Transportation Asset Management Webinar Series

Webinar 74

Life Cycle Planning

Sponsored by FHWA and AASHTO

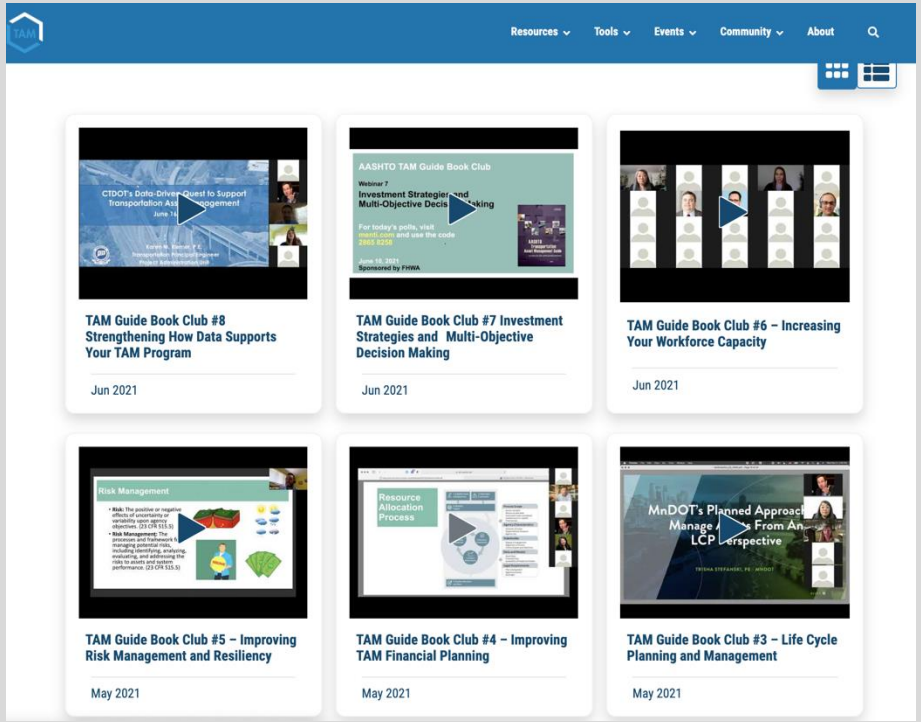
U.S. Department of Transportation
Federal Highway Administration

AASHTO
The Voice of Transportation

April 16th, 2025

FHWA/AASHTO Asset Management Webinar Series

- This is the 74th in a webinar series that has been running since 2012
- Webinars are held every two months, on topics such as off-system assets, asset management plans, asset and risk management, and more
  - Usually, the 3rd Wednesday of the month, 2PM Eastern
- We welcome ideas for future webinar topics and presentations
- Submit your questions using Zoom's chat feature



Welcome

FHWA and the AASHTO Subcommittee on Asset Management are pleased to sponsor this webinar series

- Sharing knowledge is a critical component of advancing asset management practice
- FHWA Asset Management Hub: https://www.fhwa.dot.gov/asset/pubs.cfm

Webinar Objectives

- Learn about how DOTs can shift from an Age-Based State of Good Repair metric to a Component Condition-Based SOGR.
- Highlighting the need for resilience in transportation planning and the corresponding adaptive design criteria for at-risk infrastructure.
- Feature DOT plans to develop risk registers to manage assets in climate vulnerable areas.

Webinar Agenda

2:00 **Welcome, Overview, and Agenda**
Justin Bruner, AASHTO AM Subcommittee
Tashia Clemons, FHWA
Hyun-A Park, Spy Pond Partners

2:15 **Component Condition-Based Traffic Signals Asset Management Program**
Miguel Simon, Connecticut Department of Transportation

2:35 **Lifecycle Planning for Pavement and Bridge Assets at the Washington State DOT**
Matt Versdahl, Washington State Department of Transportation

2:55 **Resilient Transportation Systems**
Maria Mutuc, Virginia Department of Transportation

3:15 **Q&A, Discussion and Next Steps**
Hyun-A Park, Spy Pond Partners

Component Condition-Based Traffic Signals Asset Management Program

Miguel Simon – Asset Management Group
Connecticut Department of Transportation

April 16, 2025

Agenda

- CTDOT TAM Program
- Traffic Signals Asset History
- State of Good Repair
- Traffic Signal Components
- Traffic Signal Dashboard
- Lessons Learned

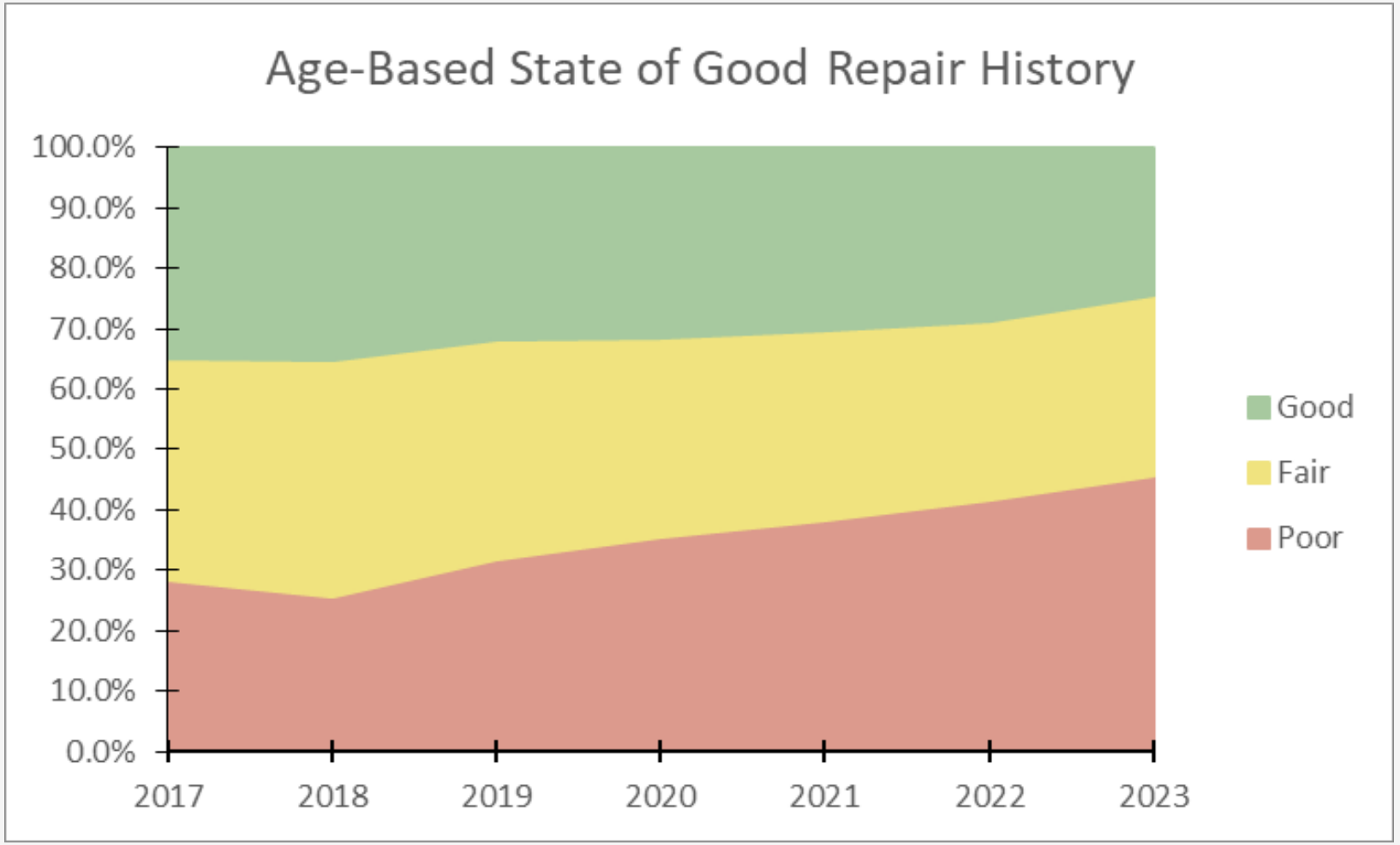
CTDOT TAM Program

- Bureau of Engineering & Construction
  - Project Administration Unit
    - TAM Group
      - Asset Liaisons
  - Highway, Bridge, Traffic Design Units
    - Asset Stewards

Traffic Signals Asset History

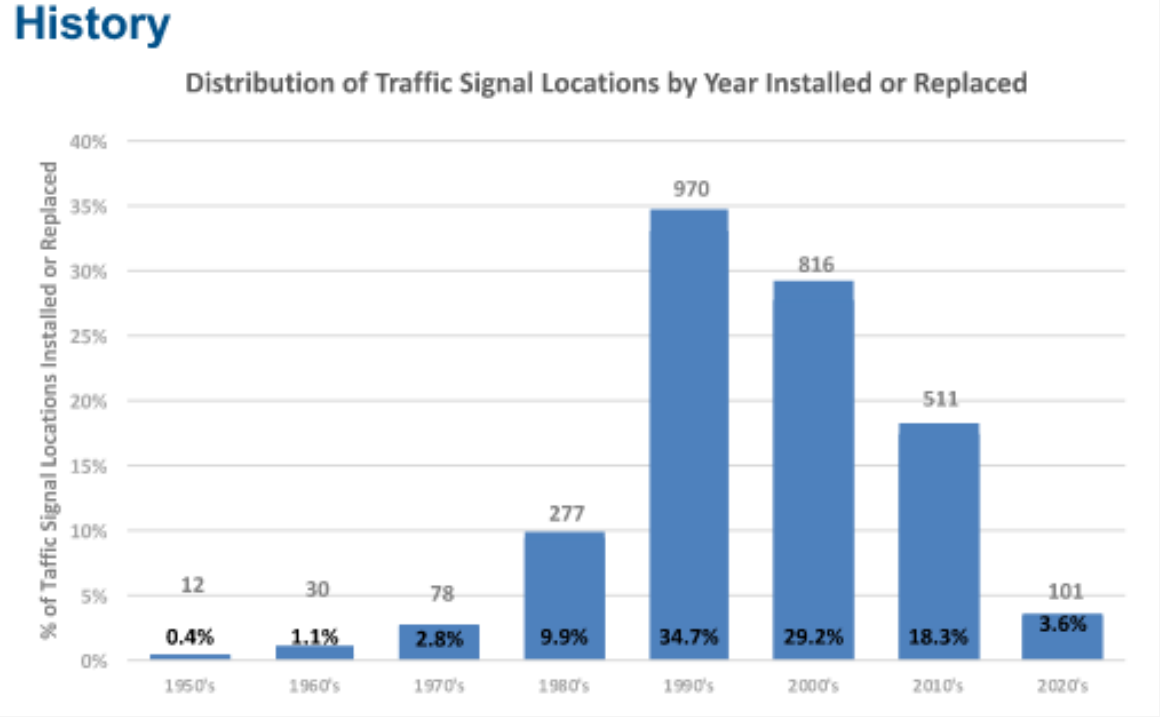
- Traffic Signals were included in CTDOT's first TAMP in 2018
- State of Good Repair based on age of structure (mast arm or span pole) from 2018-2024
- Component condition-based State of Good Repair implemented in 2024

Traffic Signals Asset History



Why Shift to Component Condition-Based Approach?

- Age alone does not fully represent asset condition.
- Components have varying lifespans.
- Additional Traffic Signal management enhancements (electronic maintenance forms, online dashboard)

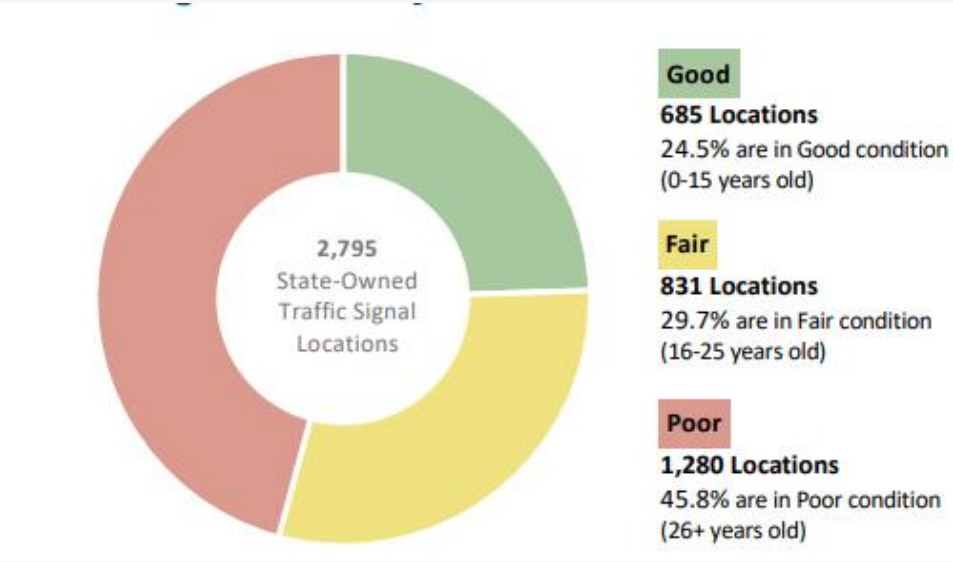


Comparing State Of Good Repair Approaches

Age-Based State of Good Repair

Age of signal structure

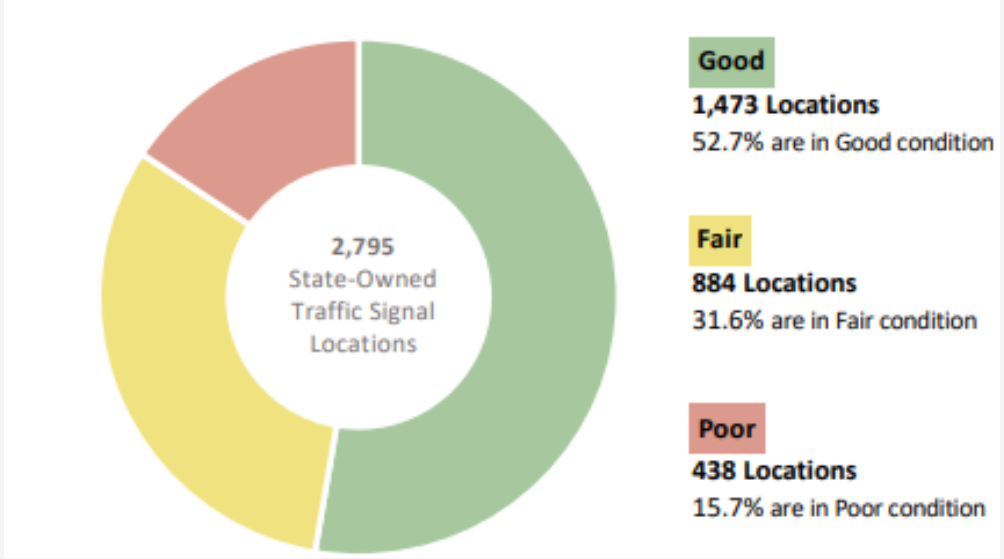
- 0-15 years – Good Signal Condition
- 16-25 years – Fair Signal Condition
- 26+ years – Poor Signal Condition



54% State of Good Repair

Component Condition-Based State of Good Repair

Four components inspected and each assigned a State of Good Repair rating that rolls up to an overall condition rating identified using a matrix.



84% State of Good Repair

Traffic Signal Components

Structures

Span Pole

Mast Arms

Control Box

8 Phase Closed Loop

16 Phase

Vehicle Detection

360-Video Camera

Loops

Communication

Computerized Traffic Signal System (Adaptive)

Computerized Traffic Signal System (Time of Day)

Traffic Signal Decision Matrix

- Each component rated good, fair, or poor
- Traffic Signal State of Good Repair determined by matrix
- 81 possible combinations

DECISION MATRIX BASED ON RATING COMBINATIONS

Case No.	Structures	Controller/ Cabinet	Detection	Communication	SOGR
1	Good	Good	Good	Good	Good
2	Good	Good	Good	Fair	Good
3	Good	Good	Fair	Good	Good
4	Good	Fair	Good	Good	Good
5	Good	Good	Good	Poor	Good
8	Good	Good	Fair	Fair	Good
9	Good	Fair	Fair	Good	Good
10	Good	Fair	Good	Fair	Good
11	Good	Good	Fair	Poor	Good
16	Good	Fair	Good	Poor	Good
26	Good	Fair	Fair	Fair	Good
7	Good	Poor	Good	Good	Fair
14	Good	Poor	Fair	Good	Fair
15	Good	Poor	Good	Fair	Fair
19	Good	Poor	Good	Poor	Fair
22	Good	Poor	Fair	Poor	Fair
23	Good	Fair	Fair	Poor	Fair
25	Good	Poor	Fair	Fair	Fair
28	Fair	Good	Good	Good	Fair
29	Fair	Good	Good	Fair	Fair
30	Fair	Good	Fair	Good	Fair
31	Fair	Fair	Good	Good	Fair
32	Fair	Good	Good	Poor	Fair
34	Fair	Poor	Good	Good	Fair
35	Fair	Good	Fair	Fair	Fair
36	Fair	Fair	Fair	Good	Fair

Traffic Signal – State Of Good Repair Dashboard

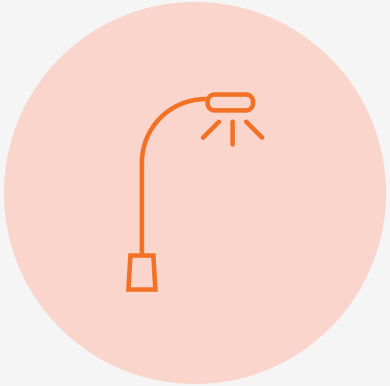
Next Steps

CONTINUE INSPECTIONS

IDENTIFY TRENDS IN COMPONENT LIFE CYCLES

REFINE FUTURE PROJECTIONS

Lessons Learned



STRUCTURES HAD LONGER LIFE SPAN THAN INITIALLY PROJECTED

DON’T WAIT FOR PERFECT DATA SET TO ADD TO TAM PROGRAM

CONSIDER PROJECTIONS WHILE DETERMINING INVENTORY & CONDITION METHODOLOGY

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Asset Management Group (ct.gov)

Lifecycle Planning for Pavement and Bridge Assets at the Washington State DOT

Matt Versdahl, Statewide Asset Manager, Washington State DOT

April 16, 2025

Agenda

- Integrating Risk and Resilience into LCP
- Assets in Climate Vulnerable Areas

What is Lifecycle Planning at WSDOT?

- Considerations from construction to disposal
- Goal: Minimize long-term costs while maintaining performance
- Helps prioritize investments and set preservation strategies

Why It Matters in Washington

- Climate, geography, and usage vary widely as well as volume.

Lifecycle Cost Components

- Initial Construction
- Routine Maintenance
- Rehabilitation
- Operation Costs
- End-of-Life Costs

How WSDOT does it

- WSDOT Pavement Management System (WSPMS)
- Bridge Engineering Information System (BEISt)
  - Condition, deterioration models, maintenance data, treatment costs, inflation and discount rates, anticipated budgets

- Pavement assets managed according to general type of material (flexible or rigid).

Lifecycle Cost Analysis (LCCA)

- LCCA compares long-term costs of asset strategies
- Uses Equivalent Uniform Annual Cost (EUAC)
- Supports decisions like choosing pavement type
  - Analysis of alternatives conducted

Lifecycle Cost Analysis (LCCA)

- Example of project level analysis:

Costs	Alternative 1	Alternative 2
ROW	$ 100,000.00	$ 100,000.00
Design	$ 250,000.00	$ 250,000.00
Construction	$ 500,000.00	$ 435,000.00
Total Initial Costs	**$ 850,000.00**	**$ 785,000.00**
Operations/Maintenance	$ 200,000.00	$ 300,000.00
Other Annual Costs	$ 14,000.00	$ 20,000.00
Total Annual Costs	**$ 214,000.00**	**$ 320,000.00**
Rehabilitation Cost	**$ 79,000.00**	**$ 18,000.00**
Salvage Value	**$ 25,000.00**	**$ 36,000.00**
Lifespan (Years)	**10**	**10**

Lifespan Least Common Multiple	**10**
Base Year	2026
Discount Rate	5%

Add New Alternative

Delete Last Alternative

Generate Comparison

Do not change cells highlighed in gray

Discount Factor	Year	Calendar Year	Alternative 1	Alternative 2
1.0000	0	2026	$ 850,000.00	$ 785,000.00
0.9524	1	2027	$ 203,809.52	$ 304,761.90
0.9070	2	2028	$ 194,104.31	$ 290,249.43
0.8638	3	2029	$ 184,861.25	$ 276,428.03
0.8227	4	2030	$ 176,058.33	$ 263,264.79
0.7835	5	2031	$ 167,674.60	$ 250,728.37
0.7462	6	2032	$ 159,690.09	$ 238,788.93
0.7107	7	2033	$ 152,085.80	$ 227,418.03
0.6768	8	2034	$ 144,843.62	$ 216,588.60
0.6446	9	2035	$ 137,946.31	$ 206,274.85
0.6139	10	2036	$ 146,725.27	$ 218,553.12
Total			**$ 2,517,799.11**	**$ 3,278,056.05**

Lifecycle Cost Analysis (LCCA)

- Example of project level analysis:

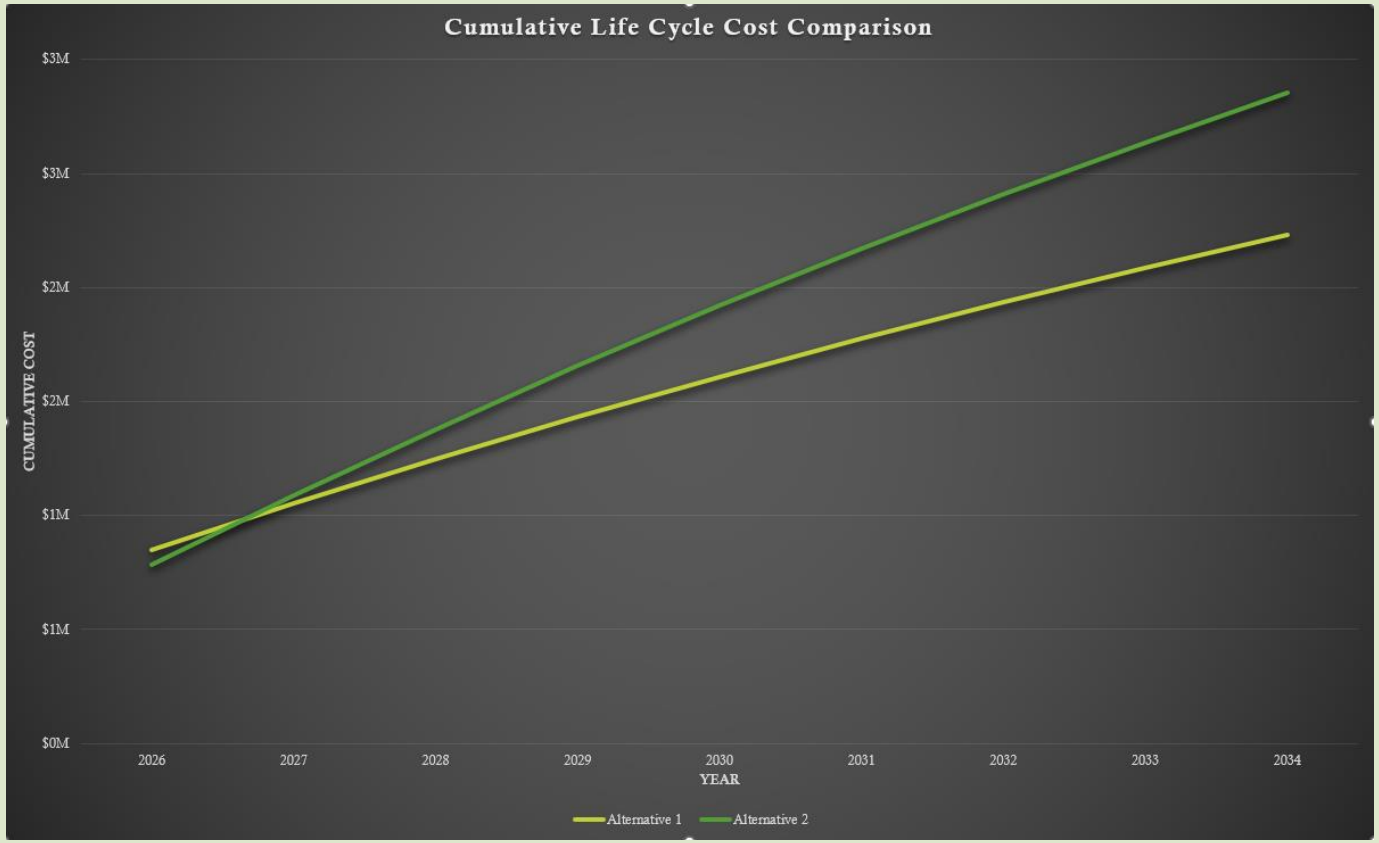
Measure	Alternative 1	Alternative 2
Present Worth	$ 2,517,799.11	$ 3,278,056.05
Equivalent Uniform Annual Cost	$ 326,066.50	$ 424,523.26

Ranking	Alternative	Present Worth
1	Alternative 1	$ 2,517,799.11
2	Alternative 2	$ 3,278,056.05

Ranking	Alternative	Equivalent Uniform Annual Cost
1	Alternative 1	$ 326,066.50
2	Alternative 2	$ 424,523.26

Lifecycle Cost Analysis (LCCA)

- Example of project level analysis:



Year	Alternative 1	Alternative 2
2026	$ 850,000.00	$ 785,000.00
2027	$ 1,053,809.52	$ 1,089,761.90
2028	$ 1,247,913.83	$ 1,380,011.34
2029	$ 1,432,775.08	$ 1,656,439.37
2030	$ 1,608,833.41	$ 1,919,704.16
2031	$ 1,776,508.01	$ 2,170,432.53
2032	$ 1,936,198.10	$ 2,409,221.46
2033	$ 2,088,283.91	$ 2,636,639.49
2034	$ 2,233,127.53	$ 2,853,228.08
2035	$ 2,371,073.84	$ 3,059,502.94
2036	$ 2,517,799.11	$ 3,278,056.05

Lifecycle Cost Analysis (LCCA)

Exhibit 4-3: WSDOT Pavement Treatment Options

Surface Type	Management Strategy[1]	Work Type[1]	Life Extension[1] (Years)	Agency Cost[1,2] ($ Total/Lane Mile)	$EUAC_{4\%}$[1,3] ($ Annual/Lane Mile)
Flexible Pavements (Chip Seal and Asphalt)	**Maintenance:** Most cost-effective option, and used to extend time between resurfacing activities.	**Minor Repair:** • Patching • Crack sealing	Chip Seal: 2 Asphalt: 3	Chip Seal: $2,500 Asphalt: $5,000	Chip Seal: $1,325 Asphalt: $1,802
	Rehabilitation: Properly timed resurfacing activities to preserve pavement structure.	**Resurface:** • Add surface layer or mill and inlay • Hot-seal & hot-mix asphalt	Chip Seal: 7 Asphalt: 15	Chip Seal: $45,000 Asphalt: $225,000	Chip Seal: $7,497 Asphalt: $20,237
	Reconstruction: Most expensive option, generally avoided by properly timed resurfacing.	**Reconstruction + Resurfacing:** • Every 9 yrs. (Chip Seal) • In yrs. 20 & 35 (Asphalt)	Chip Seal: 54 Asphalt:50	Chip Seal: $200,000 + $45,000 each Asphalt: $1,000,000 + $225,000 each	Chip Seal: $13,100 Asphalt: $53,985
Rigid Pavements (Concrete)	**Rehabilitation:** Opportunities for further life-extending treatments are limited.	**Resurface/retrofit:** • Diamond grinding • Dowel bar retrofit • Selective slab replacement	Concrete: 15	Concrete: $400,000	Concrete: $35,976
	Reconstruction: Most expensive option. Required at end of concrete pavement life.	**CSOL + Resurfacing:** • In yrs. 20 & 35 **Resurfacing methods include:** • Asphalt Replacement • Unbonded Concrete Overlay	CSOL Concrete: 50	CSOL Concrete: $900,000 + $225,000 each	CSOL Concrete: $49,330
		Reconstruction	Concrete: 50	Concrete: $2,500,000	Concrete: $116,376

Lifecycle Cost Analysis (LCCA)

- Long Life Pavements
- Chip Seal Conversions with lower AADT vs. asphalt resurfacing
- Budget Constraints - Strategic Maintenance

Lifecycle Cost Analysis (LCCA)

Exhibit 4-4: Summary of the WSDOT Pavement Network Savings – Baseline vs. Current Strategy[2]

Treatment Type	Applicable Lane Miles	Average Service Life (years)	Average Cost ($/Lane-Mile)	Average Annual Network Cost ($ Millions)
Average Annual Network Cost – 2010 Baseline				
Chip Seal Resurfacing	4,580	6	$45,000	$34
Asphalt Resurfacing	11,570	14	$225,000	$186
Concrete Reconstruction	2,080	50	$2,500,000	$104
Total Annual Average Network Cost - Baseline				**$324**
Average Annual Network Cost – 2025 (With Strategy Implementation)				
Chip Seal Resurfacing with Maintenance	7,580	9	$47,500	$40
Asphalt Resurfacing with Maintenance	8,570	17	$230,000	$116
Concrete Reconstruction with Triage	1,820	65	$2,900,000	$81
Triage then CSOL	260	50	$1,350,000	$7
Total Annual Average Network Cost – After Implementation				**$244**
Avg. Annual Cost Savings[1]				**$80**

Lifecycle Cost Analysis (LCCA)

- Bridge
  - Quantitative Analysis

Lifecycle Cost Analysis (LCCA)

Exhibit 4-5: WSDOT Bridge Treatment Options

Management Strategy[3,4]	Work Type[3,4]	Life Extension[2] (Years)	Total 10 Year Needs[1] ($ in millions)
Maintenance: Day-to-day temporary maintenance repairs keeping bridges in service. **Bridge Cleaning Program**: Intended to keep structure coatings free of debris buildup and extend the life of the coating.	**Minor Repair:** • Clean fracture critical steel bridges prior to inspection • Deck Patching & crack sealing • Small movement expansion joints	1 to 3	Current backlog of Repairs #: 1,045 Cost: $12
Steel Bridge Painting Program: Intended to perform work when it's due to prevent corrosion, extend service life, and keep the bridge in fair or better condition.	**Steel element preservation:** • Remove existing paint • Apply new paint system	Steel Truss: 20 to 25 Steel Girder: 30 to 40	Structures #: 184 Cost: $ 781.1
Concrete Deck Overlay Program: Intended to repair and overlay concrete decks to provide corrosion protection for steel reinforcing and roadway surface, prolong service life, and avoid expensive replacements.	**Concrete Deck Repair and Overlay:** • Hydro-Milling of the deck • Deck repair and overlay: - Hydro-mill deck surface (1") - Apply modified concrete - Polyester Concrete	25 to 30	Structures #: 303 Cost: $867.9
Bridge Scour Mitigation Program: Mitigate risk of bridge failure by designing, permitting, and constructing bridge scour repairs under contract. Top 20-30 candidates will be addressed over the next 10 years.	**Retrofit:** • Protect foundations with rip-rap • Install barbs in river to channel river flow • Repair voids under footings and pilings with concrete fill	N/A	Structures #: 268 Cost $: N/A Included in rehabilitation & reconstruction total. $30
Bridge Seismic Retrofit Program: Intended to address bridges not meeting current seismic design standards. WSDOT will address highest priorities on Interstate and selected state routes in the central Puget Sound Area	**Retrofit:** • Concrete columns with steel or composite material • Strengthen existing crossbeams with new bolsters • Address abutments/intermediate piers with girder stops between girders	N/A	Structures #: 593 *Includes partial retrofits Cost $: N/A Included in rehabilitation & reconstruction total.
Element Repair and Replacement: Repair and replace specific deteriorated bridge elements, performing major preservation repairs to improve low condition ratings.	**Element repair:** • Anchor cables • Expansion joints • Other bridge elements • Mechanical elements • Concrete columns	Up to 25	Structures #: 94 Cost[5] $: 589.7
Reconstruction: Replace or rehabilitate bridges in poor condition. An evaluation of rehabilitation option is compared to full bridge replacement. If rehabilitation costs exceed 60% of new bridge, then bridge replacement is recommended.	**Replace/Rehabilitate:** • Selected timber bridges • Replace selected steel and concrete bridges in poor condition • Replace selected concrete bridge deck	New Bridge: 75+	

Risk Management

- Enterprise
- Network
- Project
- Risks are ranked and considered in treatment plans and rehab activities
  - Helps to optimize strategy

- Workshop style approach to developing risk registers

Other considerations

Exhibit 5-5: Summary of Pavement Asset Risk Management for Pavement Treatment Impacts

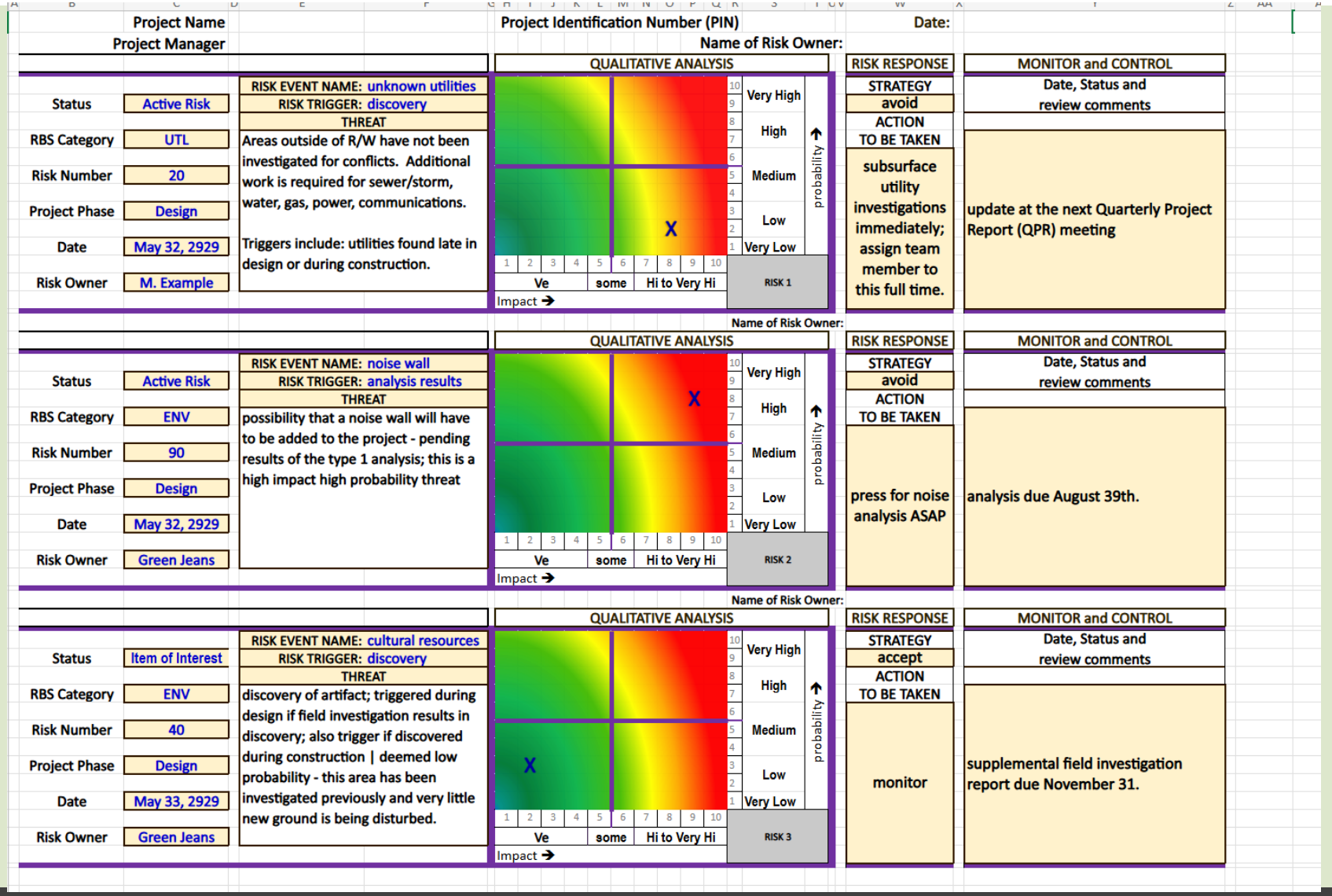
Consideration	Pavement Treatment
Risk Statement and Impact	If pavement projects are not programmed at the correct time, then life-cycle costs might increase.
Asset Risk Category	Operational
Level of Risk	High
Risk Treatment Strategy	Mitigation
Current Strategy	To support the implementation of strategic maintenance, WSDOT has an integrated approach that influences the timing and requirements of when future paving projects occur, maximizing the pavement life before a more intensive treatment option is selected. As part of the overarching investment strategies for pavements, WSDOT is actively engaged in implementing Lowest Lifecycle cost strategies. The pavement office also has well documented asset management practices as communicated in the pavement manual. Pavement performance is actively monitored through performance measures established in the *Gray Notebook*.
Risk Treatment Plan	Improve procedures to make project programming more accurate. More time needs to be spent reviewing the program of projects for completeness and accurate timing.
Anticipated Level of Risk Post Treatment	High

Other considerations

Exhibit 5-6: Summary of Pavement Asset Risk Management for Preventive Maintenance Strategy Impacts

Consideration	Preventive Maintenance Strategy
Risk Statement and Impact	If the preventive maintenance strategy is not effectively implemented, then early resurfacing or reconstruction may need to occur, increasing life-cycle costs.
Asset Risk Category	Operational
Level of Risk	High
Risk Treatment Strategy	Mitigation
Current Strategy	The Pavement office works closely with Headquarters and Region maintenance staff to train and identify best practices for pavement strategic maintenance. This is to ensure the most effective implementation of strategic maintenance. Training consists of pavement deterioration identification, appropriate treatment types, and root cause analysis. Maintenance crews also provides feedback on effectiveness of treatment options and successes and challenges experienced in the field. The Pavement office also works to promote consistent implementation of strategies across the Regions.
Risk Treatment Plan	Develop a single approach and implementation strategy that is consistent across Regions. Identify the scenarios and root causes of why strategies were not effective. The effectiveness of a strategy such as risk treatment is measured through pavement life extension.
Anticipated Level of Risk Post Treatment	Medium

Other considerations



Project Name		Project Identification Number (PIN)		Date:	
Project Manager			Name of Risk Owner:		

		QUALITATIVE ANALYSIS	RISK RESPONSE	MONITOR and CONTROL
Status	Active Risk	RISK EVENT NAME: unknown utilities RISK TRIGGER: discovery THREAT Areas outside of R/W have not been investigated for conflicts. Additional work is required for sewer/storm, water, gas, power, communications. Triggers include: utilities found late in design or during construction.	STRATEGY avoid ACTION TO BE TAKEN subsurface utility investigations immediately; assign team member to this full time.	Date, Status and review comments update at the next Quarterly Project Report (QPR) meeting
RBS Category	UTL			
Risk Number	20			
Project Phase	Design			
Date	May 32, 2929			
Risk Owner	M. Example			

Name of Risk Owner:

		QUALITATIVE ANALYSIS	RISK RESPONSE	MONITOR and CONTROL
Status	Active Risk	RISK EVENT NAME: noise wall RISK TRIGGER: analysis results THREAT possibility that a noise wall will have to be added to the project - pending results of the type 1 analysis; this is a high impact high probability threat	STRATEGY avoid ACTION TO BE TAKEN press for noise analysis ASAP	Date, Status and review comments analysis due August 39th.
RBS Category	ENV			
Risk Number	90			
Project Phase	Design			
Date	May 32, 2929			
Risk Owner	Green Jeans			

Name of Risk Owner:

		QUALITATIVE ANALYSIS	RISK RESPONSE	MONITOR and CONTROL
Status	Item of Interest	RISK EVENT NAME: cultural resources RISK TRIGGER: discovery THREAT discovery of artifact; triggered during design if field investigation results in discovery; also trigger if discovered during construction | deemed low probability - this area has been investigated previously and very little new ground is being disturbed.	STRATEGY accept ACTION TO BE TAKEN monitor	Date, Status and review comments supplemental field investigation report due November 31.
RBS Category	ENV			
Risk Number	40			
Project Phase	Design			
Date	May 33, 2929			
Risk Owner	Green Jeans			

Lifecycle Cost Analysis (LCCA)

- Bridge
  - Scour mitigation
  - Seismic retrofits
  - Preventative maintenance
  - Painting
  - Deck repair – modified concrete overlays
  - Rehab vs. replacement

Other considerations

- May include extreme weather and resilience
  - Sea Level Rise
  - Precipitation
  - Temperature
  - Fire
  - Seismic

- Transportation Resilience Improvement Plan (underway)

Climate Impacts Vulnerability Assessment

Other considerations

Very low to low			Moderate			Critical to Very Critical			
1	2	3	4	5	6	7	8	9	10
Criticality of asset									

Notice that along with the qualitative terms there is an associated scale of 1 to 10, this is to serve as a facilitation tool for some people who may find it useful to think in terms of a numerical scale – although the scoring by each individual is of course subjective. The scale is a generic scale of criticality where "1" is very low (least critical) and "10" is very critical.

Typically involves:
- non-NHS
- low AADT
- alternate routes available

Typically involves:
- some NHS
- non-NHS
- low to medium AADT
- serves as an alternative for other state routes

Typically involves:
- Interstate
- Lifeline
- some NHS
- sole access
- no alternate routes

Exhibit 2-4 Rating Scale for Asset Criticality

Other considerations

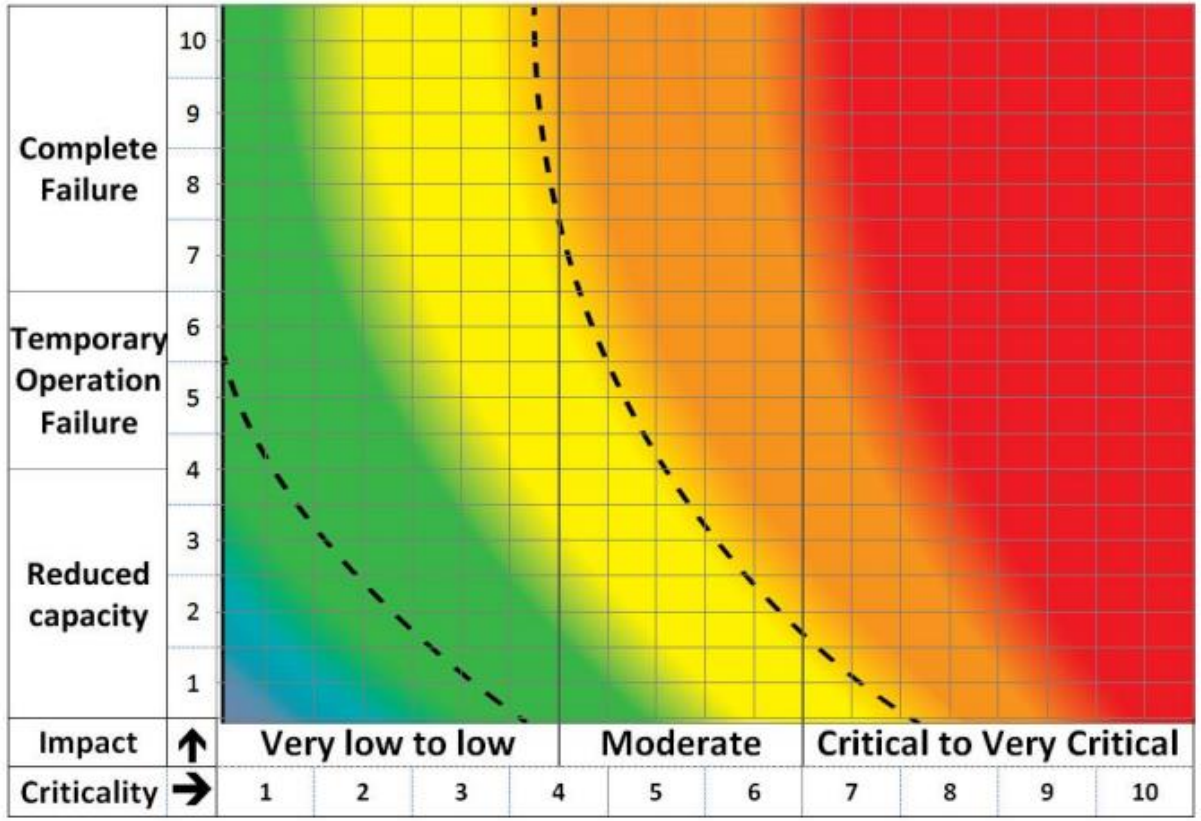


Exhibit 2-6 Impact – Asset Criticality Matrix or "Heat Sheet"

10 9 8 7		**Complete Failure** Results in **total loss or ruin of asset**. Asset *may* be available for *limited* use after at least 60 days and **would require major repair or rebuild over an extended period of time**. "Complete and/or catastrophic failure" typically involves: ▪ Immediate road closure ▪ Travel disruptions ▪ Vehicles forced to reroute to other roads ▪ Reduced commerce in affected areas ▪ Reduced or eliminated access to some destinations May sever some utilities. May damage drainage conveyance or storage systems.
6 5 4		**Temporary Operational Failure** Results in **minor damage and/or disruption** to asset. Asset would be available with either full or limited use within 60 days. "Temporary operational failure" typically involves: ▪ Temporary road closure, hours to weeks ▪ Reduced access to destinations served by the asset ▪ Stranded vehicles Possible temporary utility failures.
3 2 1		**Reduced Capacity** Results in **little or negligible impact** to asset. Asset would be available with full use within 10 days and has **immediate limited use still available**. "Reduced capacity" typically involves: ▪ Less convenient travel ▪ Occasional/brief lane closures, but roads remain open ▪ Some vehicles may move to alternate routes.

Adapted from Oregon Transportation Research and Education Consortium – Risk Assessment Presentation

Exhibit 2-5 Workshop Impact Rating Scale

Maintenance

WSDOT

Maintenance Accountability Process

ACTIVITY LEVEL TARGETS CY 2024 - STATEWIDE

Maintenance Activity	State of Good Repair	2023-25 Funding Level	2024 Delivered LOS
Group - 1 Roadway Maintenance and Operations			
1A1 Pavement Patch	90%	90%	92%
1A3 Shoulder Maintenance	C	D	D
1A4 Sweeping and Cleaning	A	C	D
Group - 2 Drainage Maintenance and Slope Repair			
2A1 Ditch Maintenance	B	B	B
2A2 Culvert Maintenance	C	F	F
2A3 Catch Basin and Inlet Maintenance	A	A	A
2A4 Stormwater Facility Maintenance	A	A	A
2A5 Slope Repair	B	F	F
Group - 3 Roadside and Vegetation Management			
3A1 Roadside Cleanup	C	F	F
3A2 Noxious Weed Control	B	C	D
3A3 Nuisance Vegetation Control	C	D	D
3A4 Vegetation Obstruction Control	C	D	D
3A5 Landscape Maintenance	C	D	D
Group - 4 Bridge and Urban Tunnel Maintenance and Operations			
4A1 Bridge Deck Repair	90%	90%	92%
4A2 Structural Bridge Repair	90%	90%	92%
4A3 Bridge Cleaning	B	B	B
4B1 Special Bridge and Ferry Operation	A	A	A
4B3 Urban Tunnel Systems Operation	B	B	B
Group - 5 Snow and Ice Control Operations			
5B1 Snow and Ice Control Operations	A	B	B
Group - 6 Traffic Control Maintenance and Operations			
6A1 Pavement Striping Maintenance	B	C	**F**
6A2 Raised/Recessed Pavement Marker Maintenance	C	C	**D**
6A3 Pavement Marking Maintenance	C	D	D
6A4 Regulatory Sign Maintenance	C	D	D
6A5 Guide Sign Maintenance	C	D	D
6A6 Guidepost Maintenance	C	F	F
6A7 Barrier Maintenance	B	B	B
6B1 Traffic Signal Systems	C	C	C
6B2 Highway Lighting Systems	B	B	B
6B3 Intelligent Transportation Systems	A	A	A
Group - 7 Rest Area Operations			
7B1 Rest Area Operation	B	B	B

Missed Target Compared to Funding Level

State of Good Repair Funding Needed

Note: * Pavement and bridge asset conditions are given as percentage of WSDOT owned highway lane miles in fair or better condition (pavement) and percentage of WSDOT owned bridges in fair or better condition by bridge deck area. Pavement data lags one year behind indication (i.e., 2024 column corresponds to 2023 data). Pavement is part of an integrated approach using Washington State Pavement Management System condition rating, which takes into account all maintenance and preservation work completed and/or needed.

Key Takeaways

- Lifecycle Planning = Smart, cost-effective asset management
- WSDOT uses data, models, and field insights
- Longer life and lower cost for transportation assets


VDOT
Virginia Department of Transportation

RESILIENT TRANSPORTATION SYSTEMS

Incorporating Resilience into Current Business Practices

TAM Webinar #74

April 16, 2025

NEED FOR RESILIENCE

Changing Environmental Conditions

Hazards and Threats

- Temperature
- Sea Level Rise
- Increased Precipitation
- Extreme Weather Events
- Rockfall & Slope Failures

Impacts

- Asset deterioration and failure
- Operational, maintenance and emergency management challenges
- Need to identify cost-effective solutions

https://wtop.com/virginia/2022/07/crews-still-searching-for-17-people-after-virginia-flooding/

https://www.delmarvanow.com/story/news/local/maryland/2021/10/29/flooding-high-surf-forecasted-maryland-virginia-eastern-shore/6190651001/

NEED FOR RESILIENCE

Virginia Resilience Planning Efforts

Commonwealth Planning

- Virginia Coastal Resilience Master Plan
- Virginia Flood Protection Master Plan
- Virginia State Hazard Mitigation Plan
- Resilience Coordination Working Group

Local Planning

- Fairfax, Norfolk, Virginia Beach
- NVRC, HRPDC, MPPDC, etc.

****** VDOT plan needed to inform and align agency, local planning efforts***

RESILIENCE DRIVERS

Executive Orders

Commonwealth of Virginia
Office of the Governor

Executive Order

NUMBER TWENTY-FOUR (2018)

INCREASING VIRGINIA'S RESILIENCE TO SEA LEVEL RISE AND NATURAL HAZARDS

Importance of the Initiative

Sea level rise, land subsidence, higher average temperatures, more frequent and intense weather events, severe drought, and increased development, have increased risk and will continue to increase and exacerbate risk from natural hazards across the Commonwealth of Virginia. The number of federally declared disasters has steadily increased nationally and in Virginia. The number has experienced a 250 percent increase in federally declared disasters over the past 20 years, including declarations for flooding, hurricanes, severe storms, and wildfire.

NUMBER FORTY-FIVE

FLOODPLAIN MANAGEMENT REQUIREMENTS AND PLANNING STANDARDS FOR STATE AGENCIES, INSTITUTIONS, AND PROPERTY

Importance of the Initiative

Executive Order 24 "Increasing Virginia's Resilience to Sea Level Rise and Natural Hazards," issued in November 2018, set the Commonwealth on a course towards addressing its risk and resilience to natural hazards, including flooding. A key element of that Order required an analysis of flooding and flood preparedness in the Commonwealth. Based on that analysis, the Commonwealth must establish new policies and directives to ensure that necessary actions are taken to protect state property from the risk of floods.

Legislation

VIRGINIA ACTS OF ASSEMBLY -- 2021 SPECIAL SESSION I

CHAPTER 51

An Act to amend and reenact §§ 33.2-214.2 and 33.2-353 of the Code of Virginia, relating to transportation projects; resiliency.

[H 2071]

Approved March 11, 2021

Be it enacted by the General Assembly of Virginia:

1. That §§ 33.2-214.2 and 33.2-353 of the Code of Virginia are amended and reenacted as follows:

§ 33.2-214.2. Transparency in the development of the Six-Year Improvement Program, statewide prioritization process, and state of good repair program.

A. The Board shall develop the Six-Year Improvement Program pursuant to § 33.2-214 in a transparent manner that provides to the public, elected officials, and other stakeholders the opportunity to engage and comment in a meaningful manner prior to the adoption of such program.

B. No later than 150 days prior to a vote to include projects or strategies evaluated pursuant to § 33.2-214.1 in the Six-Year Improvement Program, the Office of Intermodal Planning and Investment shall make public, in an accessible format, (i) a recommended list of projects and strategies for inclusion in the Six-Year Improvement Program based on the results of such evaluation; (ii) the results of the screening of candidate projects and strategies, including whether such projects are located on a primary evacuation route; ~~and~~ (iii) *whether a project has been designed to be or the project sponsor has committed that the design will be resilient; and (iv)* the results of the evaluation of candidate projects

The Statewide Transportation Plan shall be updated as needed but no less than once every four years. The plan shall promote economic development and all transportation modes, intermodal connectivity, environmental quality, accessibility for people and freight, *resiliency,* and transportation safety.

B. The Statewide Transportation Plan shall establish goals, objectives, and priorities that cover at least a 20-year planning horizon, in accordance with federal transportation planning requirements. The plan shall include quantifiable measures and achievable goals relating to, but not limited to, congestion reduction and safety, transit and high-occupancy vehicle facility use, job-to-housing ratios, job and housing access to transit and pedestrian facilities, air quality, movement of freight by rail, and per capita vehicle miles traveled. The Board shall consider such goals in evaluating and selecting transportation improvement projects for inclusion in the Six-Year Improvement Program pursuant to § 33.2-214.

C. The plan shall incorporate the measures and goals of the approved long-range plans developed by the applicable regional organizations. Each such plan shall be summarized in a public document and made available to the general public upon presentation to the Governor and General Assembly.

D. It is the intent of the General Assembly that this plan assess transportation needs and assign priorities to projects on a statewide basis, avoiding the production of a plan that is an aggregation of local, district, regional, or modal plans.

2. That the Commissioner of Highways shall ensure resiliency is incorporated into the design standards for new construction projects.

Transportation Planning

Guiding Principles

GP1: Optimize Return on Investments
Implement the right solution at the right price, striving to meet current needs while advancing long-term prosperity and livability.

GP2: Ensure Safety, Security, and Resiliency
Provide a transportation system that is safe for all users, responds immediately to short-term shocks such as weather events or security emergencies, and adapts effectively to long-term stressors such as sea level rise.

Table 7: VTrans 2021 Long-term Risk & Opportunity Register

Macrotrend	Characterization	Description
Increase in Flooding Risk		1. A large number of the state's roadways are at risk of flooding 2. Several unknown and unquantified flooding risks are present 3. Impacts of increased flooding risk are disproportionately higher for certain geographic areas and populations
		4. Proactively eliminate or mitigate identified flooding risks 5. Increase the state's preparedness to address other macrotrends associated with climate change megatrend

Attachment A: 2021 VTrans Strategic Actions[1]

1. *Collect data (e.g., right-of-way mapping, precipitation, roadway elevation, etc.) to accurately assess flooding risks for state- and locally-maintained roadways that can be used to identify funding needs and prioritize investment.*
   - Responsible entity(s): VDOT
   - Intent: This action addresses VTrans Risk & Opportunity Register Item #2: Several unknown and unquantified flooding risks are present.

2. *Develop policies, based on robust data collection and analysis, to ensure flooding risks are reflected in transportation asset life cycle and/or transportation project planning processes.*
   - Responsible entity(s): VDOT, DRPT
   - Intent: This action addresses VTrans Risk & Opportunity Register Item #4: Proactively eliminate or mitigate identified flooding risks.

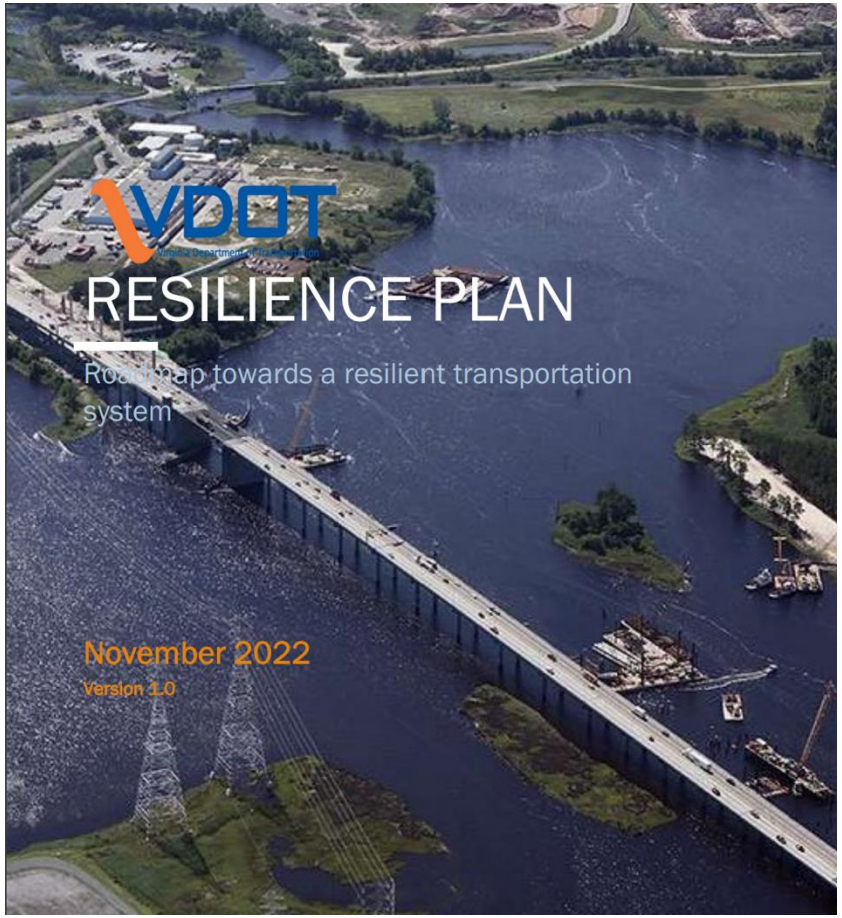
3. *Collaborate with state/regional agencies to systematically identify solutions that facilitate consistent and systematic prioritization and support the allocation of state resources to address flooding risks.*
   - Responsible entity(s): VDOT, DRPT
   - Intent: This action addresses VTrans Risk & Opportunity Register Item #4: Proactively eliminate or mitigate identified flooding risks.

DEFINITION OF TRANSPORTATION RESILIENCE

Transportation Resilience

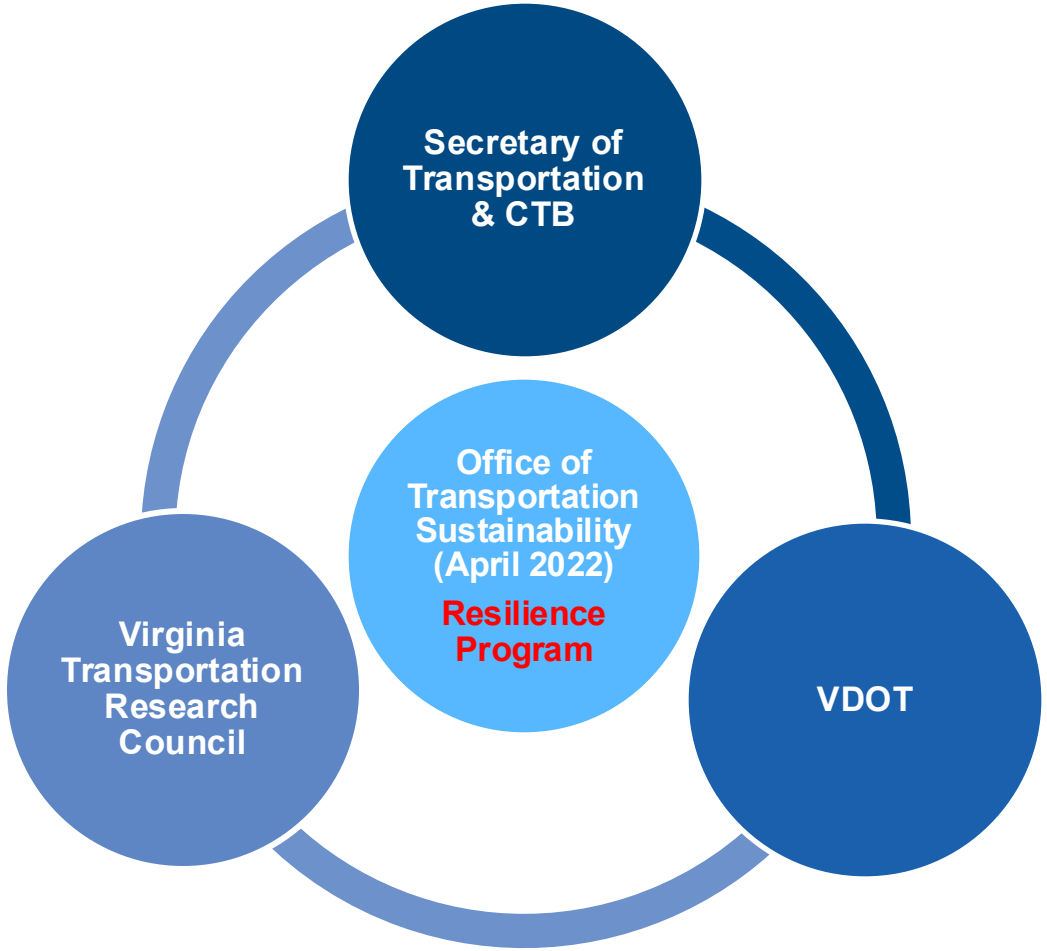
Resilience is the capability of a transportation project or strategy to anticipate, prepare for, respond to, or recover from significant multi hazard threats with minimum damage and disruption to the transportation network, while preserving and incorporating natural and built infrastructure that helps to mitigate these threats.

Incorporate resilience into existing business practices



RESILIENCE ROLES

Organizational Support for Resilience Efforts



Resilience Research Advisory Committee

- Led by VTRC and Resilience Program
- Resilience research across Divisions

Chiefs, Deputy Commissioner & Commissioner

Resilience Administrators Committee

- Division Administrators
- District Engineers

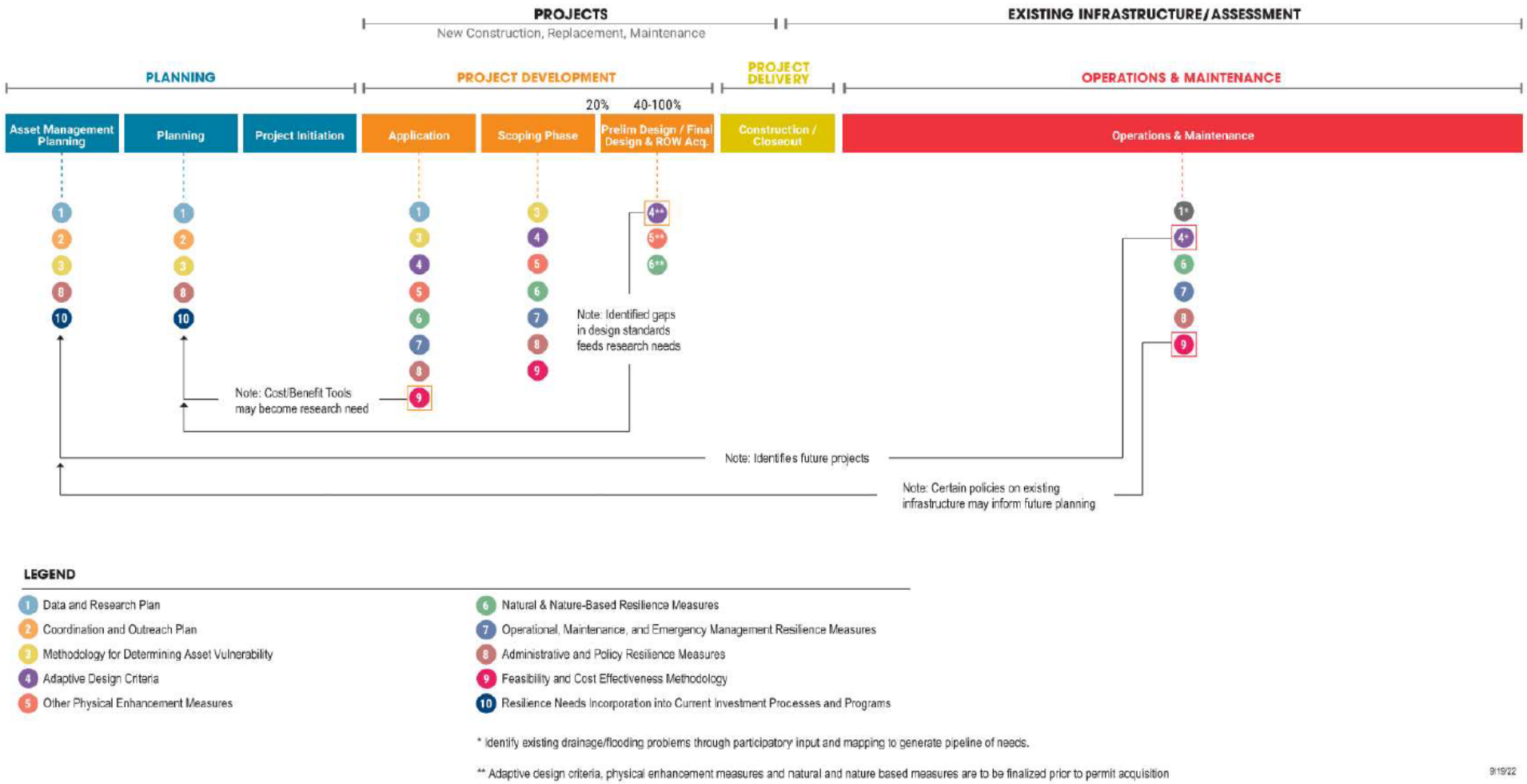
Resilience Steering Committee

- Environmental Division
- Location and Design Division
- Materials Division
- Business Integrated Solutions Division
- Structures and Bridge Division
- Infrastructure Investment Division
- Safety, Security and Emergency Management
- Asset Management Division
- Operations Division
- Maintenance Division
- Governance and Legislative Affairs Division
- Virginia Transportation Research Council
- Transportation and Mobility Planning Division

VDOT RESILIENCE PLAN – Objectives & Strategies

VDOT RESILIENCE PLAN – PDOM Integration

Figure 3. Integration of Resilience Plan Strategies into VDOT's Existing Business Practices



VDOT BUSINESS PLAN – Resilience Objectives

Virginia Department of Transportation
FY2024-2026 Business Plan

Objective 3.4: Implement VDOT's Resilience Plan

VDOT will maintain and strengthen the resilience of its infrastructure, called for in the VDOT Resilience Plan that will influence the agency's construction program. The Resilience Plan is a framework to incorporate resilience into the agency's business including transportation planning, project development, delivery, operations, maintenance and emergency management.

Related Strategies

- 3.4.1 **By June 2025, incorporate or enhance resilience review into design processes** through accomplishment of the following key milestones:
  - **Milestone 1: June 2024 –** Identify suite of enhanced or adaptive design criteria for further consideration.
  - **Milestone 2: December 2024 –** Develop a methodology to determine infrastructure vulnerability.
  - **Milestone 3: June 2025 –** Incorporate application of appropriate design criteria based on vulnerability assessment.
  - **Milestone 4: June 2025 –** Develop or revise supporting standards, guidance documents and policies.

3.4.1 VDOT Resilience Plan Implementation Milestones

Virginia Department of Transportation
FY2024-2026 Business Plan

Objective 4.2: Maintain and Strengthen the Resilience of Virginia's Roadway Infrastructure

Goal: Resilient Roadway Infrastructure

VDOT will maintain and strengthen the resilience of its infrastructure through establishment of the strategies called for in the VDOT Resilience Plan that will influence the agency's maintenance and operations programs.

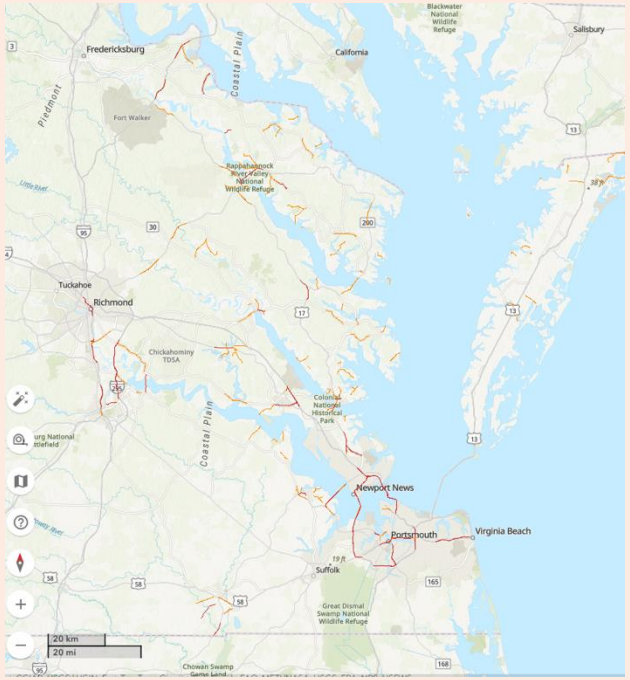
Related Strategies

- 4.2.1 **June 2024 – Identify a suite of operational and maintenance measures** for further consideration.
- 4.2.2 **June 2025 – Adopt operational and maintenance resilience measures** based on vulnerability assessment.
- 4.2.3 **June 2025 – Develop or revise supporting standards, guidance documents and polices** to integrate into current business practices.

4.2 Implementation Milestones

VDOT RESILIENCE TOOLS

1 Identify Vulnerable Infrastructure



Visualization Tool

2 Options to Address/Mitigate Vulnerability

- Adaptive Design Criteria
- ✓ Structures & Bridge Manual – Published Chapter 33
- ❑ Drainage Manual (Hydraulics) – Draft Chapter
- ❑ Manual of Instruction (Pavement and Geotech) – Draft Chapters
- Other Physical Enhancement Practices
- Nature Based Solutions
- Traffic Operations/Emergency Management Practices
- Maintenance Practices

Resilience Practices Toolbox

3 Evaluating BCR and ROI

$$\text{Benefit/Cost Ratio} = \frac{\Delta A+\Delta B+\Delta C+\Delta D+\Delta E}{\Delta \$}$$

Δ A = Annual Replacement Benefit
Δ B = Annual Maintenance Benefit
Δ C = Annual Closure Benefit
Δ D = Annual Traffic Benefit
Δ E = Annual Ecosystem Services Benefit

Δ$ = Projected Cost of Resilience

ROI = (benefits – cost)/cost * 100

Benefit Cost Analysis Tool

RESILIENCE TOOLBOX – Resilience Practices

Adaptive Design Criteria

Enhanced Design Criteria for At Risk Infrastructure – incorporating forward looking conditions

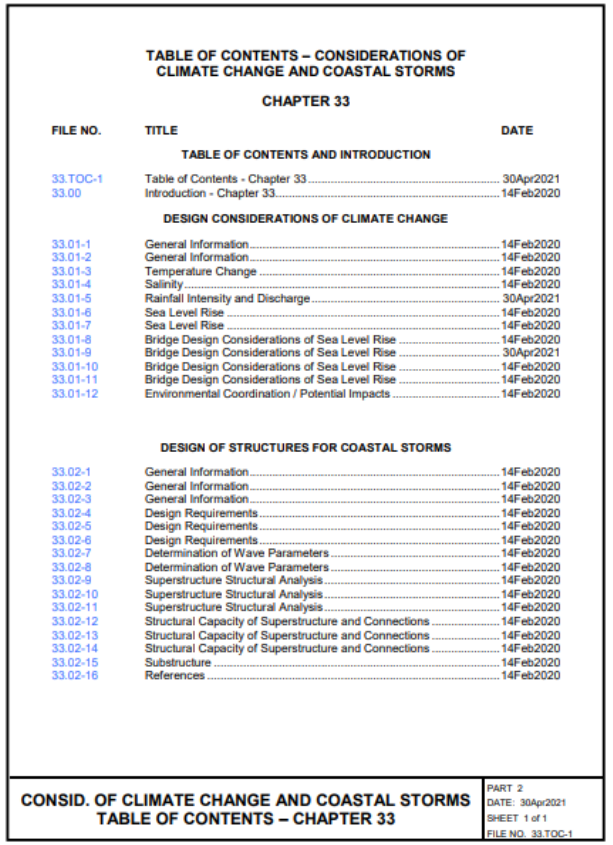


TABLE OF CONTENTS – CONSIDERATIONS OF CLIMATE CHANGE AND COASTAL STORMS

CHAPTER 33

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	TABLE OF CONTENTS AND INTRODUCTION	
33.TOC-1	Table of Contents - Chapter 33	30Apr2021
33.00	Introduction - Chapter 33	14Feb2020
	DESIGN CONSIDERATIONS OF CLIMATE CHANGE	
33.01-1	General Information	14Feb2020
33.01-2	General Information	14Feb2020
33.01-3	Temperature Change	14Feb2020
33.01-4	Salinity	14Feb2020
33.01-5	Rainfall Intensity and Discharge	30Apr2021
33.01-6	Sea Level Rise	14Feb2020
33.01-7	Sea Level Rise	14Feb2020
33.01-8	Bridge Design Considerations of Sea Level Rise	14Feb2020
33.01-9	Bridge Design Considerations of Sea Level Rise	30Apr2021
33.01-10	Bridge Design Considerations of Sea Level Rise	14Feb2020
33.01-11	Bridge Design Considerations of Sea Level Rise	14Feb2020
33.01-12	Environmental Coordination / Potential Impacts	14Feb2020
	DESIGN OF STRUCTURES FOR COASTAL STORMS	
33.02-1	General Information	14Feb2020
33.02-2	General Information	14Feb2020
33.02-3	General Information	14Feb2020
33.02-4	Design Requirements	14Feb2020
33.02-5	Design Requirements	14Feb2020
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33.02-7	Determination of Wave Parameters	14Feb2020
33.02-8	Determination of Wave Parameters	14Feb2020
33.02-9	Superstructure Structural Analysis	14Feb2020
33.02-10	Superstructure Structural Analysis	14Feb2020
33.02-11	Superstructure Structural Analysis	14Feb2020
33.02-12	Structural Capacity of Superstructure and Connections	14Feb2020
33.02-13	Structural Capacity of Superstructure and Connections	14Feb2020
33.02-14	Structural Capacity of Superstructure and Connections	14Feb2020
33.02-15	Substructure	14Feb2020
33.02-16	References	14Feb2020

CONSID. OF CLIMATE CHANGE AND COASTAL STORMS
TABLE OF CONTENTS – CHAPTER 33

PART 2
DATE: 30Apr2021
SHEET 1 of 1
FILE NO. 33.TOC-1

Structure & Bridge

- S&B Chapter 33: Considerations of Climate Change and Coastal Storms (Feb 2020, Rev 2022)
  - Salinity: corrosion resistant materials
  - Rainfall intensity and discharge: 20% increase – deck drainage; 200-yr flood – scour and buoyancy calcs
  - SLR: MHT increased by 4 ft in tidal locations; low chord at least 2 ft above MHT

RESILIENCE TOOLBOX – Resilience Practices

Adaptive Design Criteria

Enhanced Design Criteria for At Risk Infrastructure – incorporating forward looking conditions

Hydraulics – Draft Chapter

- Precipitation Increase and Projected IDF Curves Considerations for design of drainage and stormwater conveyance systems

Materials – Draft Chapters

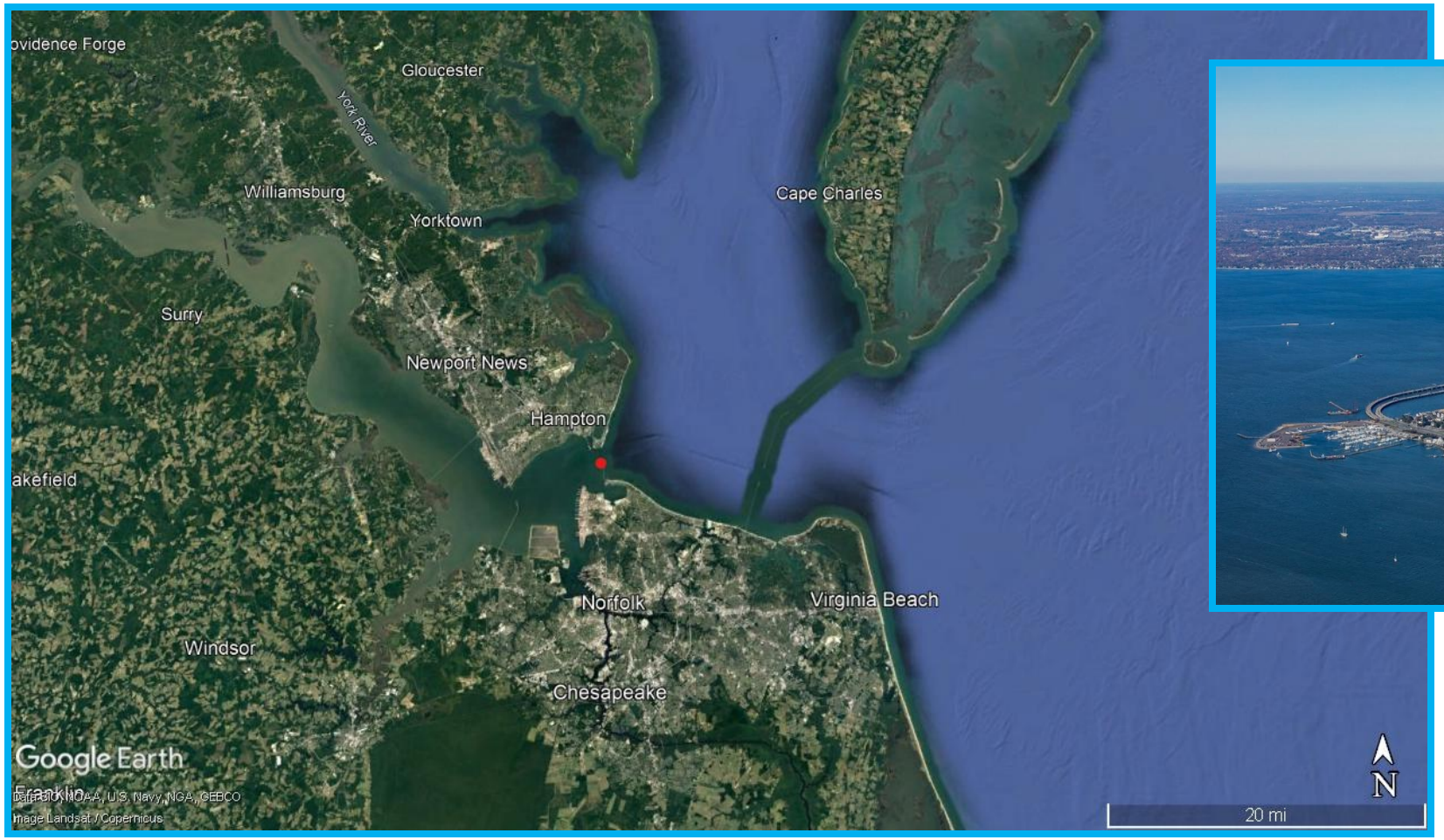
- Pavement design considerations
- Slope and embankment design considerations

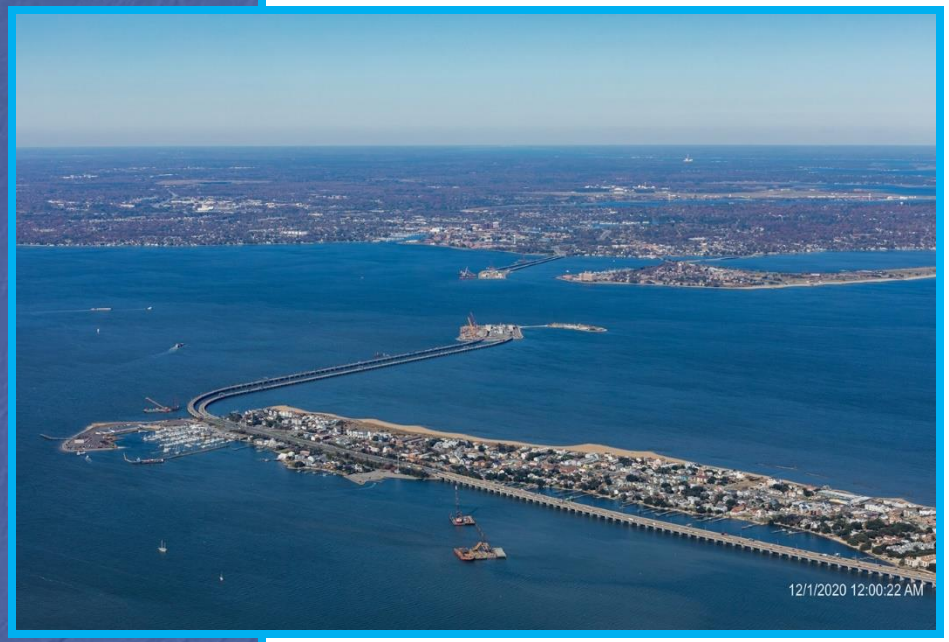
Environmental – Draft Reference Manuals

- Natural and Nature Based Solutions
- Other Physical Enhancements

Adaptive Design Criteria

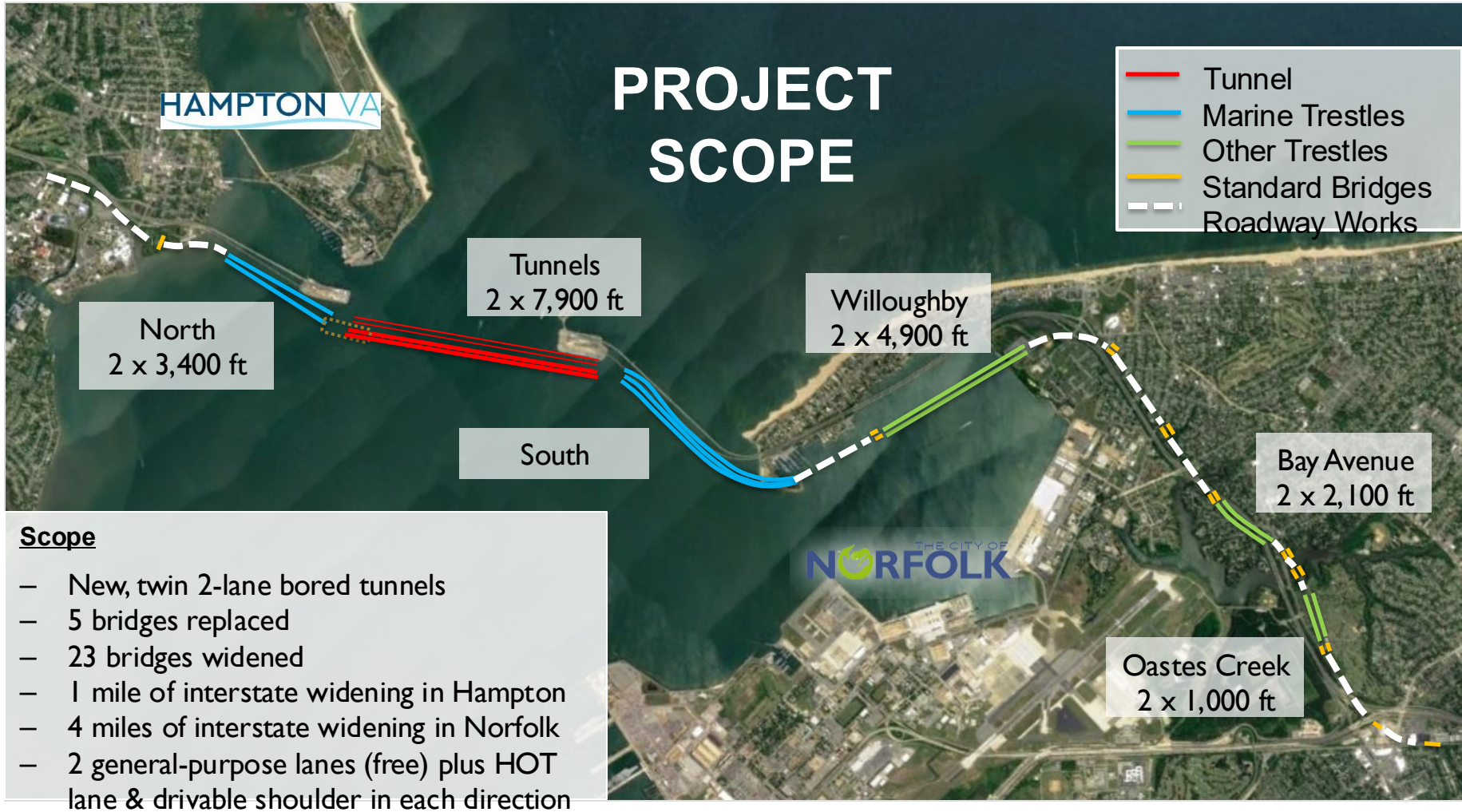
I-64 Hampton Roads Bridge Tunnel (HRBT) Expansion Project





Adaptive Design Criteria

- 2020 – 2026/27
- First bored tunnel for Virginia
- Design/Build Project
- Project Funding:
  - 92% - regional gas and sales tax
  - 8% - state and federal funds



Scope

- New, twin 2-lane bored tunnels
- 5 bridges replaced
- 23 bridges widened
- 1 mile of interstate widening in Hampton
- 4 miles of interstate widening in Norfolk
- 2 general-purpose lanes (free) plus HOT lane & drivable shoulder in each direction

Adaptive Design Criteria

Climate change and coastal storms considerations

- Higher structures to accommodate sea level rise (5-10 ft)
- Floodgates in the tunnels were designed for the effects of storm surge plus an additional 5 feet
- Increased number of scuppers/deck drainage to account for increase in precipitation

Adaptive Design Criteria

Climate change and coastal storms considerations

- Use of corrosion resistant and corrosion free materials
- Concrete piles: carbon fiber or stainless steel prestressing strands
- Pier caps: stainless steel reinforcement & low permeable concrete
- Pre-stressed concrete bulb tee girders: carbon fiber prestressing strands & low carbon chromium shear reinforcement with low permeable concrete
- Bridge Deck: stainless steel reinforcing steel with low cracking concrete

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VDOT

Virginia Department of Transportation

Thank You!

Q&A and Discussion

Submit your questions using Zoom’s chat feature or raise your hand!

All webinars available online:

https://www.tam-portal.com/event-directory/tam-webinars/

Save the Dates!

A bimonthly webinar series, Wednesdays at 2:00 PM EST

Next Webinar

Wednesday, June 18th, 2025 – 2:00 PM EST
Topic: Risk Management Plans in TAMPs.

More to follow!

Federal Highway Administration

AASHTO
THE VOICE OF TRANSPORTATION

For more information or to register:

https://www.tam-portal.com