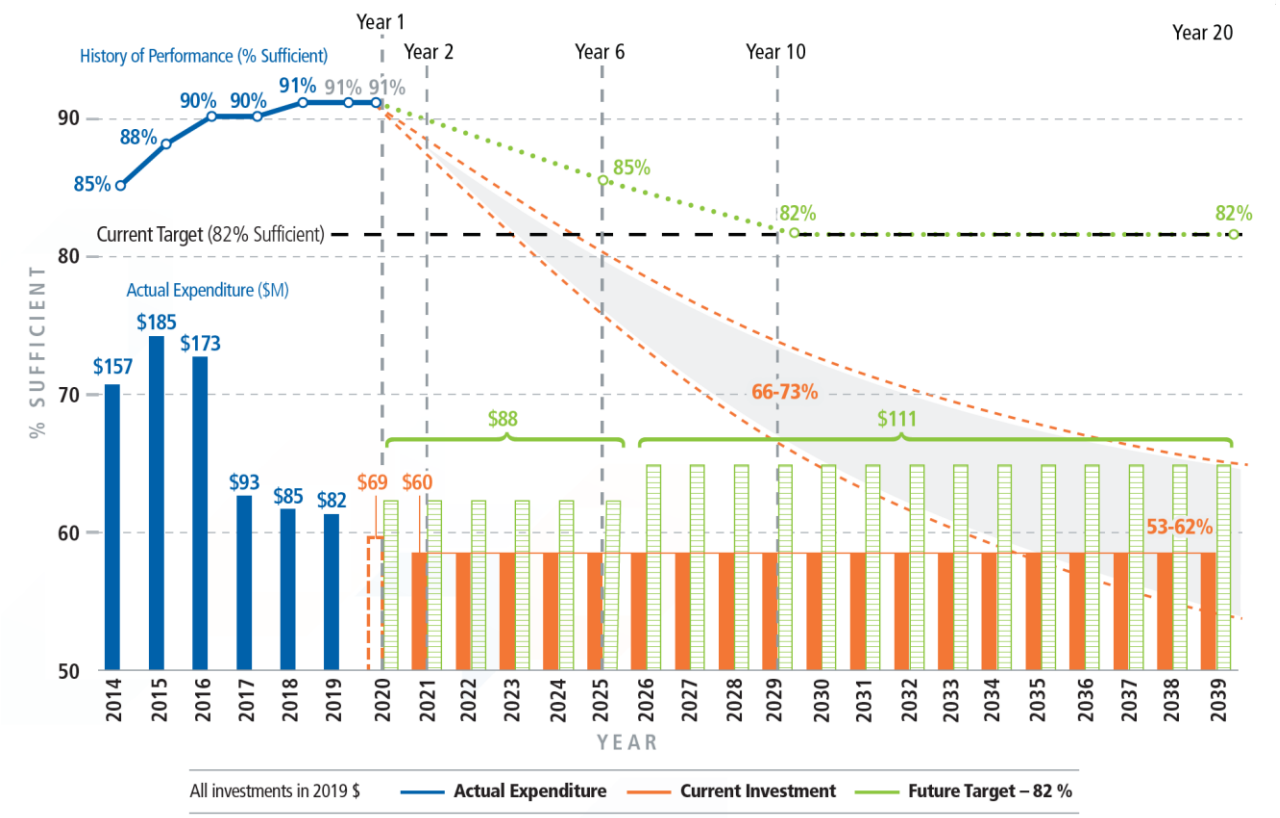


Figure 4. 20-Year Outlook for Primary System: Predicted Performance for alternative Investment Strategies.

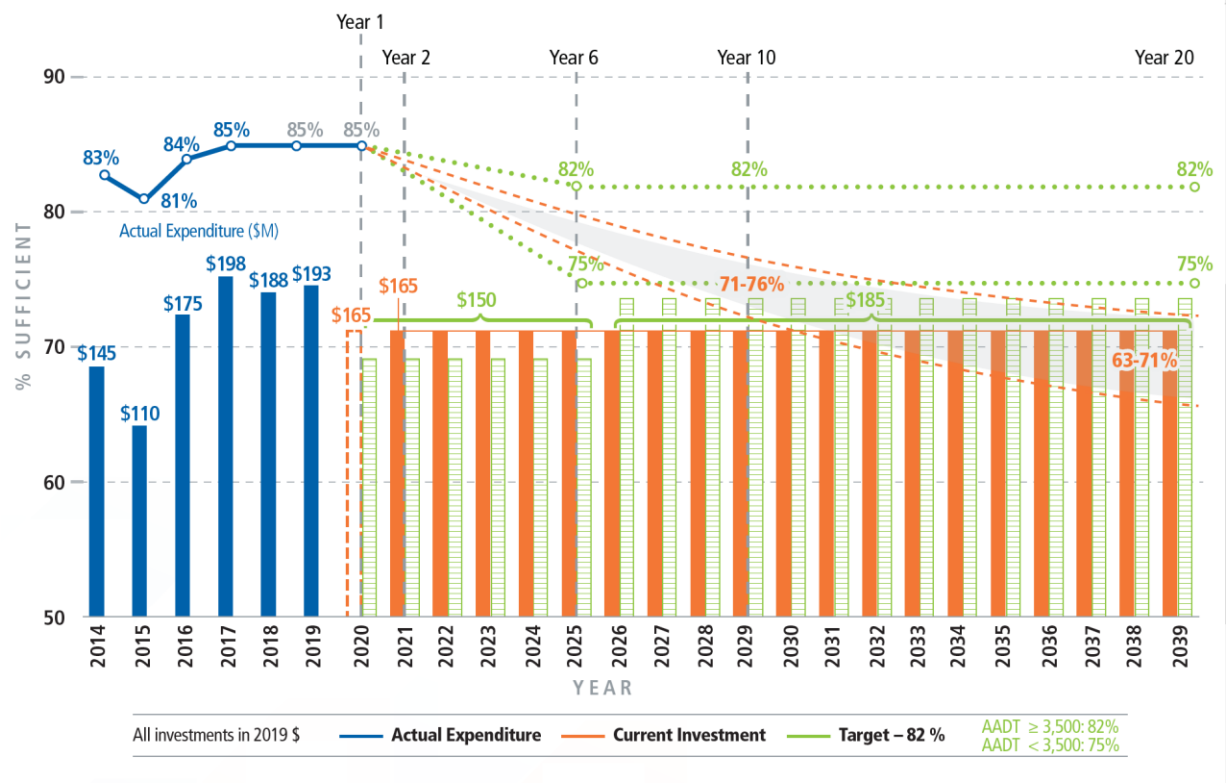
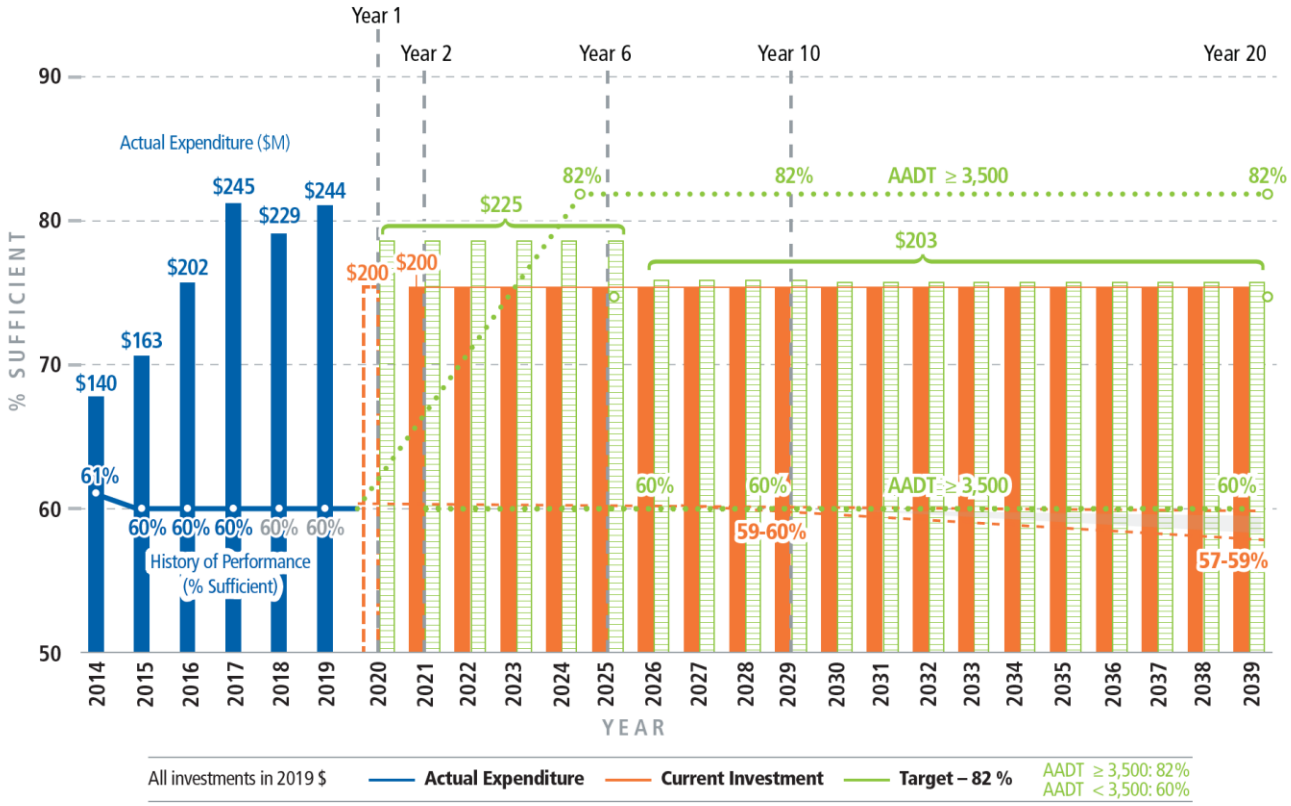


Figure 5. 20-Year Outlook for Secondary System: Predicted Performance for alternative Investment Strategies.



BRIDGE PERFORMANCE TARGET SETTING APPROACH

VDOT has a long history of using performance management to develop investment strategies and implement its bridge program. The bridge performance management system has evolved over time, starting over a decade ago with the establishment of goals for the percentage of structurally deficient (Poor) bridges and the deployment of a public-facing dashboard.

As VDOT attained its targets for reducing structurally deficient bridges, they were incrementally tightened to create higher standards. Later, these targets were supplemented by system preservation goals and recommended best practices for system preservation, all of which are published in the *Manual of the Structure and Bridge Division*. Some of the performance measures were based on judgment, and others were the product of performance modeling and system-level life-cycle analysis. However, VDOT had not conducted a single, systematic, long-term evaluation of its network to predict future conditions based on various funding and treatment scenarios. That changed in 2019 when VDOT completed its *Comprehensive Review*.

Optimizing Investment and Treatment Strategies for Long-Term Sustainability

The *Comprehensive Review* was an exhaustive, scenario-driven, long-term evaluation of existing assets. Bridge conditions were analyzed for a 50-year horizon using different funding levels and treatment models. The effort sought to answer the following questions for each highway system (interstate, primary, and secondary):

1. What is an acceptable level of service for VDOT's bridges?
2. What is the most appropriate balance of treatment methods (preventive, restorative, rehabilitative, replacement) to maximize the value of available funds?
3. How much funding is required to sustain the inventory at the acceptable level of service as determined in question #1 by deploying the balance of treatments established through question #2?

The effort began with an investigation to determine the most appropriate basis for measuring bridge performance, which was conducted by a committee of subject matter experts. The traditional approach of focusing on the percentage of structurally deficient bridges, while effective in leading to fewer Poor bridges, also led to a "worst first" approach directing most of the resources to the most deteriorated (and expensive to treat) bridges. After evaluating a full range of possible methods for measuring bridge performance, including practices used in other states, the committee recommended using the average GCR, weighted by the importance of each bridge, as the primary performance measurement for evaluating bridge condition. The committee also recommended the establishment of minimum thresholds for the percentage of bridges in Good or Fair condition (not Poor) by highway system.

The committee produced the following high-level findings:

1. **Required Level of Service** (Performance Measures and Targets):
    a. An acceptable level of service for VDOT's bridges is an average GCR of 5.6, weighted by the importance of each bridge. However, this must be accompanied by stability in the rate of bridge deterioration by the deployment of materials and actions that slow bridge deterioration.
    b. Minimum thresholds for the percentage of bridges on each highway system in Good or Fair condition (not Poor/SD) are required.
    c. The interstate system should have no structures posted for load.

2. **Investment Strategies**. Following consideration of a range of approaches, available bridge funding should be invested so that approximately 25% of funds are applied to replacement and the remainder are applied to preserving existing bridges through rehabilitation, restoration, and preventive maintenance.

3. **Funding Needs**. Combined bridge funding from the Highway Maintenance and Operations Program and the State of Good Repair Program ($384 million, not including needs for inspections, emergencies, and routine maintenance) is adequate to sustain the bridge inventory to an adequate level of service for approximately 50 years, as long as the investment philosophy described in item #2 above is applied immediately and adjustments for inflation are made over time. This would require the following actions:
    a. Sustained commitment to continue funding at current levels
    b. A change to the state law that currently limits State of Good Repair (SGR) Program bridge funding to structurally deficient bridges (*Code of Virginia § 33.2-369*)

    If the legal and regulatory changes are not enacted, an additional $122 million per year is required to sustain the inventory at an acceptable level of service.

Figure 6 through **Figure 8** illustrate the recent performance and models' predicted outcomes for each highway system based on the funding indicated. Future performance is shown for both average weighted GCR and percentage of bridges in Good or Fair condition. Two scenarios are shown for each system: the dashed green lines represent the proposed preservation philosophy, and the orange lines represent the current, or replacement emphasis, approach. The figures reflect performance for all bridges in the inventory (including non-NHS and non-NBI).

Figure 6. 50-Year Outlook for Interstate System: Predicted Performance for Preservation-First vs. Replacement-Emphasis Investment Strategies

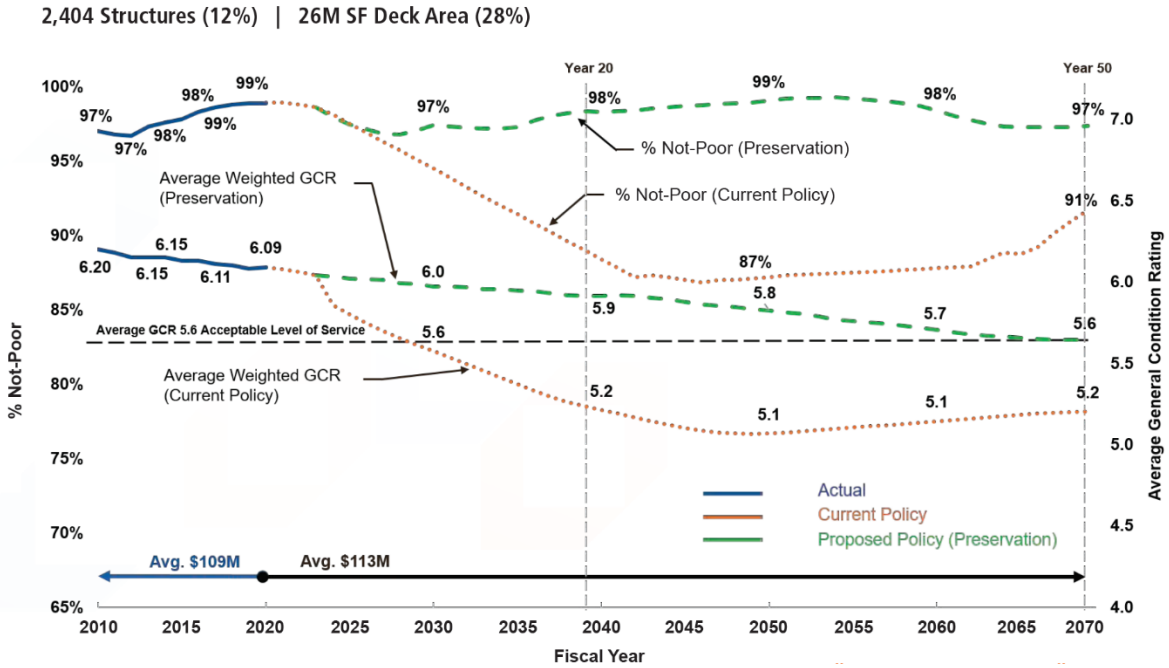


Figure 7. 50-Year Outlook for Primary System: Predicted Performance for Preservation-First vs. Replacement-Emphasis Investment Strategies

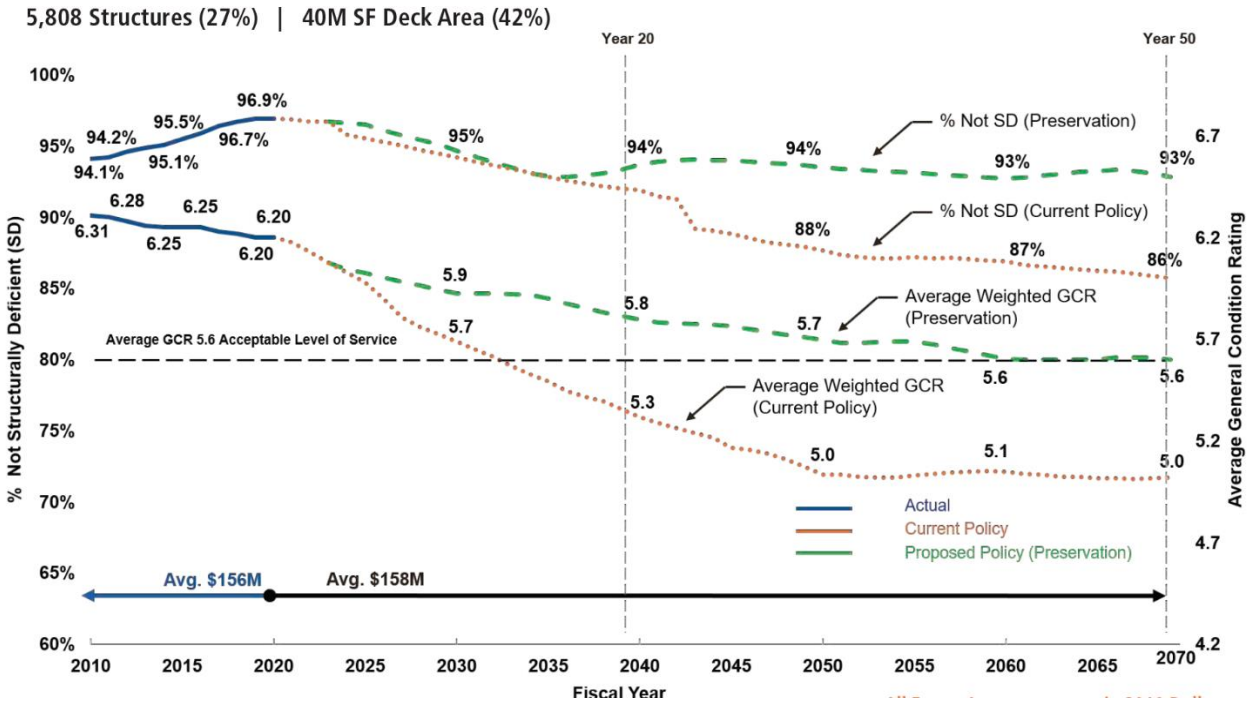
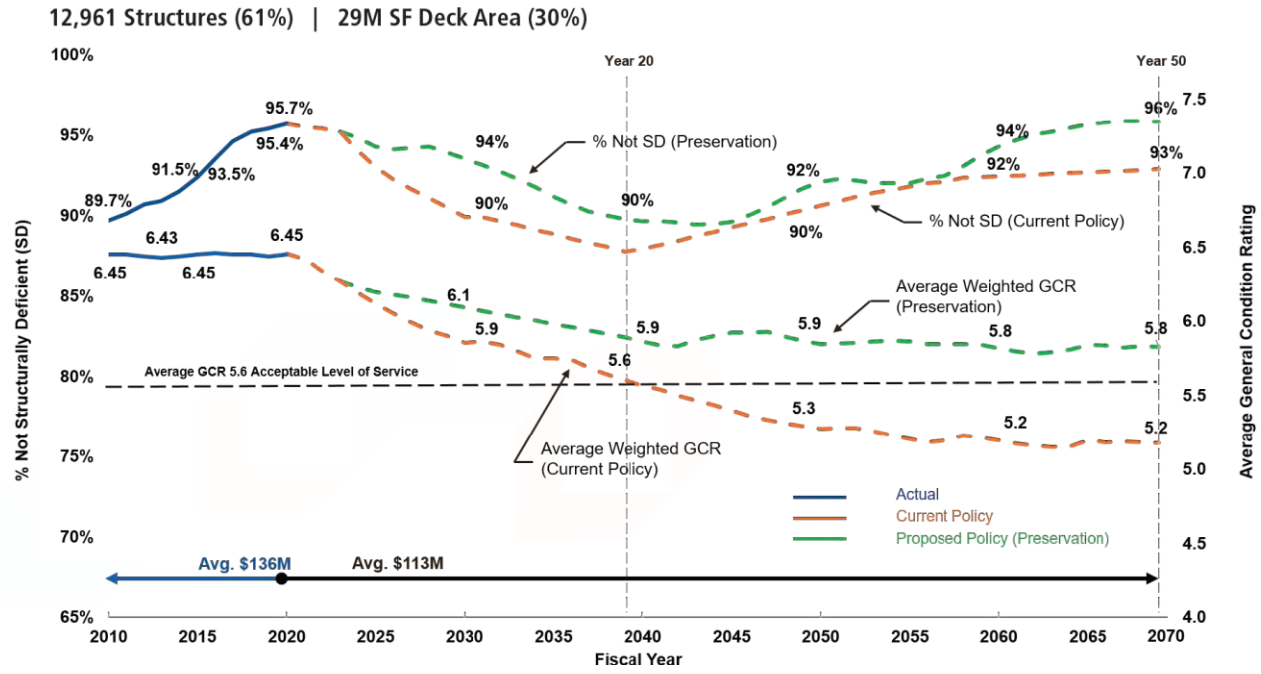


Figure 8. 50-Year Outlook for Secondary System: Predicted Performance for Preservation-First vs. Replacement-Emphasis Investment Strategies



VDOT has incorporated several of the recommendations from the *Comprehensive Review* into its practices, including adoption of the recommended performance measures by the Board's December 2019 resolution[14] and revised guidance emphasizing preservation.

However, a change to the eligibility requirements in the *Code of Virginia* for SGR, is still needed.

[14] http://www.ctb.virginia.gov/resources/2019/dec/reso/9.pdf

STATE OF GOOD REPAIR

Table 12 summarizes the VDOT State of Good Repair performance targets for the NHS. The State of Good Repair target has been calculated to represent the NHS equivalent to the Board approved targets for the broader VDOT system and converting to the FHWA performance metrics. These targets are the long-term performance targets that VDOT will work to achieve or exceed.

Table 12: State of Good Repair Performance Target Definitions for the NHS

	NHS State of Good Repair Target FHWA Measure		Federal Minimum
Pavements	Interstate NHS	% Good ≥ 45%	-
		% Poor < 3%	% Poor < 5%
	Non-Interstate NHS	% Good ≥ 25%	-
		% Poor < 5%	% Poor < 5%
Bridges	% Poor < 5%		- % Poor < 10%

4. LIFE CYCLE PLANNING

Sound asset management requires strategic investment decisions over the full life cycle of an asset. These decisions should be made within the context of network-level investment strategies intended to optimize available funding to meet network performance goals. FHWA calls this approach to asset investment Life-Cycle Planning (LCP).

In the context of the efficient management of a large network of highway assets, LCP should emphasize the preservation of assets in Good condition to efficiently extend the life of assets and delay costly rehabilitation and reconstruction activities. However, rehabilitation and reconstruction must be a part of any long-term life-cycle plan because preservation cannot extend the life of an asset indefinitely. The *Comprehensive Review* used network-level LCP analysis as a basis for sustainable long-term investment strategies.

The following sections describe the LCP processes undertaken by VDOT to ensure an optimized approach to treatment decision-making.

PAVEMENTS – LIFE CYCLE PLANNING

The State of the Pavement document describes the life cycle planning and implementation processes for which pavement data and systems are used:

- **Pavement Needs Analysis** – Annual network level life cycle analysis to assess optimized funding needs.
- **Planning for Preventive Maintenance and Resurfacing** – Process for selecting projects based on condition data, analysis and engineering input.
- **Pavement Performance Reporting** – Public (dashboard) and legislative reporting.
- **Federal HPMS Reporting** – For submission to FHWA.
- **Research Needs** – To better understand different pavement treatment strategies and optimize pavement life with available resources.

Pavement Management System

In 2010, VDOT implemented the Agile Assets Pavement Analyst software as VDOT's Pavement Management System (PMS). This system holds pavement inventory, condition, and maintenance history and is the official repository for other pavement-related data including type, surface and subsurface layer thicknesses, materials and construction dates, historical inspection data (distress, roughness, and rutting), historical testing data (deflection), and treatment history (type of treatment, location, and date). The PMS provides a wide array of decision-making tools; including pavement needs optimization and performance setting analysis, deterioration model development and condition forecasting, unconstrained decision matrix analysis, and reporting.

The Pavement Maintenance Scheduling System (PMSS) is a second application utilized. It provides the ability to establish annual paving schedules and to develop reports based on contract details. The tool is used to schedule paving activities and develop annual pavement maintenance and rehabilitation contracts, review scheduled paving activities, and review reports on planned contracts. The application can also generate reports on the scope of projects, quantities of materials, types of materials, and cost of materials.

VDOT's PMS meets the requirements of 23 C.F.R. § 515.17.

VDOT Pavement Maintenance Treatment Activities and FHWA Work Types

VDOT categorizes pavement maintenance work into five maintenance activity categories: "Do Nothing", "Preventative Maintenance", "Corrective Maintenance", "Restorative Maintenance", and "Rehabilitation / Reconstruction".

- **"Do Nothing" (DN)** is an important treatment activity category because it is often necessary to defer potential maintenance in the context of limited pavement TAM funding and the wide-ranging needs of the pavement network.
- **"Preventative Maintenance" (PM)** is characterized by low-cost maintenance interventions ranging from minor patching and crack sealing activities to thin hot mix asphalt concrete overlays (typically <1" in depth).
- **"Corrective Maintenance" (CM)** is another commonly used pavement preservation technique. CM typically involves 1.5" to 2" asphalt concrete overlays (with or without milling) or partial depth patching.
- **"Restorative Maintenance" (RM)** is typically employed when pavement distress has reached a point where a structural intervention is required. A typical RM treatment can involve a two-lift asphalt overlay (with or without milling) or full depth pavement patching.
- **"Major Rehabilitation" or "Reconstruction" (RC)** is typically reserved for pavements nearing the end of their useful life.

Typical costs of each treatment category are provided in **Table 13**. Cost information is gathered on an annual basis through review of the last two years of contract bid history. Typical life-cycle extensions and modeled CCI improvements were developed through detailed analysis of years of work history and pavement condition data collection.

Table 13 links the VDOT treatment types to the FHWA Work Types that are presented in the investment strategy section and will be reported through the consistency determination process.

Table 13: Pavement Maintenance Treatment Categories and FHWA Work Types

FHWA Work Types	VDOT Definition	Typical Cost per Lane Mile
Initial Construction		$1M - $1.1M
Reconstruction	"Major Rehabilitation" or "Reconstruction" (RC). See definition above.	$720k – 1.1M
Rehabilitation	"Restorative Maintenance" (RM), and a portion of "Corrective Maintenance" (CM) on heavily distressed pavements	$90k - $440k
Preservation and Maintenance	Preventative Maintenance" (PM), and a portion of "Corrective Maintenance" (CM) on lightly distressed pavements	$30k - $250k

BRIDGES – LIFE CYCLE PLANNING

VDOT's bridge management system has been developed to optimize the life-cycle value of bridge interventions, with an emphasis on long-term investment value over short-term gains. VDOT uses the condition data discussed previously, along with modeling systems that incorporate treatment cost, deterioration rates, and action-effectiveness predictions to determine recommended treatment activities for each bridge. The following section details maintenance treatment activities, maintenance treatment selection strategies, deterioration modeling, and analysis approach.

Bridge Management System

This section provides a high-level summary of VDOT's bridge management system. VDOT developed its bridge management system (BMS) over the course of many years to optimize the performance of its inventory. Its BMS emphasizes long-term investment value over short-term gains. By evaluating current and future conditions, life-cycle value, resiliency, functionality, risk probability, and risk consequence, VDOT directs its program at the system level and on an individual bridge basis to maximize the use of available funding for network sustainability.

Although bridge management systems can be defined in narrow terms by the software program(s) used, VDOT takes a much broader view of its BMS. For VDOT, software is only a single component of a system developed to optimize network performance. VDOT's BMS is a comprehensive bridge management methodology that incorporates modeling tools, dedicated funding pools, strategic delivery methods, performance management, the aggressive implementation of research, and design guidance based in risk minimization and life-cycle optimization. Taken together, these elements form VDOT's BMS, which allows it to manage its bridge inventory.

VDOT's BMS meets the requirements of 23 C.F.R. § 515.17. Its most significant components are listed below:

- **A suite of modeling tools**. These include the AASHTO bridge management software (BrM) and a set of more directed, internally developed software tools that incorporate the same bridge management principles. These tools are used to model and optimize performance both for individual bridges and for large populations of bridges. The modeling tools evaluate both GCR and AASHTO elements to predict near and long-term (future) performance. Some of the more important components of these tools include:
    - A set of Markovian deterioration models based on transition probabilities
    - A health index that correlates bridge condition to current bridge valuation and deterioration
    - A set of action-effectiveness models
    - Unit cost data
    - A set of rational, heuristic rules to incorporate human reasoning into the work recommendation process
    - Multivariable prioritization formulas for selecting bridge projects. The formulas optimize the utility of bridge projects by using objectively collected condition and inventory data to assess risk and life cycle value while weighing condition, functionality, and importance.
- **Strategic methods for delivering the program**. These include statewide and regional contracts for painting, on-call maintenance, and engineering consultants.
- **Performance management**. VDOT set goals and tracks progress using performance targets and regular reporting, including dashboards and the annual State of the Structures and Bridges Report.
- **Systematic methods for conducting applied research and implementing its recommendations**. Working through the Virginia Transportation Research Council and its research advisory committees, VDOT conducts innovative research. The most promising research is deployed through a critical fund dedicated solely to practical implementation.

- **Design Guidance**. VDOT's *Manual of the Structure and Bridge Division*[15] *(Manual)* and *Policy Memoranda*[16] use risk mitigation strategies and employ life-cycle principles to direct its design, construction, and maintenance programs. *Chapter 32*[17] of the *Manual* specifically addresses maintenance. The guidance requires best practices that have been demonstrated to provide the best life-cycle value; even if first costs are higher (examples include corrosion-resistant materials and jointless construction).

Bridge Maintenance Treatment Activities and FHWA Work Types

VDOT's *Manual* categorizes bridge maintenance into four maintenance activity categories: Preventive Maintenance (including planned and condition-based preventive maintenance), Restorative Maintenance, Rehabilitative Maintenance, and Replacement. The full definitions are found in Chapter 32 of the *Manual*, but abbreviated descriptions that generally align with FHWA's Bridge Preservation Guide are as follows:

- **Preventive Maintenance** is characterized by low-cost maintenance treatments, including joint repair/elimination, waterproofing, washing, sweeping, vegetation/sediment removal, lubrication, and spot/zone painting. It can be condition-based or planned. Generally performed on bridges in good or fair condition.
- **Restorative Maintenance** treatments include overlays, patching, substructure repair, and beam repair
- **Rehabilitative Maintenance** is used when considerable intervention is needed to extend the life of a bridge. It may include, but is not limited to, replacement of major components such as the superstructure or the deck.
- **Replacement** is a full bridge (or culvert) replacement.

Treatment costs are established using VDOT bid tabulations and are updated on a regular basis. Bid tabulations are the prices submitted by contractors when they bid on work for VDOT, and each price is recorded in a database with the detailed work item.

Table 14 summarizes typical bridge treatment categories and their average unit costs and links the FHWA work types that have been used in the investment strategy and will be reported through the consistency determination process.

Table 14: Bridge Maintenance Treatment Costs for Various Work Types

FHWA Work Types	VDOT Definition	Typical Ranges Cost Per Square Foot*
Initial Construction	"Replacement" see definition above.	$1,110
Reconstruction	"Replacement"	$1,110
Rehabilitation	"Rehabilitation"	$104 - $174
Preservation	"Preservation" with the exception that all coatings are included	$70 - $90
Maintenance	Routine and unplanned maintenance including patching and spot repairs	$3

*Costs provided are for an entire project, including all necessary phases to complete the work, such as right-of-way, preliminary engineering, construction inspection, utilities, approach roadway tie-ins, and maintenance and protection of traffic. Replacement costs exhibit a broad range, depending on project complexity. The values indicated represent a conservative average project cost for Virginia's bridges. Note that "bridge only" costs for specific bridge construction items investigated by FHWA were approximately $280/SF in Federal Fiscal Year 2020.

[15] http://www.virginiadot.org/business/bridge-manuals.asp
[16] http://www.virginiadot.org/business/resources/bridge/Manuals/IIM/SBIIM.pdf
[17] http://www.virginiadot.org/business/resources/bridge/Manuals/Part2/Chapter32.pdf

Although VDOT is decentralized and districts have the flexibility to adjust spending priorities as necessary, internal guidance provides suggested spending priorities by maintenance category as follows: Preventive Maintenance (25%), Restorative Maintenance in conjunction with system preservation (50%), and Rehabilitation and Structure Replacement (25%).

Life Cycle Planning Implementation

To understand the system-level needs of its bridges, each structure within Virginia's network is analyzed to establish an unconstrained treatment recommendation. This analysis is termed the "unconstrained needs analysis" because it provides a treatment recommendation for each bridge in the network regardless of available funding. As projects develop, more detailed information is added to the system-level findings of the unconstrained needs analysis to select the best scope of work.

VDOT categorizes bridges by condition in order to direct its program and evaluation efforts most effectively. The Poor/SD condition category receives a significant amount of attention and funding due to the advanced state of deterioration experienced by these bridges. VDOT uses a multi-objective prioritization formula to prioritize structurally deficient NBI bridges (discussed in more detail in Chapter 7 [Risk]).

VDOT will continue to use life-cycle principles as the primary basis for its bridge management program. Chapter 32 of VDOT'S *Manual* establishes requirements for life-cycle analysis for bridge rehabilitation and replacement projects. In addition to these provisions, VDOT's *Manual* and its *2020 Road and Bridge Specifications*[18] have incorporated a life-cycle cost approach to the provisions for materials and construction details. Rather than require a life-cycle analysis on each individual project, parametric life-cycle analyses were performed for particular technological advances prior to their adoption in VDOT's standards. Each of the requirements listed below was implemented after VDOT determined that it would improve the life-cycle investment for Virginia's bridges:

- Corrosion-resistant reinforcement in all new concrete bridge decks (which limits corrosion and the associated concrete deterioration)
- High performance concrete in all new bridge components
- Low cracking deck concrete
- Jointless bridges
- Carbon fiber and stainless steel pre-stressing strands

Virginia has chosen to proactively implement actions that will result in the best life-cycle investment rather than reevaluate such decisions on each project. If a treatment or material is known to reduce life-cycle costs, it becomes a requirement for all projects for which it will produce the best investment of public funds. In each of the above examples, a small incremental increase in the initial cost reaps decades of additional service life.

Virginia has been widely recognized as a leader in the development and successful implementation of new technologies, techniques, and materials for use in new and existing bridges. VDOT has used this history of innovation to make the Commonwealth's bridges more durable, safer, and less expensive to build. Many elements contribute to this success. Two of the most prominent elements are:

- **The Virginia Transportation Research Council (VTRC):** This organization works with VDOT's Structure and Bridge Division, the Materials Division, and the nine districts to solve problems in the most practical manner. The results are extraordinary. This organization conducts semiannual meetings of its research advisory committees, in which subject matter experts evaluate new technologies, recommend further research, and develop strategies for cost-effective implementation of those technologies.
- **Collaboration:** VDOT, Virginia's localities, and many of the state's universities work together to perform solution-driven research. There are nine "Research Advisory Committees" that hold semi-annual meetings, bringing together the users and developers of technology to help keep the research focused and progressing. This cooperation keeps Virginia on the cutting edge of bridge technology.

[18] http://www.virginiadot.org/business/resources/const/VDOT_2020_RB_Specs.pdf

5. FINANCIAL PLAN

All states must work within a constrained budget when developing their asset management approach. It is critical to know the sources of funds for maintenance activities and the need for those funds for each asset. These inputs allow the management systems to maximize the program that can be delivered.

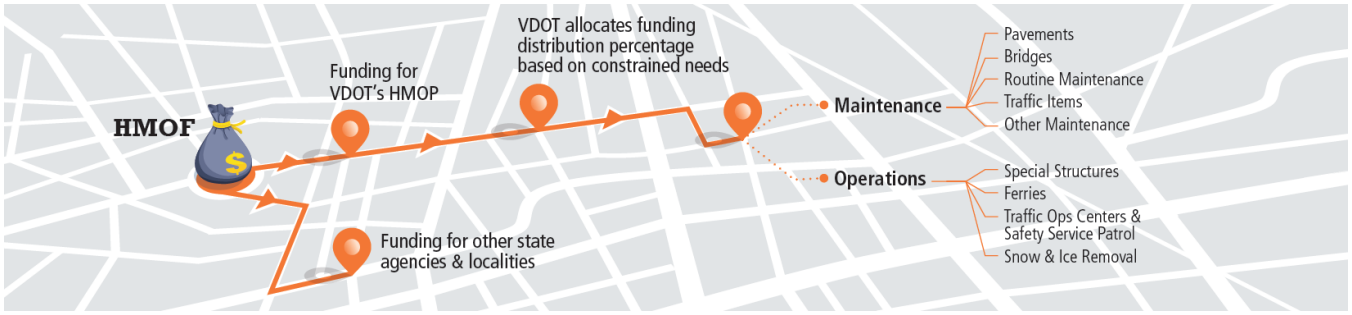
FUNDING SOURCES AND PROCESS

The four key sources of funding for pavements and bridges on the NHS are described in the following sections.

Highway Maintenance and Operating Fund (HMOF)

VDOT, localities, and other state agencies receive payments from the Highway Maintenance and Operating Fund (HMOF). The method used to compute the amount each locality is paid is established by statute. Funds from the HMOF support VDOT's Highway Maintenance and Operations Program (HMOP) for the agency's maintenance, operations, and services (**Figure 9**).

Figure 9. HMOF Funding Allocation Methodology



Once VDOT receives the HMOP distribution, funding is allocated statewide based on needs assessments. These needs assessments are discussed further within the Biennial Report.

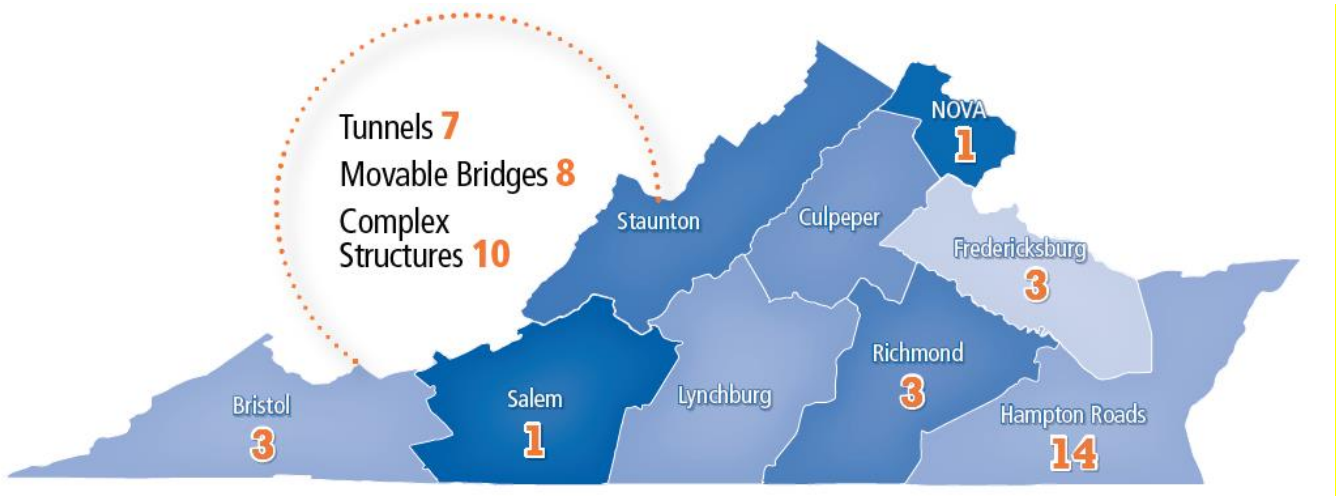
State of Good Repair Program

The State of Good Repair Program is dedicated to VDOT and locality deteriorated pavements and structurally deficient bridges. The process for needs assessment, and distribution of these funds, is described within the *Biennial Report*.

Special Structures Fund

VDOT's assets include 25 Special Structures that are tunnels, movable bridges, and complex structures (**Figure 10**). These structures are considered "special" due to their complexity, maintenance and operations cost, level of risk, and importance. Determination of importance is based on factors including potential long detours, high traffic, economic significance (shipping and vehicular), and access to vital facilities including military facilities and ports.

Figure 10. Locations of VDOT Special Structures



Special Structures have been the subject of a series of concerted efforts and reports over the past several years. VDOT's business plans have included provisions for the study, prioritization, risk assessment, and needs determinations for the Special Structures.

Through the *Comprehensive Review,* VDOT developed the 2019 50-Year Long-Term Plan with a view to inform the development of a Special Structure Fund as defined by § 33.2-1532 of the *Code of Virginia*, known as the Special Structure Fund. The fund was created for the maintenance and replacement of Special Structures (unique structures), as determined by the Commonwealth Transportation Board.

Special Structures are considered separately from other bridges, with a dedicated funding source. Of the 25 Special Structures, 13 are bridges on the NHS (as listed in **Table 15**).

Table 15: VDOT Special Structures on the NHS

Category	Special Structure on NHS
Complex Structure	460 Connector
Complex Structure	High Rise Bridge Approaches
Complex Structure	HRBT Bridge Approaches
Complex Structure	James River Bridge Approaches
Complex Structure	MMBT Approach-North
Complex Structure	MMBT Approach-South
Complex Structure	Varina-Enon
Complex Structure	Willoughby Bay
Movable Bridge	Berkley
Movable Bridge	Coleman
Movable Bridge	Eltham
Movable Bridge	High Rise
Movable Bridge	James River Bridge

Considering Initial Construction

New construction undertaken to improve mobility or safety (not primarily for reasons of asset management) can affect pavements and bridges in two ways:

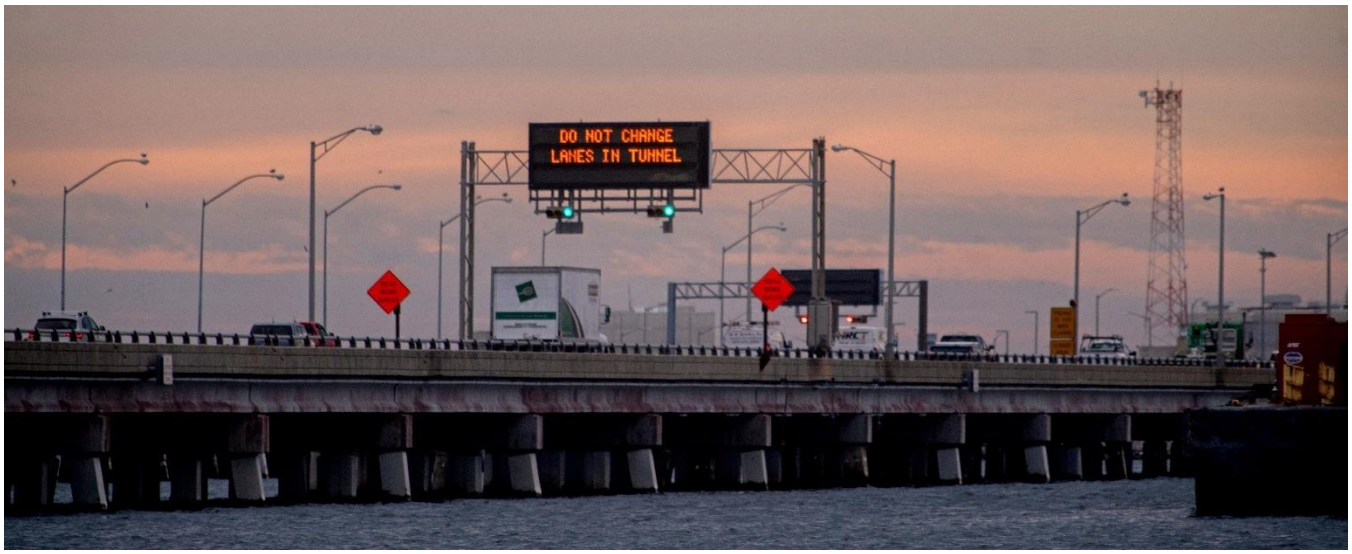
1. Additional Investment – some new construction projects will improve existing pavements or bridges as part of these projects.

2. Additional Assets – some will add additional pavement or bridge assets that must be managed.

In most instances, item 2 will have relatively minimal needs relative to the remainder of the network. New assets are considered in the VDOT optimization process for pavement (e.g., I-64 additional general-purpose lanes) and bridges (e.g., the Hampton Roads Bridge Tunnel Expansion Project).

The Hampton Roads Bridge Tunnel (HRBT) Expansion Project[19] is the largest construction project in Virginia's history and includes construction of a new tunnel. Although tunnel structures are not included within this TAMP, VDOT considers the new HRBT as part of its 50-Year Special Structures Plan.

VDOT is working to improve the process to understand the contribution item 1 above (additional investment) makes to improve performance. The pavement program considers planned work on existing pavement when undertaking needs analysis through the PMS.



[19] https://hrbtexpansion.org/

VDOT 10-YEAR FINANCIAL PLAN

Table 16 through **Table 18** provide the total predicted funding available for pavements and bridges across the NHS from the funding sources mentioned in the previous section.

Table 16: VDOT Pavements 10-Year Financial Plan ($M)

	FY 21	FY 22	FY 23	FY 24	FY 25	FY 26	FY 27	FY 28	FY 29	FY 30
Interstate NHS	*$173*	*$339*	*$108*	*$91*	*$130*	*$139*	*$158*	*$111*	*$111*	*$168*
Non-Interstate NHS	*$126*	*$136*	*$161*	*$121*	*$136*	*$119*	*$137*	*$190*	*$113*	*$113*

Table 17: VDOT Bridges (excluding Special Structures) 10-Year Financial Plan ($M)

	FY 21	FY 22	FY 23	FY 24	FY 25	FY 26	FY 27	FY 28	FY 29	FY 30
NHS	*$181*	*$183*	*$215*	*$274*	*$262*	*$257*	*$224*	*$203*	*$204*	*$226*

Table 18: VDOT Special Structure Bridges on the NHS 10-Year Financial Plan ($M)

	FY 21	FY 22	FY 23	FY 24	FY 25	FY 26	FY 27	FY 28	FY 29	FY 30
Special Structures	*$11.7*	*$19*	*$40*	*$41*	*$57*	*$66*	*$79*	*$39*	*$29*	*$30*

6. INVESTMENT STRATEGIES

The *Comprehensive Review* looked at a range of different investment strategies for both pavements and bridges as described in Chapter 3.

The following sections identify the planned investment strategies for the NHS.

PAVEMENTS – INVESTMENT STRATEGY

The *Comprehensive Review* process identified new performance targets for much of the VDOT network but not specifically for NHS pavements. It will, however, require a revised investment strategy that reduces the condition of NHS pavements that are currently exceeding the performance targets.

As mentioned in Chapter 5, the initial construction costs included here are a summary of the improvements expected to be made through construction projects on existing pavements. This dollar value was calculated based on the planned lane miles to be treated and the cost of that treatment as shown in **Table 19**.

Table 19: Proposed NHS Pavement Investment Strategy ($M).

		CY 21	**CY 22**	**CY 23**	**CY 24**	**CY 25**	**CY 26**	**CY 27**	**CY 28**	**CY 29**	**CY 30**
Interstate NHS		*$173*	*$339*	*$108*	*$91*	*$130*	*$139*	*$158*	*$111*	*$111*	*$168*
	Initial Construction	$85	$251	$20	$3	$42	$28	$47	--	--	$57
	Reconstruction	$4	$4	$4	$4	$4	$6	$6	$6	$6	$6
	Rehabilitation	$63	$63	$63	$63	$63	$79	$79	$79	$79	$79
	Preservation and Maintenance	$21	$21	$21	$21	$21	$26	$26	$26	$26	$26
Non-Interstate NHS		CY 21	CY 22	CY 23	CY 24	CY 25	CY 26	CY 27	CY 28	CY 29	CY 30
		$126	*$136*	*$161*	*$121*	*$136*	*$119*	*$137*	*$190*	*$113M*	*$113*
	Initial Construction	$34	$44	$69	$29	$44	$6	$24	$77	$7	--
	Reconstruction	$5	$5	$5	$5	$5	$6	$6	$6	$6	$6
	Rehabilitation	$57	$57	$57	$57	$57	$70	$70	$70	$70	$70
	Preservation and Maintenance	$30	$30	$30	$30	$30	$37	$37	$37	$37	$37

BRIDGES – INVESTMENT STRATEGY

At present, VDOT investment strategies are aligned with the current SGR legislation requirements. The proposed VDOT investment strategy is provided in **Table 20**. It does not include special structures, which are addressed in **Table 21**.

Table 20: Proposed NHS Bridge Investment Strategy *($M, Excluding Special Structures)*

Anticipated Investment for NBI Bridges by Work Type											
	Work Type	**FY 21**	**FY 22**	**FY 23**	**FY 24**	**FY 25**	**FY 26**	**FY 27**	**FY 28**	**FY 29**	**FY 30**
NHS	**Initial Construction**	$3	$3	$3	$3	$3	$3	$3	$3	$3	$3
	Reconstruction	$100	$101	$101	$156	$128	$101	$101	$101	$101	$101
	Rehabilitation	$37	$38	$67	$63	$70	$68	$51	$57	$55	$67
	Preservation	$13	$14	$14	$14	$14	$14	$14	$14	$14	$14
	Maintenance	$28	$27	$30	$38	$47	$71	$55	$28	$31	$41
	TOTAL	*$181*	*$183*	*$215*	*$274*	*$262*	*$257*	*$224*	*$203*	*$204*	*$226*

Additional funding is available through the Special Structures Fund. The Special Structures program utilizes alternative work types that are described in **Table 21**. Within the table these are also aligned to the FHWA work types.

Table 21: Proposed NHS Bridge Investment Strategy for Special Structures ($M).

	Anticipated Investment for Special Structures by Work Type											
NHS – Special Structures	**Work Type**	**VDOT Special Structures Work Type**	**FY 21**	**FY 22**	**FY 23**	**FY 24**	**FY 25**	**FY 26**	**FY 27**	**FY 28**	**FY 29**	**FY 30**
	Initial Construction	**New Structure Construction**	-	-	-	-	-	-	-	-	-	-
	Reconstruction	**Structure Replacement**	-	-	-	-	-	-	-	-	-	-
	Rehabilitation	**Component Replacement**	$0.2	$8	$21	$26	$23	$21	$50	$23	$18	$21
	Preservation and Maintenance	**Prioritized Maintenance**	$0.5	$1	$9	$7	$15	$27	$9	$8	$5	$1
		Routine Maintenance	$11	$10	$10	$8	$19	$18	$20	$8	$6	$8
	TOTAL		*$11.7*	*$19*	*$40*	*$41*	*$57*	*$66*	*$79*	*$39*	*$29*	*$30*

7. RISK MANAGEMENT

Virginia's extensive network of highway assets must be maintained within a constrained budget. Making the best use of each maintenance dollar has compelled VDOT to assess risk from the perspective of individual assets and entire systems, such as strategically important high-demand travel networks. Environmental, weather, financial, and other risks are also considered as they can have dramatic impacts to achieving and sustaining VDOT asset performance for pavements and bridges. Although VDOT does not have a formal enterprise risk management program, it does rely on individual programs to effectively manage high-priority risks in their areas.

Risk Management Approach

Table 22 sets out the VDOT TAMP risk management process. Risks identified and managed through this process are discussed in the following sections.

Table 22: VDOT TAMP Risk Management Approach

<table>
<tr><th>Steps in the Risk Management Process</th><th>VDOT TAMP Risk Management Approach</th></tr>
<tr><td rowspan="4"> 
</td><td>The TAMP risk process covers the programs and processes that VDOT currently has in place to manage the mitigation of risks to the pavement and bridge assets. This chapter does not attempt to address project-level risk management processes, which are long established, and commonplace among DOTs and other large U.S. transportation asset owners.</td></tr>
<tr><td>Risks are identified with input from representatives across VDOT divisions, including asset management, structure and bridge, maintenance (including pavement management), and Office of Intermodal Planning and Investment (external to VDOT).</td></tr>
<tr><td>Risks are evaluated by likelihood of occurrence and severity of consequence and are prioritized accordingly.
Risk Matrix Defining Risk Priority
<table>
<tr><td></td><td></td><td colspan="3">Likelihood</td></tr>
<tr><td></td><td></td><td>Low</td><td>Medium</td><td>High</td></tr>
<tr><td rowspan="3">Consequence</td><td>Low</td><td>Low</td><td>Low</td><td>Med</td></tr>
<tr><td>Medium</td><td>Low</td><td>Med</td><td>High</td></tr>
<tr><td>High</td><td>Med</td><td>High</td><td>V. High</td></tr>
</table></td></tr>
<tr><td>VDOT's pavement, bridge, and financial program areas are encouraged to develop a formal approach to address high-priority risks.</td></tr>
</table>

PAVEMENT RISK MANAGEMENT

VDOT's pavement management program is responsible for identifying, evaluating, and managing programmatic risks to achievement of VDOT pavement performance goals. The pavement management program is supported by dedicated pavement management staff in the field, and the Pavement Management System, which has been in place for over 10 years and in use at all levels of the agency. The maturity of these programs, in itself, is significant risk mitigation, as most key areas are well managed through established processes and procedures.

Presented in **Table 23** is VDOT Pavement Management's evaluation of the primary risk areas within their program.

Table 23: Pavement Management Risk Register

Risk	Likelihood	Consequence	Priority	Management Approach
Data Collection Quality If pavement surface condition data quality is not maintained, network-level pavement management decision support tools may no longer function as intended. This may result in poor investment decisions and a lack of field trust in network-level investment recommendations, jeopardizing VDOT's ability to efficiently meet pavement performance expectations.	Low Based on current quality management program.	High Could impact effectiveness of program given the extent that network-level investment strategies are integrated with project-level decision making and stakeholder communication.	Med	To adequately manage pavement data collection quality, VDOT has established rigorous, documented requirements for equipment and data processing quality control for the data collection contractor. VDOT has also engaged the services of an independent, third-party contractor to perform a 10% quality assurance review of automated data collection. This review is based on a manual distress rating of pavement imagery. In addition, VDOT performs a final review on all data collection based on past performance, flagging instances where pavement ratings are not consistent with expected deterioration and known work history.
District Project Selection Alignment with Network-Level Investment Strategy If network-level pavement investment strategy is not integrated with District project-level decision making, District project selection may not align with an optimal mix of pavement TAM treatments to achieve agency goals.	Low Based on established performance-monitoring program.	High Sub-optimal project-level investment may jeopardize the ability of VDOT to effectively manage pavement performance expectations with its available budget.	Med	VDOT has implemented a pavement performance monitoring process that involves routine comparison of District-planned projects and actual work accomplishments against network treatment selection and performance goals, including quarterly reviews with executive management. This approach confirms that, not only is the proper "mix of fixes" selected in each District, but also that those treatment selections are appropriate to the pavement section. Section-specific validation of treatment selection is based on current surface condition and structural integrity as well as available traffic and construction history information. In addition, this process encourages feedback from District pavement managers to improve network-level decision support tools.

Risk	Likelihood	Consequence	Priority	Management Approach
Field Collection and Review of Planned and Actual Work Accomplishments. If VDOT field forces cannot accurately and timely collect planned and actual work accomplishment information, field forces may not be able to adjust investment plans to ensure achievement of performance goals, nor may central office staff have the quality information necessary to develop and update network-level pavement decision-support tools. Lack of efficient support tools may also result in inefficiency that may increase workload or decrease productivity of pavement management staff.	Med Without continued development and implementation of mobile data collection tools and other field decision support and data collection applications, VDOT staff are likely to struggle with traditional pen-and-paper data collection and reporting approaches.	Med Without the ability to conveniently review planned work information, District staff may struggle to develop work plans that effectively meet agency investment strategy, and central office staff may lack information necessary to effectively manage program goals.	Med	VDOT has recognized the value of Geographic Information System (GIS) - based mobile data collection to support the pavement management program. VDOT recently developed an application to link VDOT's pavement project development software with the PMS. This new GIS-based mobile application allows planned project information to be automatically populated for review and validation prior to automated upload into the PMS pavement work history. This approach reduces burdensome pen-and-paper data collection in the field , while improving the accuracy of work accomplishment information. VDOT may continue to pursue innovations of this nature to further improve the pavement TAM program.

Other Risk Areas

Other risk areas have been identified, including the availability of data necessary to support network-level decision-support tools, which must be synced from external systems into the PMS, the potential for regulatory changes that may increase legal limits of truck loads traveling public roadways, and the impact of automated vehicle technology on pavement demands.

Moving forward, VDOT will continue to monitor these and other pavement-related risk areas and manage them as appropriate.

BRIDGE RISK MANAGEMENT

The VDOT structure and bridge management program considers both program and project-level risks. Both use program and project-level require a risk management process to identify, assess, evaluate, and manage risk to inform decisions.

Program Level Bridge Risk Management

Table 24 presents VDOT Structure and Bridge Management's evaluation of the primary risk areas within their program. Risks related to funding consistency are covered in the following section on Financial Risk.

Table 24: Bridge Management Risk Register

Risk	Likelihood	Consequence	Priority	Management Approach
Preservation First - Focus on Cusp Bridges *Opportunity* Currently, the State of Good Repair Program legislation requires that the funding be used only for 'poor' structures (on any systems).	Medium Based on likelihood of legislation changes.	High Potential savings of $122M per year through the move to a preservation approach.	High	In order to execute this change, funding from the State of Good Repair Program would need to be available for work on structures that are well positioned for preservation, repair, and rehabilitation. Specifically, the emphasis going forward should be on preservation of structures that are not yet 'poor' over the partial or full replacement of structures after they become 'poor'.
Special Structures If VDOT were to fall short of its goal to proactively plan for the maintenance, repair, and funding of special structures individually, the results would be risks of service interruptions. The nature of the structures identified requires advanced planning for routing of traffic, ordering unique parts, and hiring contractors with specialized skills.	Medium Most of these assets are old and complex (at risk). Would reduce to Low if funding is provided (expected in FY 2022).	High Special Structures carry high volumes of traffic, have significant detour routes, and/or are critical to emergency response or national security. Lack of timely, proactive maintenance could result in multi-month disruption of service when key components fail.	High	A 50-Year Long Term plan has been developed for each Special Structure, which includes a maintenance plan and associated monetary needs. This plan has been prioritized through an agreed process. §33.2-1532 of the *Code of Virginia*, establishes the Special Structure Fund ("the Fund"). The Fund is for the maintenance, rehabilitation and replacement of Special Structures, as determined by the Board. As performed previously, VDOT may under take urgent tasks for critical items ahead of dedicated funding.
Seismic Vulnerability Virginia experiences an average of one earthquake per month. The largest recorded seismic event in the state was a magnitude 5.8	Low Current management practices have reduced the likelihood of this risk.	High Potential outcomes (disruption and loss of life) are significant.	Med	Virginia has developed a list of seismically vulnerable structures, which is maintained within the bridge management system. This list was reviewed and updated after the significant seismic activity experienced in 2011.

Risk	Likelihood	Consequence	Priority	Management Approach
earthquake in 2011. Depending on the magnitude of a seismic event, bridges may require special attention to ensure the safety of the traveling public.				After significant seismic events, Virginia reviews the locations and magnitudes of ground accelerations and compares this information to the locations of the seismically vulnerable bridges. At that time, determinations are made as to which bridges require special inspections. Any damages noted during special inspections are recorded and included in the list with other maintenance/repair needs. The needed repairs are prioritized according to their importance and severity of damage.
Fracture Critical Bridges Fracture-critical bridges lack redundancy, making them more vulnerable to extreme events such as impact or overloading.	Low Current management practices have reduced the likelihood of this risk.	High Potential outcomes (disruption and loss of life) are significant.	Med	Virginia has set a 15% reduction goal to minimize the number of fracture-critical structures with ADTs in excess of 1,000 in its inventory. Virginia intends to pursue this goal by replacing fracture critical superstructures when practical and minimizing the number of new fracture-critical structures (there are, however, certain new bridge projects where fracture-critical structures are essentially unavoidable). Virginia inventories its fracture-critical structures and tracks its progress toward the reduction goal on a quarterly basis.

Project Specific Bridge Risk Management Approach

Bridge management programs seek to optimize the answers to two questions:

1. Which bridges are selected for treatment?
2. What treatments are most appropriate for the bridges that receive treatment?

Virginia has fully integrated risk-mitigation into its methodology for selecting structures for treatment (question 1) through its use of a prioritization formula. The formula has been formally implemented for structurally deficient bridges in the NBI. The process is conducted using a multi-objective prioritization formula, which weighs the risk elements mentioned above along with other agency priorities.

When selecting the most appropriate treatments (question 2 above), risk mitigation is evaluated along with the many other parameters that engineers must consider when determining project scope. Some risk minimization methods are required by the *Manual of the Structure and Bridge Division*, and some are recommended for adoption by designers as “best practices.”

Considering Risk When Selecting Structures for Treatment

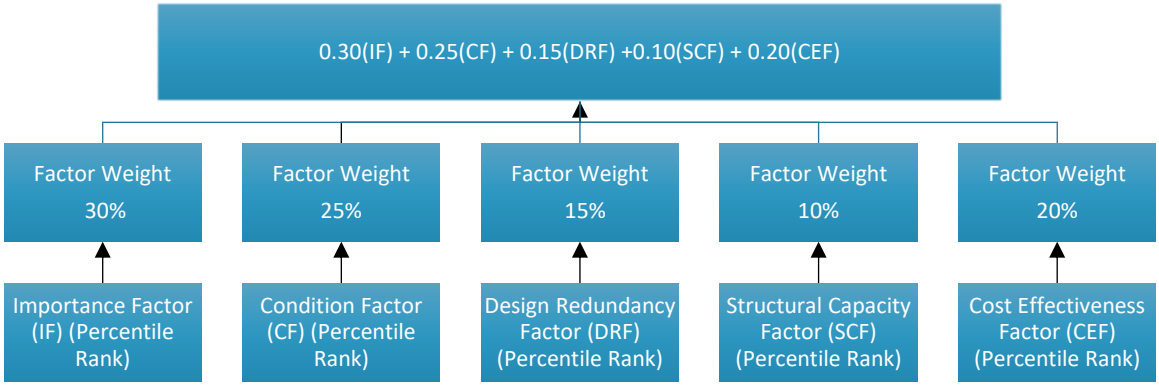
The scoring formula used to select bridges for funding was developed to meet the Board's statutory obligation to develop a "priority ranking system" for NBI SD bridges. The formula is based on five factors: Importance, Condition, Design Redundancy, Structure Capacity, and Cost Effectiveness. Each factor is multiplied by a "weighting" coefficient, and the general form of the equation is:

Priority = a(**IF**) + b(**CF**) + c(**DRF**) + d(**SCF**) + e(**CEF**)

- Max = 1.0 (highest priority); Min = 0.0 (lowest priority)
- where a, b, c, d, e are weighting coefficients and Σ (a, b, c, d, e) = 1.0
- The methodology for computing each of the factors as described in the body of this document.

The formula is based on five unitless factors, each of which may vary from 0.00 to 1.00 (see **Figure 11**).

Figure 11. Multi-Objective Prioritization Formula



IF = Importance Factor - measures the relative importance of each bridge to the overall highway network. Includes subordinate variables that consider Average Daily Traffic (ADT), Future ADT, Truck ADT, Effect of bypass (both distance and number of vehicles affected), Highway System, and Corridors of Statewide Significance.

CF = Condition Factor – measures the overall physical condition of each bridge based on the condition of each individual element.

DRF = Design Redundancy Factor - measures four important risk factors: Fracture Critical (redundancy), Scour Susceptibility, Fatigue, and Earthquake vulnerability.

SCF = Structure Capacity Factor- measures the capacity of the structure to convey traffic, including the effects of weight restrictions, vertical clearance and deck width.

CEF = Cost-Effectiveness Factor - measures the cost-effectiveness of the required work.

The factors only indicate relative significance. For example, a structure with a score of 0.62 is more significant than one with a score of 0.43 for the factor under consideration. Coefficients are selected to prioritize agency goals and may be adjusted in future years by the Board as priorities change. Coefficients currently in use are shown in **Figure 11**.

While the "Design Redundancy" factor is most closely aligned with risk, the other factors, importance (effects to motorists), condition (timeliness of interventions), and structure capacity (safety), also addresses risk and prioritize risk mitigation.

FINANCIAL RISKS

Risks to the TAMP financial plan can influence VDOT's ability to deliver the expected outcome for pavements, bridges, and other parts of the VDOT program. **Table 25** presents the primary risk areas associated with the TAMP financial plan.

Table 25: Financial Management Risk Register

Risk	Likelihood	Consequence	Priority	Management Approach
Emergency Funding Snow removal is an expensive maintenance activity that fluctuates by millions of dollars each budget cycle. Funds for snow removal are a subset of maintenance funding, which also funds pavement and bridge maintenance. If VDOT does not accurately model snow needs, the budget may be diverted from pavement and bridge maintenance, reducing the planned activities for those assets. VDOT must fund snow removal or other weather events regardless of other plans for those funds.	Medium Snow removal and winter weather preparation is funded through the same maintenance and operations budget used to pay for TAM investment. Without a method to proactively plan for snow removal expenditures, VDOT would not be able to confidently plan for TAM activities.	High Funding is already constrained for asset management, so movement of funds from pavement and bridges to snow removal activities has a negative short- and long-term impact on the maintenance program.	High	VDOT has developed a snow model for forecasting snow removal needs to improve the estimates set aside for this maintenance activity. The model combines historical snowfall data, unit cost for labor and equipment for snow removal, lane mileage, daily vehicle miles traveled (DVMT) per lane mile, and topography factors. The output of the snow model provides a snow removal need to allow for effective and proactive budgeting of maintenance funds. To ensure relevance of the model, the effectiveness of previous model predictions are evaluated and adjustments are made.
Special Structures If specific funding is not available through the Special Structure Fund, it may require funds from the Maintenance and Operations budget to be utilized.	Low Funding is expected to commence in FY 2022.	Medium If funding is not available through the Special Structure Fund, then critical work may need to be undertaken from the bridge program. This may reduce the effectiveness of that program.	Low	The Governor's 2020 omnibus bill provided funding for the Special Structures Fund.

23 CFR PART 667 – PERIODIC EVALUATION OF FACILITIES REPEATEDLY REQUIRING REPAIR AND RECONSTRUCTION DUE TO EMERGENCY EVENTS

In 2020, VDOT delivered a revised process to monitor, track, and report facilities repeatedly requiring repair and reconstruction due to emergency events. This process was designed for several purposes:

- Enable rapid reporting of the impact of emergency events.
- Provide the basis for enhancing assets to improve resiliency.
- Assist in meeting the assessment and reporting requirements of 23 CFR Part 667.

The process uses a mobile application for damaged facilities to be identified and the required information recorded (**Figure 12**).

Field data are reviewed and updated. Future modifications plan to include linking reporting to asset tag numbers. All assets damaged during severe weather and other natural disasters are recorded and can be analyzed through a GIS application (**Figure 13**).

Figure 12. Data Capture Application. Facilities Requiring Repair and Reconstruction due to Emergency Events.

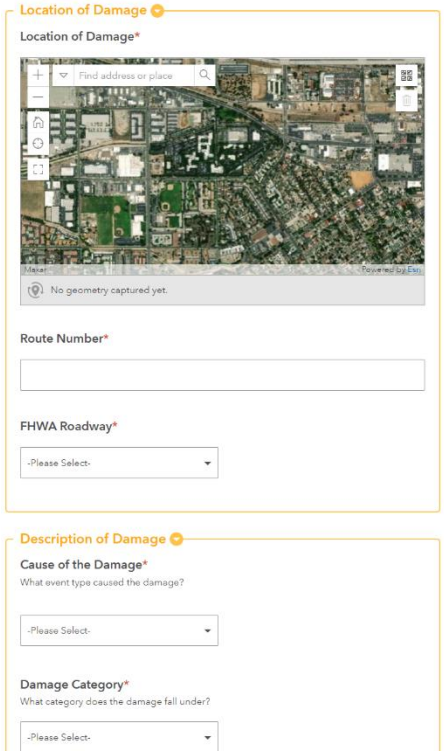
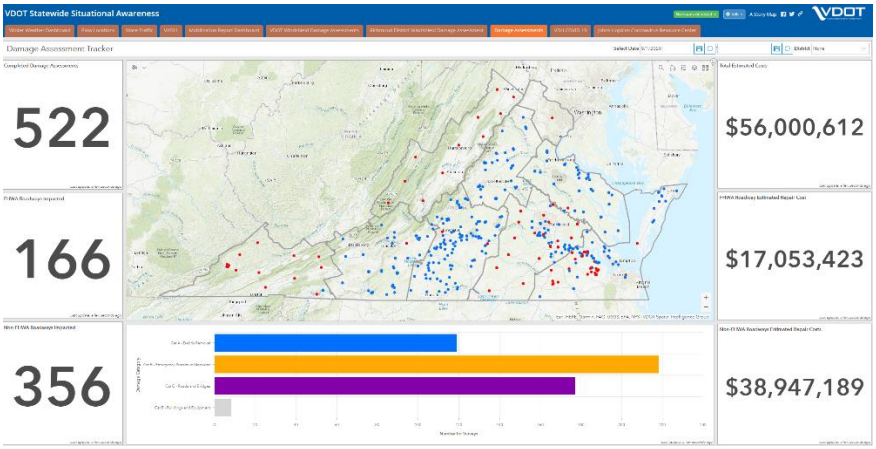


Figure 13. Interactive Reporting of Facilities Requiring Repair and Reconstruction due to Emergency Events.



The system can display the impact on, and facilitate spatial analysis of, facilities on the NHS. This process was implemented in August 2020 and was in use throughout the Commonwealth early in 2021.

Evaluation of Facilities Repeatedly Requiring Repair and Reconstruction Due to Emergency Events

Data currently available have not identified any instance of a repeatedly damaged asset. More data collected over time will allow further research and development of the process and applications.

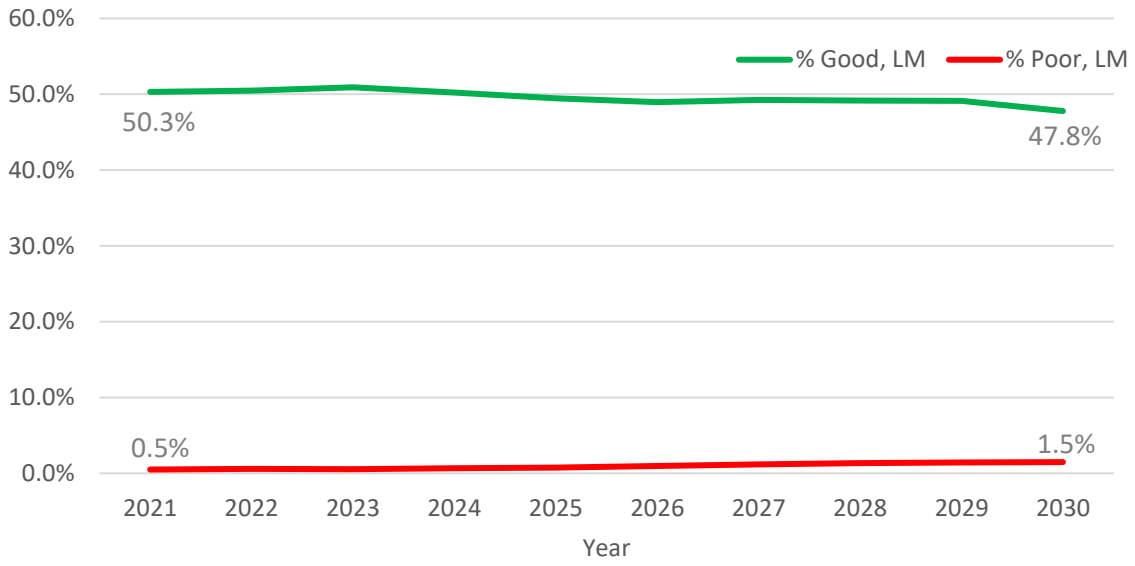
8. PERFORMANCE GAP ANALYSIS

The investment strategies identified through the *Comprehensive Review* and now incorporated in this TAMP provide VDOT with the ability to achieve long-term SGR outcomes. The *Biennial Repor*t (last updated in 2020) reports on VDOT performance for pavements and bridges across all systems. It also reports on operational performance across VDOT networks. It provides an assessment of any performance gaps across the entire maintenance and operations performance program every two years.

NHS PREDICTED PAVEMENT PERFORMANCE

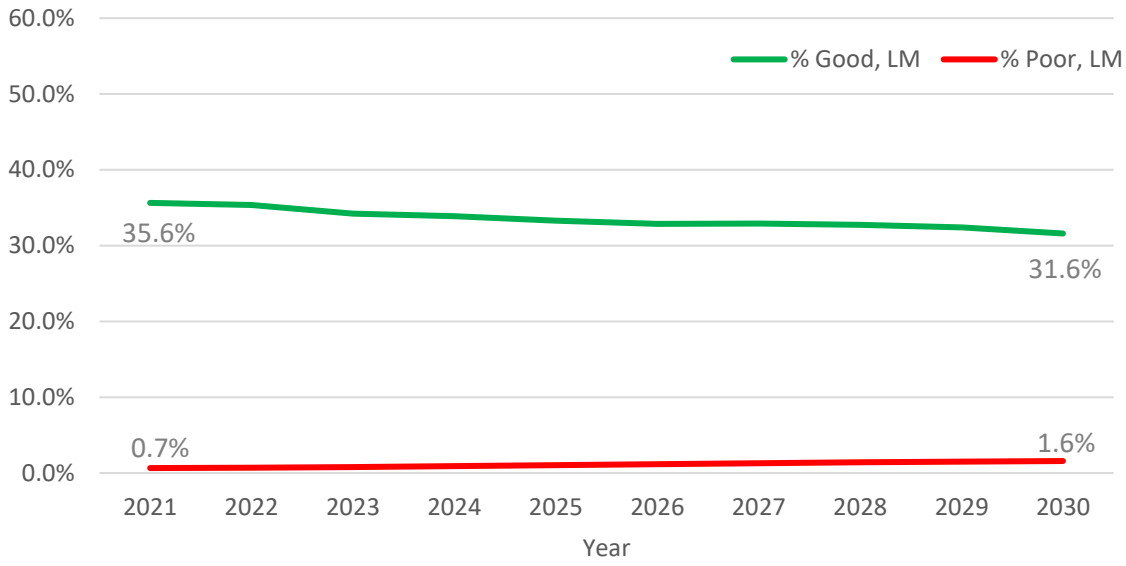
For interstates, over the next 10 years, the percentage of pavements in Good condition is predicted to decline from 50.3% to 47.8%. The percentage of pavements in Poor condition is predicted to increase from 0.5% to 1.5%. A summary of the 10-year performance forecast is provided in **Figure 14**.

Figure 14. Predicted Performance, % Good (LM, Lane Miles) and % Poor NHS Pavements on the Interstates



For non-interstate-NHS, the percentage of pavements in Good condition is also predicted to decline from 35.6% to 31.6%. The percentage of pavements in Poor condition is predicted to increase from 0.7% to 1.6%. A summary of the 10-year performance forecast for non-interstate NHS is provided in **Figure 15**

Figure 15. Predicted Performance, % Good (LM, Lane Miles) and % Poor Non-Interstate-NHS Pavements



There are no gaps in meeting state of good repair targets for good and fair pavements on the NHS. This is summarized in **Table 26**.

Table 26: Gap Analysis summary for pavements on the NHS

Federal Performance Measure		State of Good Repair Target	Predicted Performance (2030)	10-Year (2030) Predicted Gap
Interstate NHS	% Good	≥45%	47.8%	None
	% Poor	<3%	1.5%	None
Non-Interstate NHS	% Good	≥25%	31.6%	None
	% Poor	<5%	1.6%	None

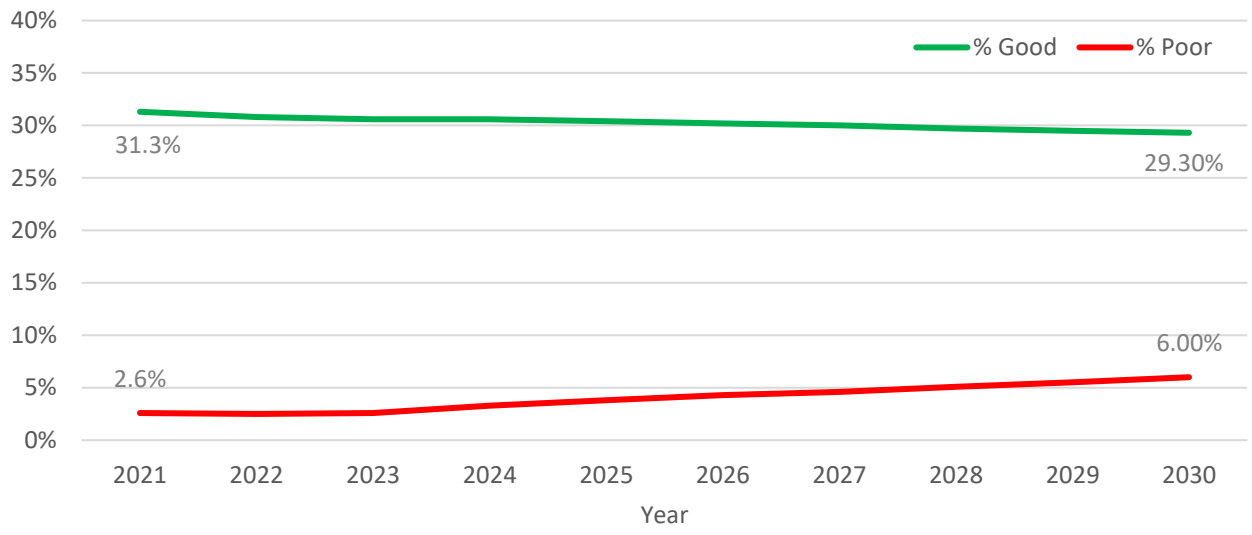
NHS PREDICTED BRIDGE PERFORMANCE

VDOT developed a 10-year bridge investment optimization and associated condition forecasts with its BMS, using deterioration modeling and projected funding levels. These analyses were correlated to the federal performance measures, and **Figure 16** shows the results.

Virginia's NBI NHS inventory includes bridges owned by VDOT, localities, other entities, and the federal government. The federal structures represent only 1% of the overall deck area of the NBI NHS inventory. This is fortunate because accurate forecasting of future conditions requires detailed knowledge that is not readily available to VDOT for these bridges. To develop reliable projections of future conditions for federal bridges, VDOT would need schedules of planned work, funding availability, scopes for projects, anticipated deterioration rates, maintenance practices, and decision logic for rehabilitation and replacement for these structures. In lieu of this information, Virginia has used its best judgment to account for and predict future conditions of federal bridges.

Over the next 10 years, the percentage of deck area of bridges in Good condition is predicted to decline from 31.3% to 29.3%. The percentage of deck area of bridges in Poor condition is predicted to increase over the next 10 years. A summary of the 10-year performance forecast is provided in **Figure 16**.

Figure 16. Predicted Performance, % Good and % Poor NBI Bridges on the NHS by Deck Area



Based on the performance gap analysis results shown in **Table 27**, VDOT anticipates exceeding the SGR target for Poor deck area (**Table 27**) at the end of the 10 year TAMP timeframe. VDOT has identified and implemented a strategy to address this gap through implementation of legislative changes to the SGR Program.

Table 27: Gap Analysis summary for NBI bridges on the NHS

Federal Performance Measure	State of Good Repair Target	Predicted Performance (2030)	Gap
Good Deck Area	N/A	29.3%	-
Poor Deck Area	5%	6%	1%