

VIRGINIA DEPARTMENT OF TRANSPORTATION RESILIENCE PROGRAM



VDOT Office of Transportation Sustainability

Established in 2022 in VDOT's Environmental Division to balance transportation needs with emerging environmental issues through stakeholder engagement, strategic planning, and project implementation



Decarbonization Program

- Electric vehicle charging
- Public transportation
- Low carbon materials

\$ *Carbon Reduction Program*
\$ *National Electric Vehicle Infrastructure Program*



Resilience Program

- Vulnerability analysis
- Adaptive design
- Green infrastructure

\$ *PROTECT Formula and Discretionary Grant Programs*



Land Stewardship Program

- Aquatic organism passage
- Wildlife connectivity
- Pollinator habitat

\$ *Culvert Aquatic Organism Passage Program*
\$ *Wildlife Crossings Pilot Program*

Resilience Drivers

Hazards and Threats

- Increased temperature
- Sea level rise
- Increased precipitation
- Extreme weather events
- Rockfall & slope failures

Impacts

- Asset deterioration and failure
- Operational, maintenance and emergency management challenges
- Shifting migration patterns, habitat, etc.



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 Actions¹

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.
 - o Responsible entity(s): VDOT
 - o 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.
 - o Responsible entity(s): VDOT, DRPT
 - o 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.
 - o Responsible entity(s): VDOT, DRPT
 - o Intent: This action addresses VTrans Risk & Opportunity Register Item #4: Proactively eliminate or mitigate identified flooding risks.

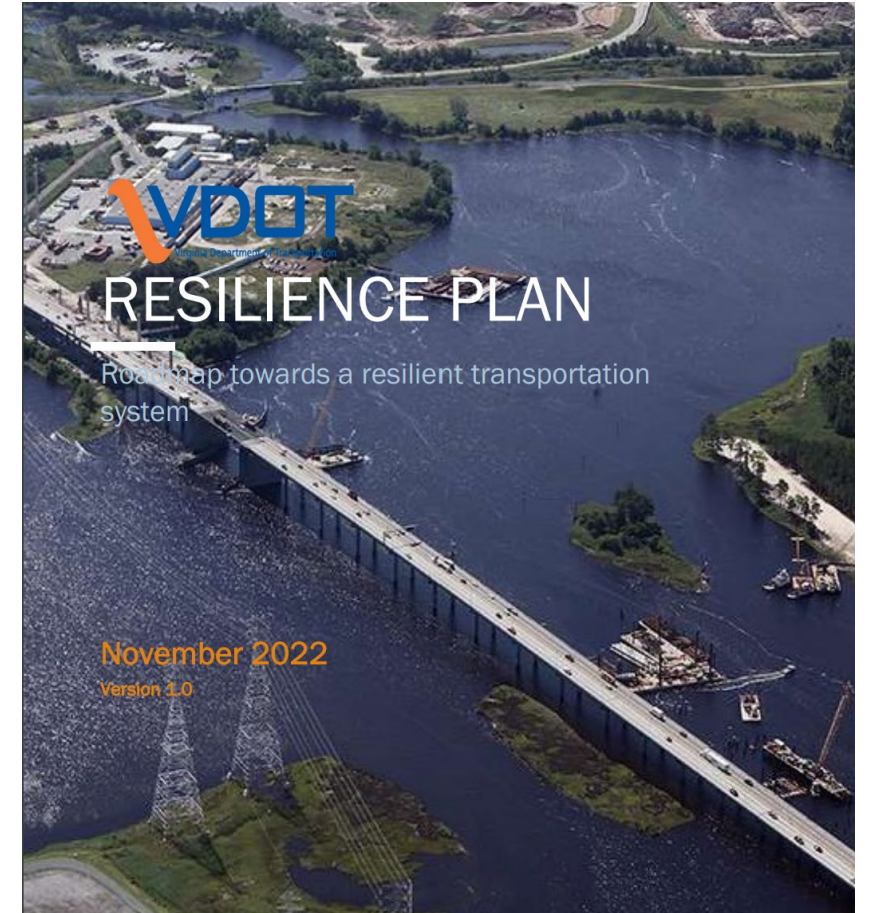
DEFINITION OF TRANSPORTATION RESILIENCE

Transportation Resilience

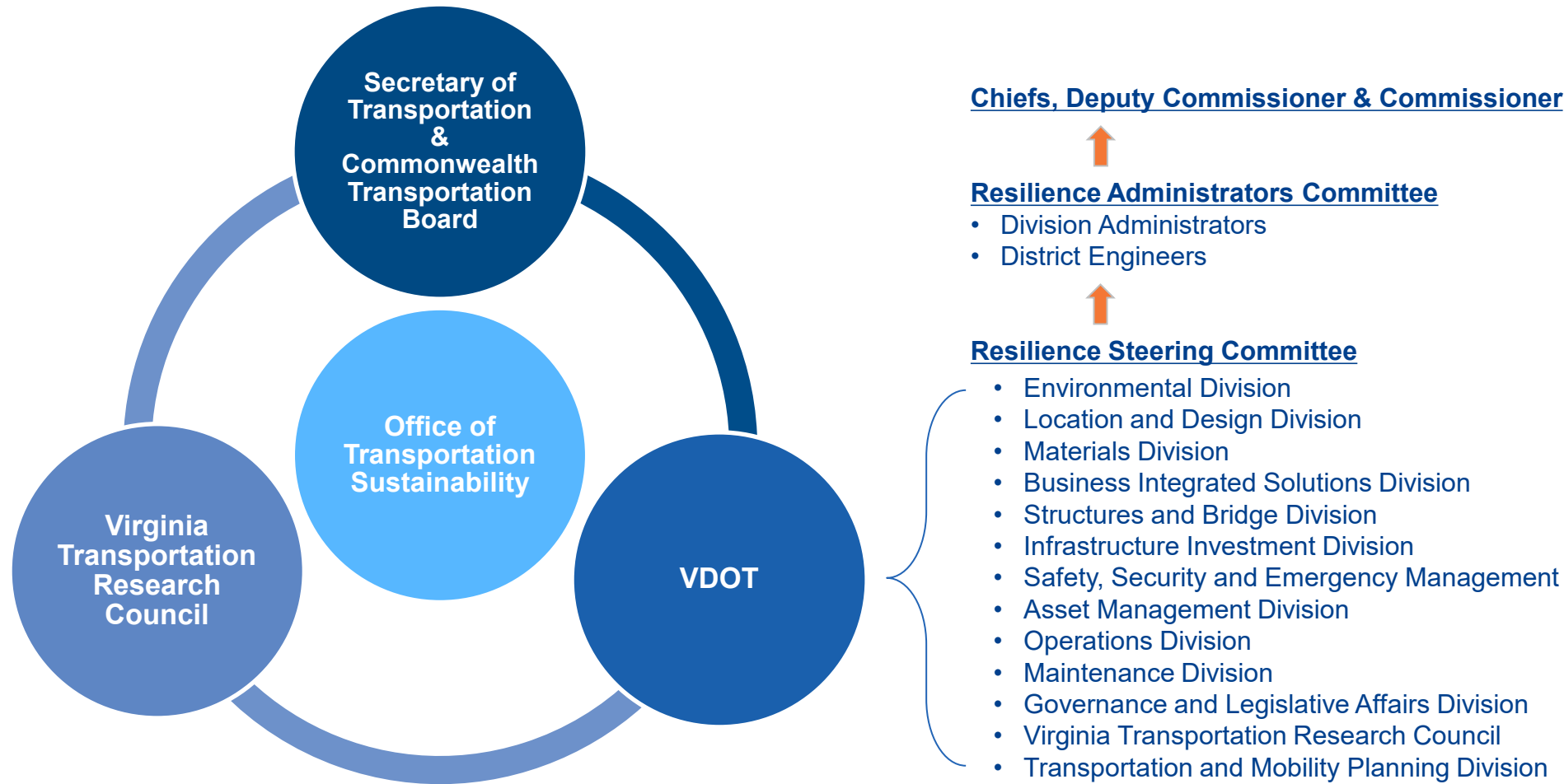
Resilience is the capability of a transportation project or strategy to anticipate, prepare for, respond to, or recover from significant multi hazard threats with minimum damage and disruption to the transportation network, while preserving and incorporating natural and built infrastructure that helps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



Incorporate resilience into existing business practices



Organizational Support for Resilience

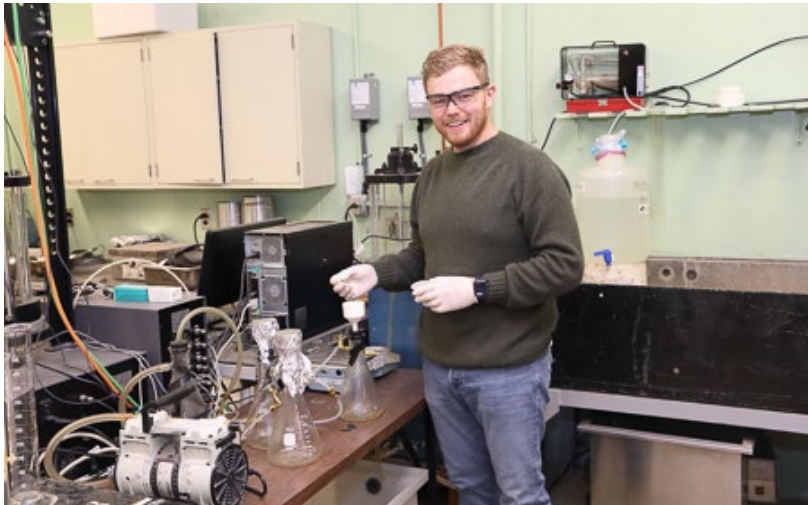


VDOT Resilience Plan



| | |
|---|---|
|  1. Data Driven Decisions | <ul style="list-style-type: none">• Authoritative Datasets• Data and Research Gaps |
|  2. Stakeholder Engagement | <ul style="list-style-type: none">• Coordination with Federal, State, MPO, Local Initiatives |
|  3. Identify At-Risk Infrastructure | <ul style="list-style-type: none">• Visualization Tool (Asset and Network Vulnerability and Risk Assessment)• Inform focus areas, projects |
|  4. Resilience Practices | <ul style="list-style-type: none">• Adaptive Design Criteria (Hydraulics, Materials, Structure and Bridge)• Other Physical Enhancement Practices• Natural and Nature-based Solutions• Operational, Maintenance, and Emergency Management Practices• Administrative and Policy Practices |
|  5. Feasibility and Cost Effectiveness Analyses | <ul style="list-style-type: none">• Develop Benefit Cost Analysis Tools |
|  6. Funding Opportunities | <ul style="list-style-type: none">• PROTECT• Other Funding Opportunities |

Strategy 1: Promote Data Driven Decisions



Characterizing & Understanding Historical Flood-related Road Closures

Investigation of Recurring Flooding at Existing Inland VDOT Structures

Feasibility and Benefit of Flood Sensors for Traffic Operations and Emergency Management Operations

Relationship between Climatic Factors and Rockfall

Development of a Method of Estimating Maximum Flood Elevation Due to Storm Surge

Methodology to Address Impact of Softened Unbound Layers Due to Flooding

Comprehensive Drainage and Material Characterization

Evaluating the Feasibility and Benefit of an Impervious Layer Inclusion Above the Ground Water Table

Assessment of Allowable Headwater Design Criteria for Large Culverts

Streamflow Discharge Projections Considering Climate Change and Application

Identification and Evaluation of Natural and Nature-Based Solutions

Pilot Application of FloodCast Technology

Identification and Evaluation of Remote Monitoring for Potential Damage Due to Flood and Seismic Events

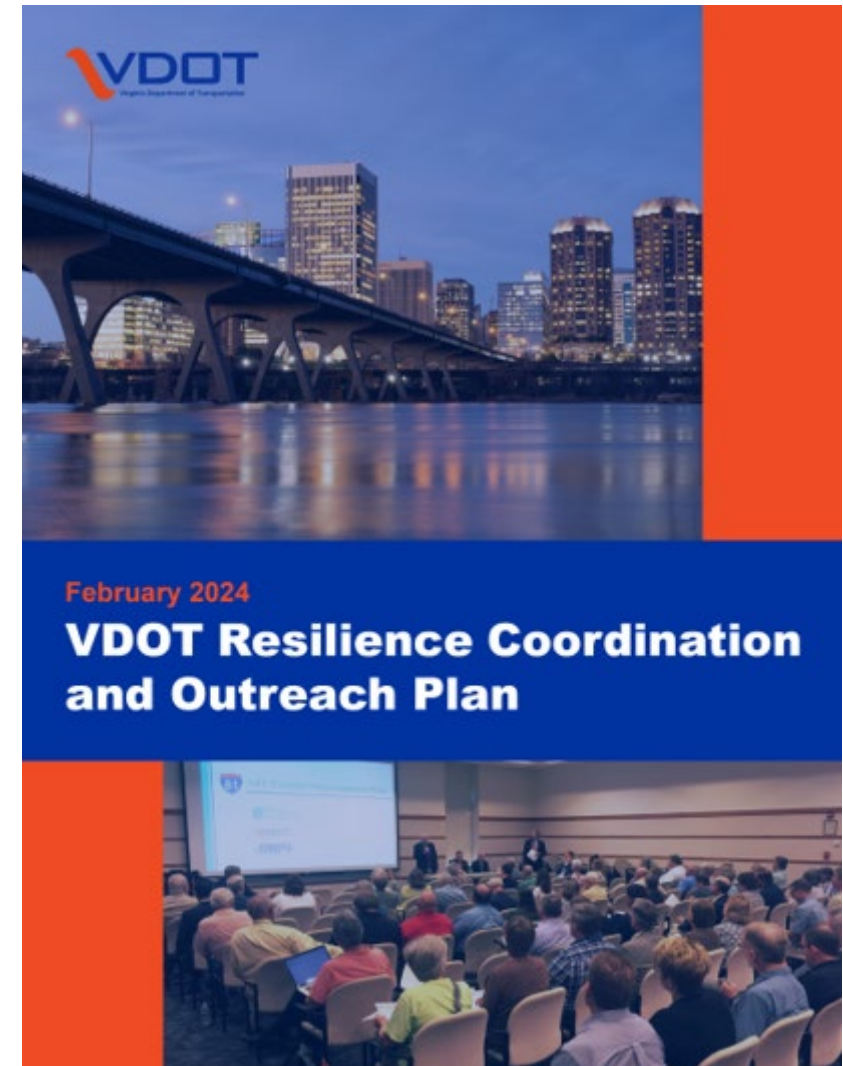
Maintenance Actions to Increase Resiliency of Bridges and Culverts

Assessing the Moisture Sensitivity or Durability of Full-Depth Reconstruction

Assessment of Flood Damage in Pavements

Strategy 2: Engage and Partner with Stakeholders

- Stakeholder engagement
- Coordination with statewide policy and other local and regional efforts in the Commonwealth
- Coordination and outreach plan completed February 2024
- Continued coordination and outreach: internal and external
 - National working groups
 - State agencies
 - Metropolitan planning organizations
 - Localities
 - Universities
 - Environmental organizations



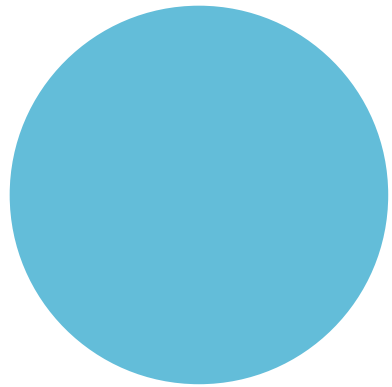
Strategy 3: Identify At-Risk Infrastructure

Develop a methodology for determining asset vulnerability

- A risk-based methodology that considers exposure, sensitivity, and criticality to provide a measure of overall vulnerability
- Provide a systematic, documented approach for the application of resilience strategies to VDOT assets

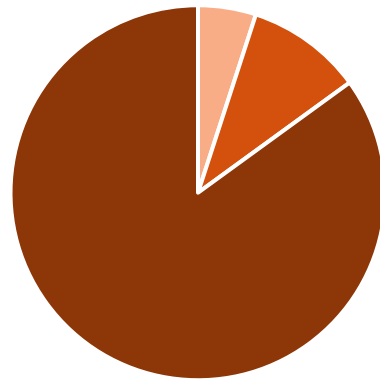
Methodology

For a given hazard (flooding/landslide), a vulnerability score is calculated based on three components:



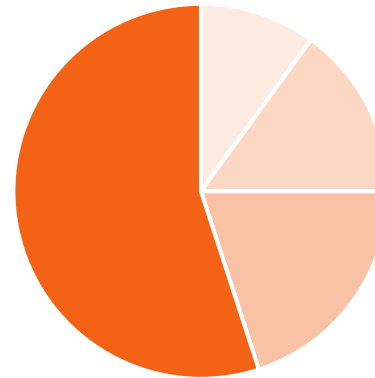
Exposure

Whether an asset is located in an area that has or will experience direct effects of climate variability and extreme weather events. Exposure is a prerequisite for vulnerability.



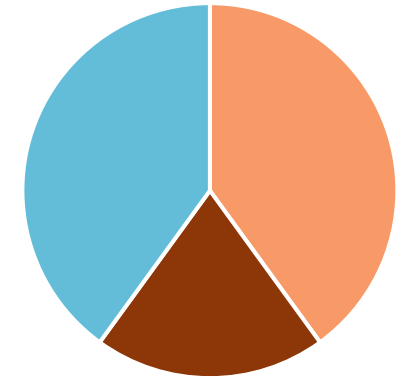
Sensitivity

How an asset responds to, or is affected by, exposure to a climate change stressor. A highly sensitive asset will experience a large degree of impact if the climate varies even a small amount.



Adaptive Capacity/Criticality

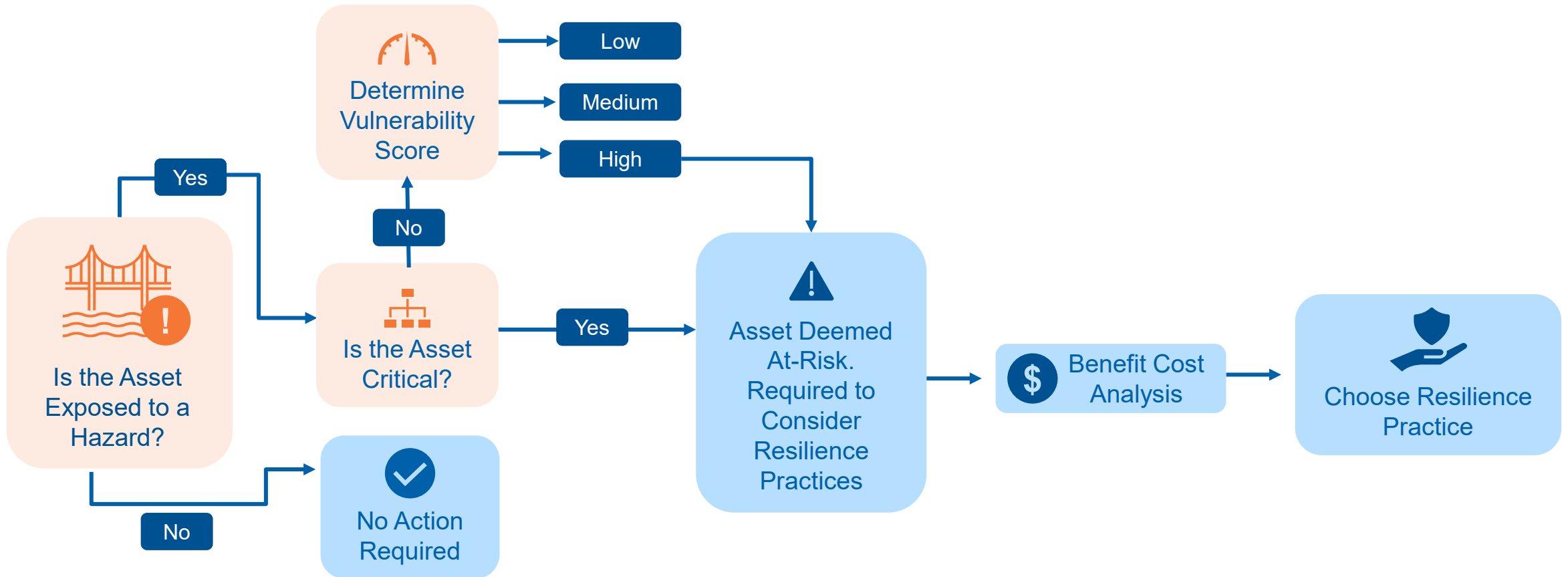
The ability of a transportation asset or system to adjust, repair, or flexibly respond to damage caused by climate variability or extreme weather.



Vulnerability

The degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change or extreme weather events.

At-Risk Infrastructure Visualization and Decision Support Tool



Strategy 4: Identify Resilience Practices

Resilience Practices Being Evaluated Include:

- Adaptive Design Criteria
 - Draft Pavement Section 609, and Draft Geotech Section 3
 - Draft VDOT Drainage Manual Chapter 18
 - Structure & Bridge Manual Chapter 33
- Other Physical Enhancement Practices
 - Small Scale Flood Barriers
 - Flood Attenuation: Breakwater, Groins, Riverine Veins, Flow Redirection Berms
 - Stormwater Improvements: Drainage/Storage Capacity, Alternative Designs, Newer innovations
 - Slope Stabilization: Revetments and Reinforcements

Strategy 4: Identify Resilience Practices

- Operational, Maintenance, and Emergency Management
 - Enhanced Maintenance Practices in Advance of Weather Events
 - Maintenance Activities for Identified At-Risk Infrastructure
 - Early Warning Device Technology
 - Equipment Design Considerations for ITS and Traffic Operations
 - Power redundancy for ITS and Traffic Operations Equipment
 - Network Redundancy Review
 - Identify Mitigation Opportunities
- Other Administrative and Policy Practices
 - Resilient Procurement
 - Enhanced Resilience Practices/Betterments
 - Resilience Certifications
 - Stormwater, Groundwater, and Green Infrastructure
 - Cool Pavements

Strategy 4c: Natural and Nature Based Solutions

Structural solution



Traditional seawalls: concrete and riprap

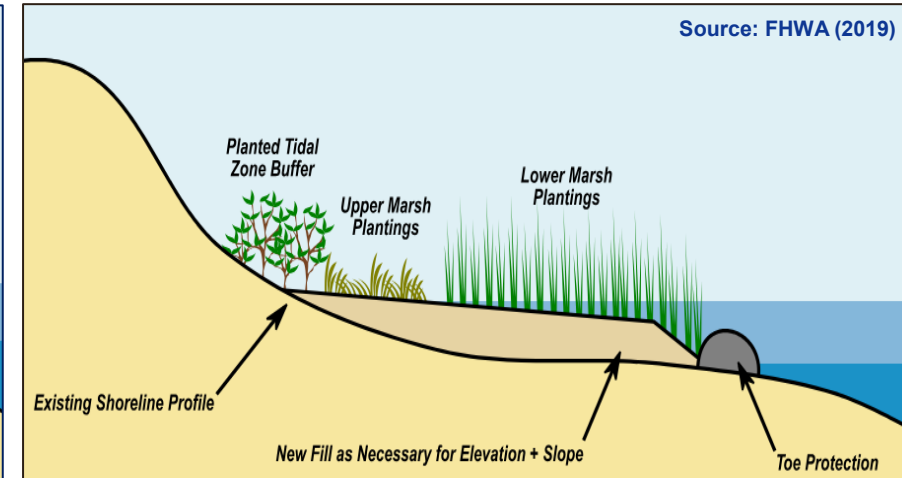
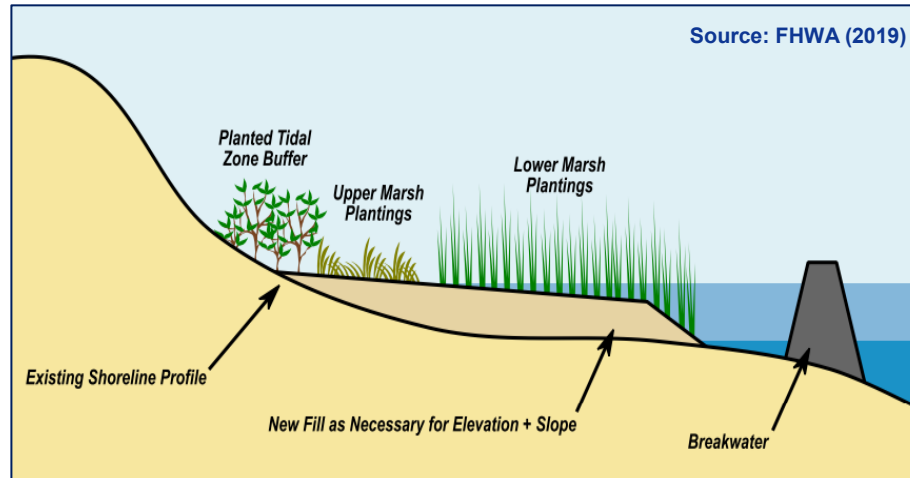
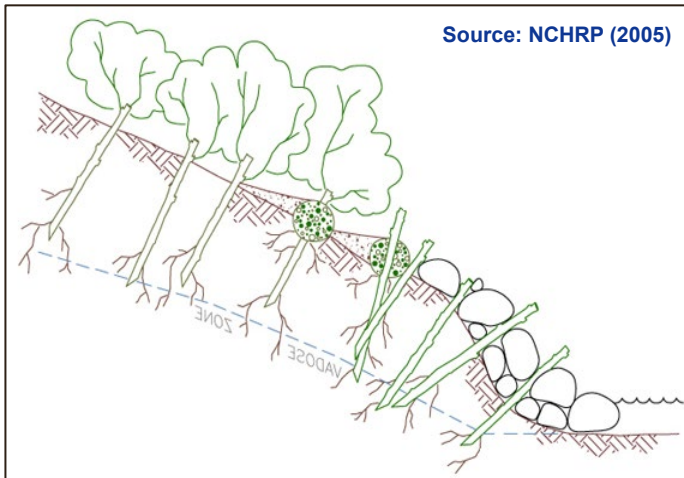
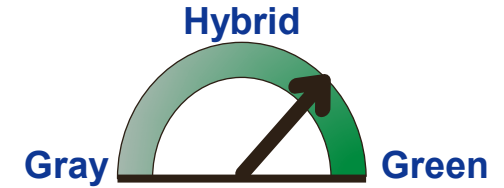
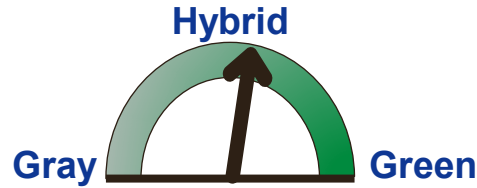
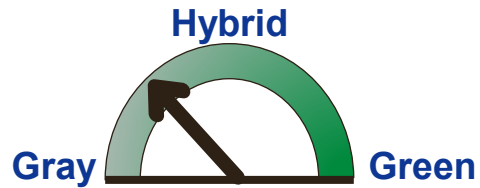
Constructed marsh, including fill and planting.
Can include breakwaters/sills to reduce wave energy

Nature-based solution



Strategy 4c: Natural and Nature Based Solutions

Conceptual Design Alternatives with corresponding benefit cost analysis



Vegetated Revetment

- Simple materials
- Simple construction
- Low ecological benefits
- Low upfront costs

Marsh + Breakwater

- Reduces wave height
- Generates pocket beaches
- Moderate ecological benefits
- Moderate upfront costs

Marsh + Sill

- Attenuates wave energy
- Stabilizes marsh platform
- High ecological benefits
- High upfront costs

Strategy 5: Feasibility and Cost Effectiveness Methodology

- Benefit-Cost Analysis Tool under development

| | | |
|-----------|---|---------------------|
| Baseline | Hours of Closure per event | 36 |
| Resilient | Hours of Closure per event | 24 |
| Δ | Hours of Closure Reduced per year | 24 |
| | Miles of Detour | 2 |
| Δ | Detour Miles Saved per year | 48 |
| | Detour MPH | 45 |
| Δ | Detour Hours Saved per year | 1.1 |
| | AADT | 500 |
| | Truck % | 20% |
| Trucks: | Travel Time Savings per hour | \$ 33.50 |
| | Vehicle Operating Cost Savings per mile | \$ 1.32 |
| | Emissions Savings per mile | \$ 0.336 |
| | Total Truck Benefit per year | \$ 11,522.13 |
| | Car % | 80% |
| Cars: | Travel Time Savings per hour | \$ 19.60 |
| | Vehicle Operating Cost Savings per mile | \$ 0.52 |
| | Emissions Savings per mile | \$ 0.119 |
| | Total Car Benefit per year | \$ 20,631.47 |
| | Others? All summing to... | |
| D | Annual Traffic Benefit | \$ 32,153.60 |

Strategy 6: Incorporate Resilience Needs into Investment Processes

- Incorporate resilience needs in current investment processes
- Identify opportunities to incorporate resilience into the Department's various funding programs
- Identify new funding opportunities available for resilience projects and initiatives
 - Promoting Resilient Operations for Transformative, Efficient, and Cost-saving Transportation (PROTECT) Program

FHWA PROTECT Program

Promoting Resilient Operations for Transformative, Efficient, and Cost-Saving Transportation (PROTECT)

**Authorized under
Infrastructure Investment
and Jobs Act**



**Ensure
transportation
resilience to natural
hazards**

**\$189M allocated for
Virginia over 5 years**



**Voluntary Resilience
Improvement Plan**

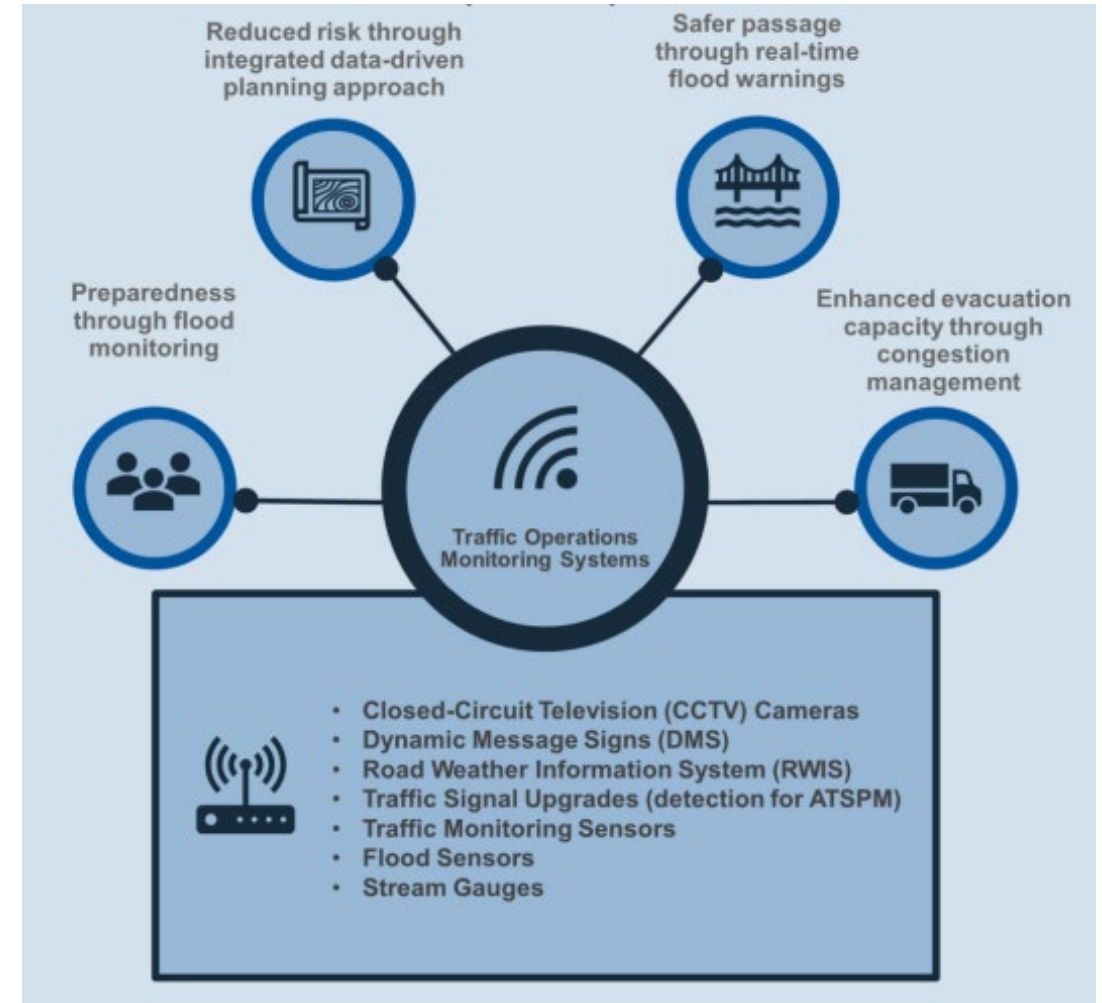
USDOT FHWA PROTECT Program

Promoting Resilient Operations for Transformative, Efficient, and Cost-Saving Transportation (PROTECT)

- Formula Funding and Discretionary Grants
 - Planning Activities, including Resilience Improvement Plan (RIP)
 - Resilience Improvements
 - Community Resilience & Evacuation Routes
 - At-Risk Coastal Infrastructure
- Initial formula funding used for resilience planning, research, and capacity building; drainage inventory; evacuation route planning; hardening and elevation of vulnerable bridges
- Grant program open to state agencies, metropolitan planning organizations, and local governments

Modernizing Operations for Virginia's Evacuation Resilience (MOVER)

- VDOT awarded \$5.4 million in April 2024
- Install a weather and traffic monitoring system to support operational and emergency response to flooding and extreme weather events in Virginia's Tidewater and Chesapeake region (Hampton Roads District, Fredericksburg District, Richmond District)
- Will serve as a regional pilot to inform future statewide monitoring efforts



Next Steps

- Continue pilot projects
- Finalize Adaptive Design Criteria and other resilience practices
- Finalize At-Risk Infrastructure Visualization Tool
- Finalize Cost-Benefit Analysis
- Evaluate incorporation of resilience into funding policies

Thank you

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