



COMMONWEALTH of VIRGINIA  
*Office of the*  
SECRETARY of TRANSPORTATION

**VTrans Trends Analysis – Webinar #2**  
**Draft Vulnerability Assessment**

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Office of Intermodal Planning and Investment (OIPI)

June 15, 2021



## DISCUSSION ITEMS

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- **Resources**
- **Purpose of the Webinar**
- **Context and Overview**
- **Methodology**
  - Limitations
- **Related Work by State Entities**
- **Next Steps**



## RESOURCES

- [Meetings Page](#) for this meeting on the VTrans Website will include presentation material.

The screenshot displays the VTrans website interface. At the top, the logo reads "VTRANS VIRGINIA'S TRANSPORTATION PLAN". A search bar contains the text "Search for meetings, reports, etc.". The navigation menu includes "About", "Vision and Actions", "Mid-Term Planning", "Long-Term Planning", and "Meetings and Updates". A red arrow points from the "Meetings Page" text in the list above to the "Meetings" sub-menu item under "Meetings and Updates".

Below the navigation, a section titled "Latest VTrans and GAP Updates" features a date "June 9, 2021" and a link "Upcoming VTrans Outreach and Engagement". The text below the link states: "There are several opportunities to gather Information and to provide feedback on the development of the VTrans Long-term Needs". To the right of this text is a photograph of a meeting.

Below the main update, there are two smaller update cards:

- Mar 24, 2021: [Get to know the Prioritized VTrans Mid-term Needs](#)
- Mar 17, 2021: [The Commonwealth Transportation Board takes action on VTrans](#)

A "View All Updates" button is located to the right of these cards.

The "Meetings" section at the bottom contains three meeting cards:

- Jun 15, 2021 | 1:30pm-3:00pm: [Webinar: VTrans Trends Analysis \(Webinar #2\): Vulnerability Assessment](#) (Other Event)
- Jun 29, 2021 | 1:30pm-3:00pm: [Webinar: VTrans Trends Analysis \(Webinar #3\): Long-term Needs Development](#) (Other Event)
- Jun 10, 2021 | 9:00am-12:40pm: [VTrans and Funding Programs](#) (Other Event)

A "View All Meetings" button is located to the right of these cards.

- This [webpage](#) provides the following resources:

- Technical Memorandum that provides more details on the methodology
- Draft Results based on the methodology

The screenshot shows the VTrans website with the following content:

- Header: VTRANS VIRGINIA'S TRANSPORTATION PLAN, Search for meetings, reports, etc.
- Navigation: About, Vision and Actions, Mid-Term Planning, Long-Term Planning, Meetings and Updates.
- Introductory text: "VTrans is Virginia's Transportation Plan. It is prepared for the Commonwealth Transportation Board by the Office of Intermodal Planning and Investment."
- Breadcrumbs: Home / Long-Term Planning / Vulnerability
- Section: **VTrans Vulnerability Assessment**
- Text: "VTrans identifies vulnerabilities of the Commonwealth's Transportation infrastructure to flooding in coastal areas due to sea level rise and storm surge events, as well as inland flooding, due to precipitation events."
- Section: **Background**
- Text: "In December of 2018, the Commonwealth Transportation Board took action to approve the VTrans Implementation Plan, which outlined key initiatives and specific actions to advance the VTrans Guiding Principles. The VTrans Vulnerability Assessment has been done in accordance with VTrans Implementation Plan Item 'to complete a resiliency assessment of Virginia's multimodal network from a transportation planning perspective.'"
- Section: **Purpose and Limitations**
- Text: "This assessment is a screening-level analysis of the vulnerability of Virginia's transportation system to current and future flood hazards by focusing on vulnerabilities from sea level rise, storm surge, and inland/riverine flooding. Lack of availability of precise data is a major limitation, therefore, these results should only be used for narrowing the focus area for more detailed examination. VTrans Vulnerability Assessment will be conducted on a periodic basis and is expected to benefit from improved data availability in the next iterations."

## TECHNICAL MEMORANDUM



FROM: Office of Intermodal Planning and Investment, Statewide Transportation Planning Section  
TO: VTrans Stakeholders  
SUBJECT: VTrans Vulnerability Assessment (Draft)  
DATE: June 2021

### 1: CONTEXT AND OVERVIEW

#### 1.1 Purpose of the Technical Memorandum

This technical memorandum documents serves the following purposes:

- Defines the terms "Vulnerability" and "Resiliency" to promote common understanding;
  - Documents data sources, methods, and processes used to identify vulnerable transportation facilities; and,
  - Identifies opportunities for improving the accuracy and expanding the scope of the assessment.
- Transportation system vulnerabilities identified based on this analysis will inform the development of VTrans Strategic Actions that may contain process and policy recommendations for the Office of Intermodal Planning and Investment (OIPI), Virginia Department of Transportation (VDOT), and Virginia Department of Rail and Public Transportation (DRPT).

#### 1.2 Structure of the Technical Memorandum

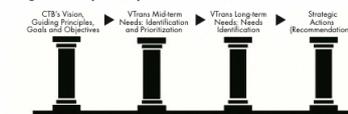
This technical memorandum includes the following appendices:

- Appendix A: List of Acronyms which list all acronyms used in this technical memorandum.
- Appendix B: Literature Review which summarizes literature review that informed the methodology outlined in this technical memorandum.
- Appendix C: Methodology for Creation of Extreme Inland/Riverine Flooding Scenario
- Appendix D: VTrans Relative Sea Level Change Scenarios
- Appendix E: Methodology to Assign Exposure Values to Roadway Segments
- Appendix F: Historical Weather Events Categories which provide details for one of the datasets used for the VTrans Vulnerability Assessment.

#### 1.3 About VTrans

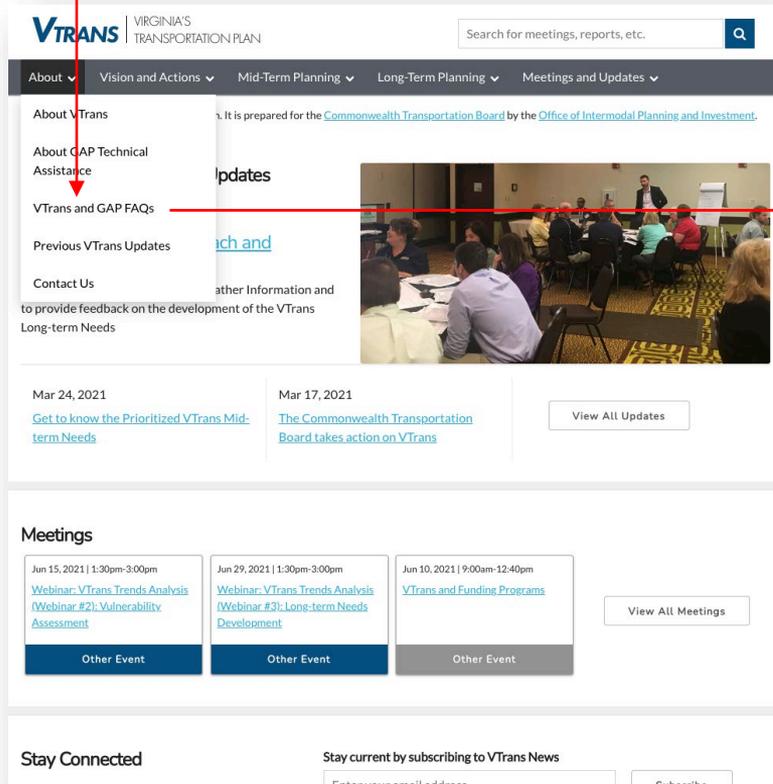
The VTrans Vulnerability Assessment is conducted as part of VTrans, Virginia's Transportation Plan, developed by the Commonwealth Transportation Board (CTB). The CTB, with assistance from OIPI, identifies mid-term and long-term transportation needs and also develops strategic actions to advance the CTB's vision and goals for the state's transportation system. This Vulnerability Assessment task informs VTrans mid-term needs and priorities, VTrans long-term needs, and VTrans Strategic Actions (Figure 1).

Figure 1: Major Components of VTrans

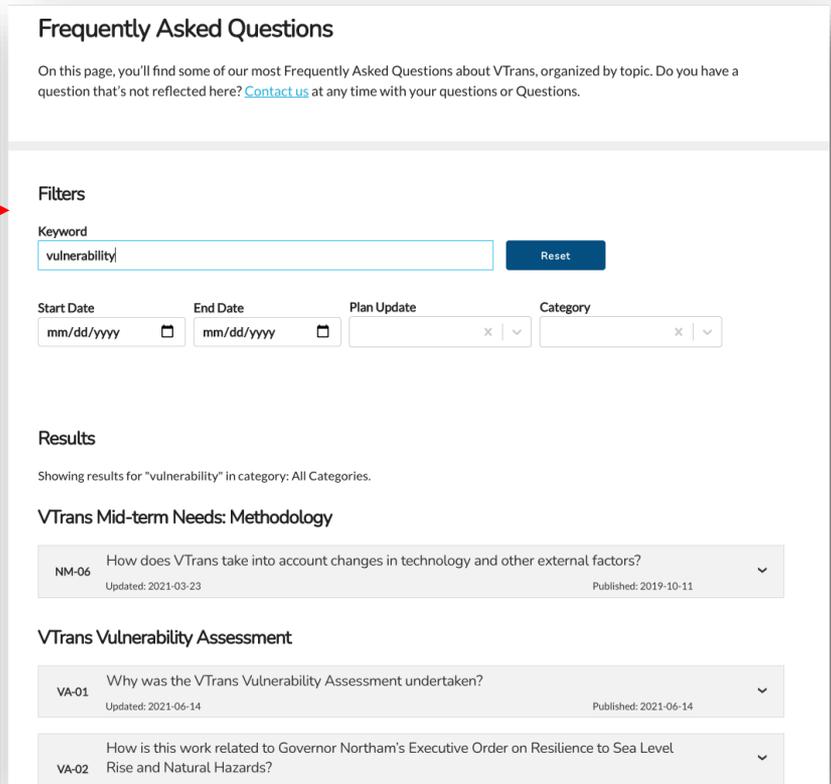


Office of Intermodal Planning and Investment of the Secretary of Transportation established pursuant to § 2.2-2322

- [Frequently Asked Questions](#) page includes questions related to the Vulnerability Assessment.



The screenshot shows the VTRANS website navigation menu. A red arrow points from the 'Frequently Asked Questions' link in the list above to the 'VTrans and GAP FAQs' menu item. The menu also includes 'About VTrans', 'About GAP Technical Assistance', 'Previous VTrans Updates', and 'Contact Us'. Below the menu, there are sections for 'Updates' and 'Meetings'.



The screenshot shows the 'Frequently Asked Questions' page. The search filter is set to 'vulnerability'. The results section shows three items:

- VTrans Mid-term Needs: Methodology**
  - NM-06 How does VTrans take into account changes in technology and other external factors?  
Updated: 2021-03-23  
Published: 2019-10-11
- VTrans Vulnerability Assessment**
  - VA-01 Why was the VTrans Vulnerability Assessment undertaken?  
Updated: 2021-06-14  
Published: 2021-06-14
  - VA-02 How is this work related to Governor Northam's Executive Order on Resilience to Sea Level Rise and Natural Hazards?



## PURPOSE OF THE WEBINAR

## PURPOSE OF THE WEBINAR | PREVIOUS AND UPCOMING OUTREACH ACTIVITIES

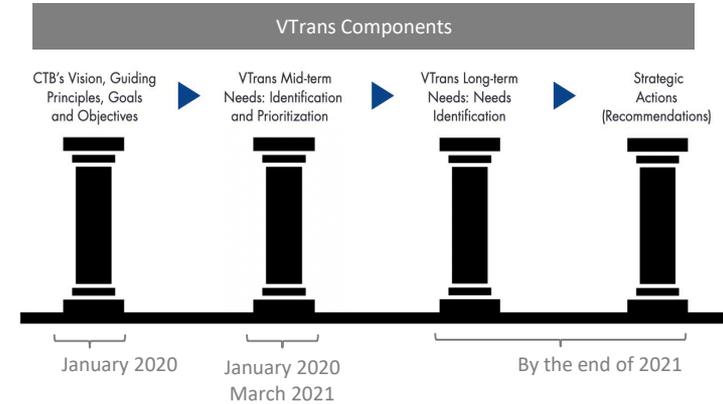
- OIPI has developed draft results that identify and quantify the **transportation system's vulnerability to flooding** from sea level rise, storm surge, and inland/riverine flooding.
- The primary purpose of sharing work on the VTrans Trends Analysis, including the items today, is to **solicit feedback from localities, regional entities, and the public on the initial results** and in-progress work prior to sharing information with the Commonwealth Transportation Board (CTB).
- **Noteworthy Items**
  - Information presented is in draft form and subject to change based on feedback received and additional refinements.



Location: Lorton Road. Source: [Fairfax County](#). Photography by Virginia Department of Transportation.

# PURPOSE OF THE WEBINAR | DIRECTION PROVIDED BY THE CTB

- In **December 2018**, CTB directed the **Office of Intermodal Planning and Investment to (OIPI) to:**
  - Evaluate mid- and long-term viability of federal, state, and regional revenues for multimodal transportation investments.
  - Identify surface transportation infrastructure needs and associated policy and legislative requirements to ensure Virginia’s readiness for shared mobility, and autonomous & connected vehicles.
  - **Complete a resiliency assessment of Virginia's multimodal network** from a transportation planning perspective.
- In **January 2020**, CTB directed OIPI to develop scenarios to assess the impacts of divergent trends to identify Long-term Needs
- In **July 2020**, OIPI presented a framework for the development of VTrans Long-term Needs to the CTB
- In **March 2021**, CTB reaffirmed that direction provided in January 2020
  - “.....develop VTrans Strategic Actions to advance the Board’s Vision and Goals adopted on January 15, 2020 by providing policy- and program-specific recommendations to address the identified and prioritized VTrans Mid-term Needs, as well as to address the **VTrans Long-term Needs identified based on divergent future trends and a vulnerability assessment** per the policy framework presented to the Board on July 14, 2020. “



## PURPOSE OF THE WEBINAR | PREVIOUS AND UPCOMING OUTREACH ACTIVITIES

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- This is the **second** of three Long-term Needs related webinars that focus on different Macrotrends and associated needs.

1. **April 14, 2021:** VTrans Trends Analysis Webinar # 1: Economic and Technology Trends ([View Material and Recording](#))

This Webinar

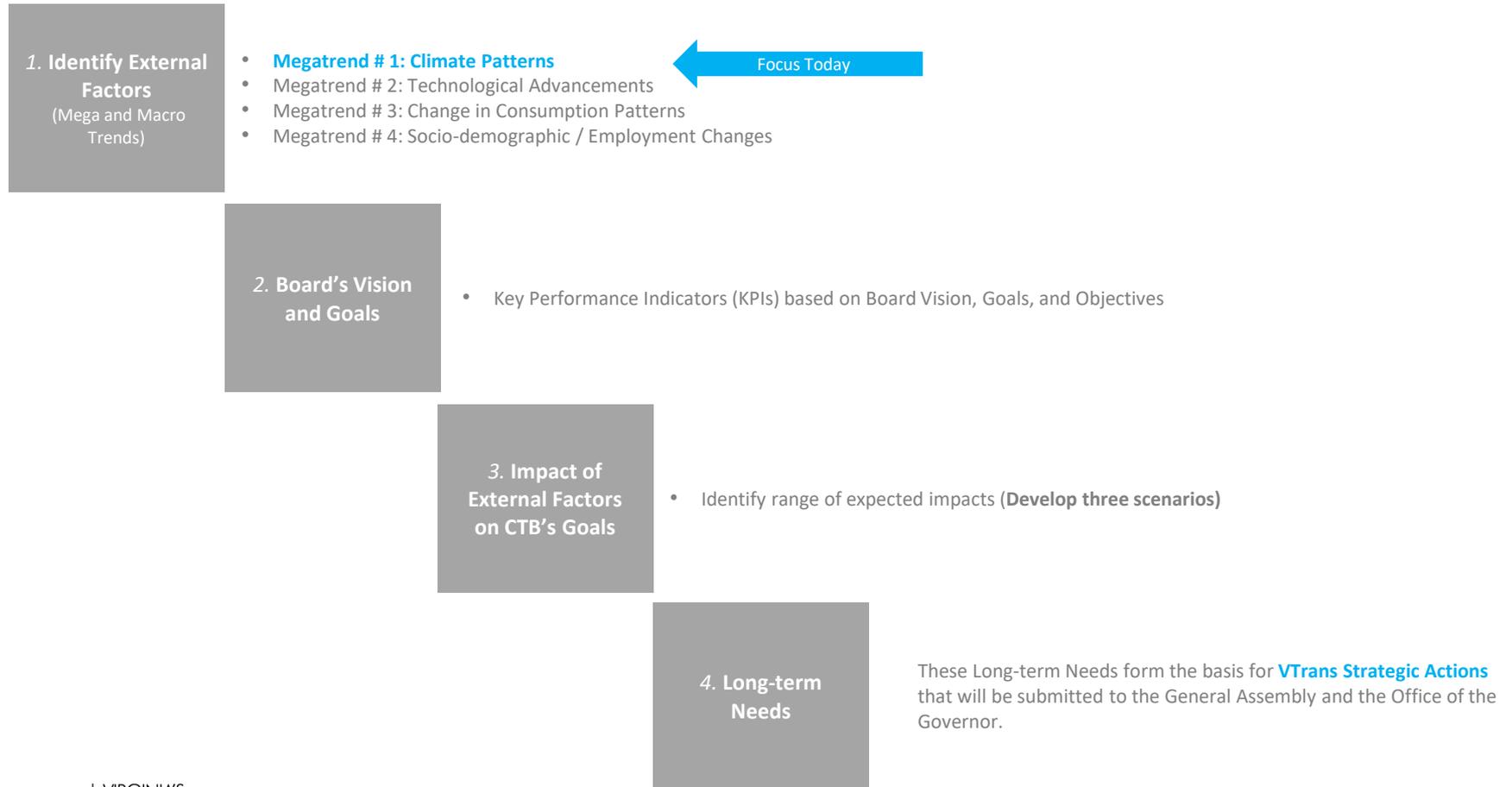
2. **June 15, 2021:** VTrans Trends Analysis Webinar # 2: VTrans Vulnerability Assessment ([View Material and Recording](#))

3. **July 27, 2021:** VTrans Long-term Needs ([Register here](#))



## CONTEXT AND OVERVIEW

# CONTEXT AND OVERVIEW | APPROACH TO THE DEVELOPMENT OF LONG-TERM NEEDS



- As directed by the CTB, OIPI has identified and is conducting analysis for **four Megatrends and ten Macrotrends** that are projected to have an impact on transportation system over the next 20 years as part of the VTrans Long-term Needs identification process.
  - Increase in system vulnerability is one of the ten Macrotrends.

## Focus of This Webinar

### MEGATREND 1: CLIMATE PATTERNS



Increase in Transportation System's Vulnerability due to Flooding

### MEGATREND 2: TECHNOLOGICAL ADVANCEMENTS



Adoption of Highly- Autonomous and Connected Vehicles



Increase in Number of Electric Vehicles



Mobility as a Service

### MEGATREND 3: CHANGE IN CONSUMPTION PATTERNS



E-commerce demand and delivery methods



Greater production automation and 3D Printing

### MEGATREND 4: SOCIO-DEMOGRAPHIC / EMPLOYMENT CHANGES



Increasing Job Flexibility / Remote Work



Professional Services Industry Growth



Growth of the 65+ Cohort



Population Shift and Urbanization

# CONTEXT AND OVERVIEW | MEGA- AND MACROTREND DEFINITIONS

Term	Definition	Notes	Example(s)
Megatrend	A large social, economic, political, environmental or technological change that is slow to form.	Once in place, megatrends influence a wide range of activities, processes and perceptions, both in government and in society, possibly for decades.	Climate Patterns
Macrotrend	An emerging pattern of change likely to impact state government and require a response.  More than one macrotrends can be associated with a megatrend.	Discerning macrotrends and associated responses to trends affecting states involves these questions: <ul style="list-style-type: none"> <li>• Does the megatrend/trend impact Virginia?</li> <li>• Is it significant?</li> <li>• Is it broad-based?</li> <li>• Is it national or regional in scope?</li> <li>• Is it short-term or long-term?</li> <li>• Is it measurable/trackable/observable?</li> <li>• Is it actionable?</li> <li>• Is there an innovative response to address new circumstances?</li> </ul>	<ul style="list-style-type: none"> <li>• Sea level rise</li> <li>• Increase in extreme weather events</li> <li>• Others</li> </ul>

Sources:

- Gordon, Theodore Jay (1994) "Trend Impact Analysis" Futures Research Methodology. Jerome C. Glen, ed. Washington, D.C: American Council for the United Nations University, 1994.
- [Transportation Policy Task Force Suggested State Legislation Docket](#), 2009. California
- [Webpage "Megatrend / Trend / Driver / Issue. European Foresight Platform."](#) Accessed on March 12, 2021.

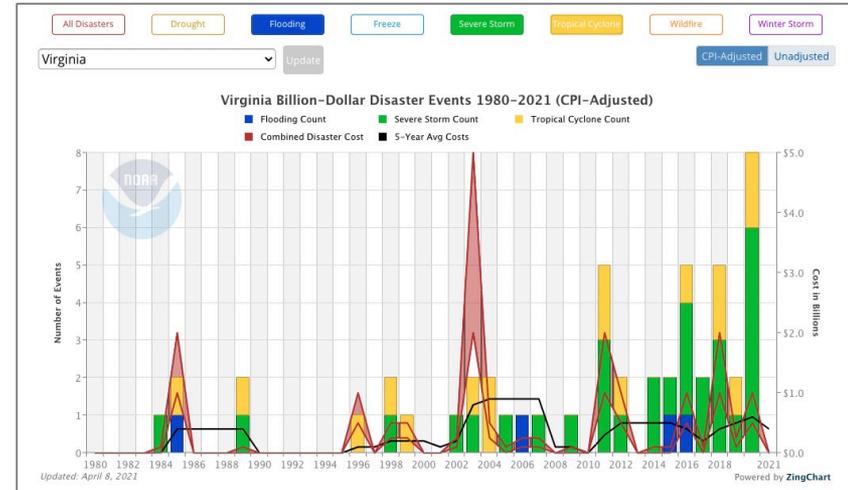
- **Why have changing climate patterns been identified as a Megatrend?**

- Per the [Fourth National Climate Assessment](#), “the number and cost of weather and climate disasters are increasing in the United States due to a combination of increased exposure (i.e., more assets at risk), vulnerability (i.e., how much damage a hazard of given intensity—wind speed, or flood depth, for example—causes at a location), and the fact that climate change is increasing the frequency of some types of extremes that lead to billion-dollar disasters.”
- Also, per [NOAA’s National Centers for Environmental Information \(NCEI\)](#), “2020 was a historic year of extremes.”
- Virginia’s transportation system is planned and designed to operate under certain conditions. A change in exposure to natural events may result in long-term needs – the focus of VTrans.

- **Why only focus on flooding-related hazards?**

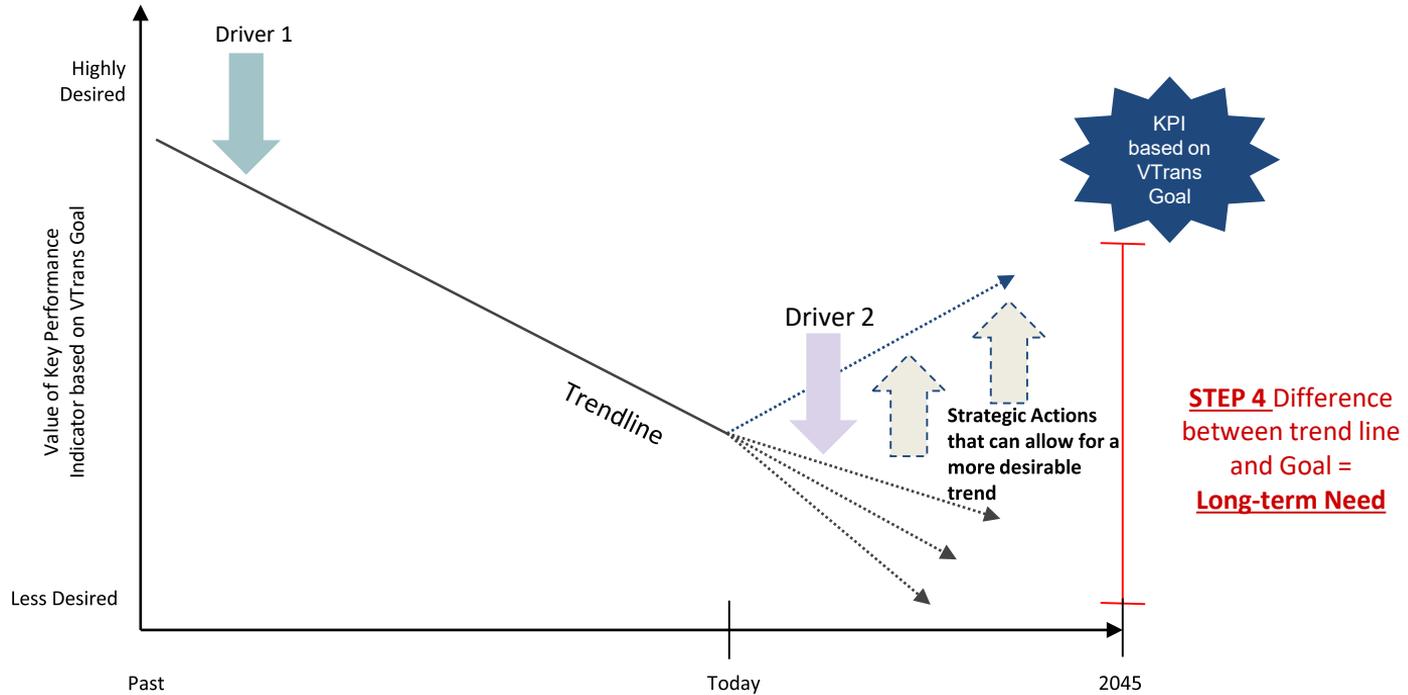
- For Virginia, sea level rise, storm surge, and inland/riverine flooding-related hazards address a large portion of the total exposure.
- These three, when combined, have statewide scope and potential impact on the surface transportation system.

Count and Cost of Billion-dollar Flooding, Severe Storms, and Tropical Cyclones in Virginia



Source: [NOAA’s National Centers for Environmental Information \(NCEI\)](#)

# CONTEXT AND OVERVIEW | APPROACH TO THE DEVELOPMENT OF LONG-TERM NEEDS - EXAMPLE

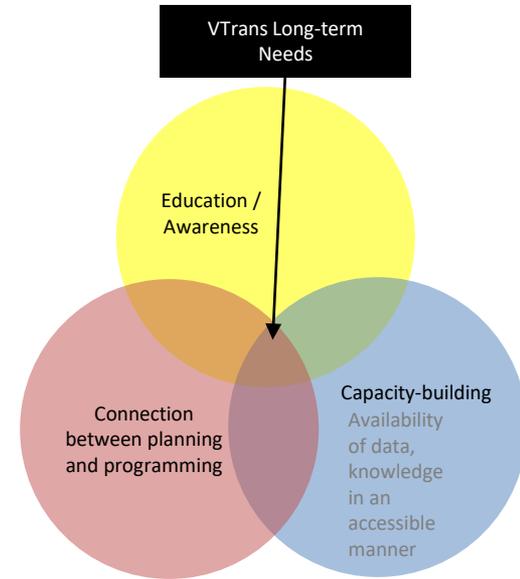


- **The purpose of the VTrans Trend Analysis is to plan, not predict by:**
  - Avoiding [“SOS or Shiny Object Syndrome”](#) while identifying Macrotrends
  - Relying on reputed, preferably peer-reviewed, research
  - Setting up a process that can be replicated and repeated as more precise data becomes available
  - Documenting limitations and opportunities for continuous improvements.

“All predictions are wrong, that's one of the few certainties granted to mankind.”

— Milan Kundera, *Ignorance*

- **The primary purposes for analyzing the Megatrend: Transportation System Vulnerability to Flooding are to:**
  - Identify Long-term Needs to continue to achieve CTB’s Vision and Goals
  - Guide the development of VTrans Strategic Actions to prepare the Commonwealth to achieve CTB’s Vision and Goals
- **To address these purposes, the following has been accomplished:**
  - Define “Vulnerability” and “Resiliency” to promote a common understanding of the goals
  - Quantify risk to Virginia’s transportation network from existing and projected flooding-related hazards
- **The secondary purposes of the VTrans Vulnerability Assessment are to:**
  - Increase awareness of transportation system’s vulnerability
  - Identify gaps and opportunities to improve measurement of vulnerability and make the transportation system more resilient

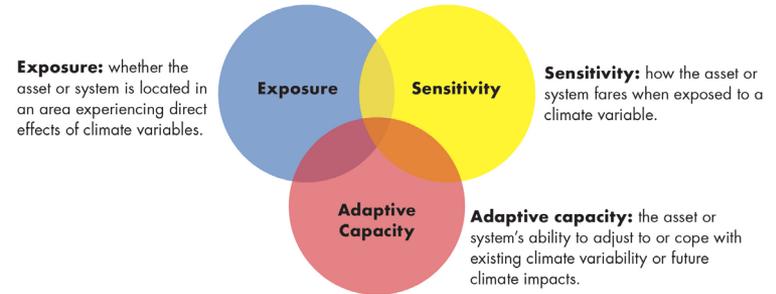




## METHODOLOGY

- **Vulnerability<sup>1</sup>**
  - Vulnerability is a function of exposure to a hazard(s), the sensitivity to the given hazard, and adaptive capacity or the system’s ability to cope.
  - This definitions is based on FHWA’s [Vulnerability Assessment and Adaptation Framework, 3rd Edition](#).
- **Resilience or Resiliency<sup>2</sup>**
  - Resiliency is the capability to anticipate, prepare for, respond to and recover from extreme weather event(s) with minimum damage to social well-being, infrastructure, the economy, and the environment.
  - FHWA defines resilience or resiliency as “the ability to anticipate, prepare for, and adapt to changing conditions and withstand, respond to, and recover rapidly from disruptions.”
  - When defining resilience, most State DOTs, MPOs, and the other transportation organizations use a similar approach to FHWA, focusing on the ability to prepare for and recover from disasters and disruptive events.
  - There can be phase/task-specific definitions – for example a definition that addresses resiliency in the context of a project planning and design.

## Definition and Framework for the VTrans Vulnerability Assessment



<sup>1</sup> Please refer to Appendix B.1 in the Technical memorandum for the Draft VTrans Vulnerability Assessment available on [this webpage](#).

<sup>2</sup> Please refer to Appendix B.2 in the Technical memorandum for the Draft VTrans Vulnerability Assessment available on [this webpage](#).

# METHODOLOGY | HAZARDS AND SCENARIOS DEVELOPED FOR MACROTREND

- **For each hazard, three scenarios have been developed to account for the following uncertainties:**
  - Policy uncertainty: globally, countries are making commitments that may potentially reduce frequency and intensity of extreme natural events. However, there are uncertainties around timeframes for implementation and adherence to the commitments.
  - Scientific uncertainty: Available literature indicates that the understanding of complex natural systems that govern climate is evolving. This imperfect understanding introduces another source of uncertainty.
  - Model uncertainty: Even with a good understanding of scientific processes, it is difficult to represent them.

Hazard	Data Source	Low Impact Scenario	Medium Impact Scenario	High Impact Scenario	Notes
Sea level rise	<ul style="list-style-type: none"> <li>• Virginia Institute of Marine Science’s data based on NOAA’s 2017 report, <a href="#">Global and Regional Sea Level Rise Scenarios for the United States</a></li> </ul>	<ul style="list-style-type: none"> <li>• Intermediate sea level rise scenario (Year 2040)</li> </ul>	<ul style="list-style-type: none"> <li>• Intermediate-high sea level rise scenario (Year 2040)</li> </ul>	<ul style="list-style-type: none"> <li>• Extreme sea level rise scenario (Year 2040)</li> </ul>	<ul style="list-style-type: none"> <li>• Based on Sewells Point tide gauge</li> <li>• Baseline year 2000, relative sea level rise values added to today’s mean high water (MHW) level to determine 2040 MHW levels.</li> </ul>
Storm surge	<ul style="list-style-type: none"> <li>• National Hurricane Center (NHC)</li> </ul>	<ul style="list-style-type: none"> <li>• Category 2 hurricane storm surge</li> </ul>	<ul style="list-style-type: none"> <li>• Category 3 hurricane storm surge</li> </ul>	<ul style="list-style-type: none"> <li>• Category 4 hurricane storm surge</li> </ul>	
Inland/Riverine Flooding	<ul style="list-style-type: none"> <li>• Federal Emergency Management Agency (FEMA), Virginia Department of Transportation (VDOT)</li> </ul>	<ul style="list-style-type: none"> <li>• 100-year flood zone AND</li> <li>• Historical weather-related damages or closures</li> </ul>	<ul style="list-style-type: none"> <li>• 500-year flood zone AND</li> <li>• Historical weather-related damages or closures</li> </ul>	<ul style="list-style-type: none"> <li>• 500-year flood zone with a buffer with varying width (10-200 ft) AND</li> <li>• Historical weather-related damages or closures</li> </ul>	<ul style="list-style-type: none"> <li>• The buffer for Scenario 3 is based on the assumption that the current flood zones may need to be reevaluated to reflect more recent patterns.</li> </ul>



# METHODOLOGY | WEIGHTING FRAMEWORK FOR HAZARDS - ROADWAYS

- **VTrans Vulnerability Assessment relies on an indicator-based evaluation which is based on FHWA's [Vulnerability Assessment Scoring Tool \(VAST\)](#)**
  - Different indicators are identified for each of the three components: (1) exposure; (2) sensitivity; and, (3) adaptive capacity.
  - Different indicators were developed for roadways (pavement) and structures.
  - Each indicator and associated weighting remains the same for all three scenarios.
  - For each Component, scores are assigned on a three-point scale.
  - The end result is nine vulnerability scores – three scenarios x three hazards.
  - In [June 2019](#), OIPI presented this approach at the CTB workshop.
  - In [March 2021](#), OIPI presented this approach to MPOs.

Component	Indicator for Roadway (Pavement)	Component Weight	Relative Indicator Weight by Hazard Exposure		
			Sea Level Rise	Storm Surge	Riverine Flooding
<b>Exposure</b>	<i>If Exposure exists</i>	40%	40%		
<b>Sensitivity</b>	Pavement Condition	20%	1%		
	Pavement Type		2%		
	Historical Weather		17%		
<b>Adaptive Capacity</b>	Functional Class	40%	4%		
	Hurricane Evacuation Route		6%	20%	0%
	AADT		8%		
	Corridors of Statewide Significance		22%	8%	28%

Note:

- The Composite score, which includes Exposure, Sensitivity and Adaptive Capacity, is developed only if an asset is exposed to a hazard.

# METHODOLOGY | WEIGHTING FRAMEWORK FOR HAZARDS - STRUCTURES

Component	Indicator for Structures	Component Weight	Relative Indicator Weight by Hazard Exposure		
			Sea Level Rise	Storm Surge	Riverine Flooding
<b>Exposure</b>	<i>If Exposure exists</i>	40%	40%		
<b>Sensitivity</b>	<i>If Bridge:</i>	20%			
	Deck Rating		0.5%		
	Superstructure Rating		0.5%		
	Substructure Rating		1%		
	<i>If Culvert:</i>				
	Culvert Rating		2%		
	Scour Criticality		4%	4%	7%
	Channel and Channel Protection		0%	2%	3%
	Waterway Adequacy		10%	8%	4%
	Historical Weather		4%		
<b>Adaptive Capacity</b>	Hurricane Evacuation Route	40%	6%	20%	0%
	Navigable Waterway		10%	4%	0%
	Importance Factor		24%	16%	40%

Note:

- Structures include bridges and other structures included in the National Bridge Inventory (NBI).
- The Composite score, which includes Exposure, Sensitivity and Adaptive Capacity, is developed only if an asset is exposed to a hazard.

- **Since the initiation of this work in 2018, several data gaps and limitations have been identified.**
  - The intent is to utilize available data and resources to the fullest extent to quantify risk to reflect the current state of practice.
  - The identified data gaps will be used to develop VTrans Strategic Actions to improve planning and preparedness.
  - Please refer to Section 1.5 in the Technical memorandum for the Draft VTrans Vulnerability Assessment available on [this webpage](#). This memorandum documents known limitations in more detail.

Known Limitations and Associated Impacts on the Draft Results	
Limitation	Impact on the Draft Results
• Lack of roadway elevation data	• Presence of false positives – locations that are exposed but are not sensitive
• Data availability	• Less precision as data for some assets is not available (e.g. pavement condition is not available for many local streets)
• Need for more up-to-date data with greater spatial and temporal precision	• Opportunities for results to be more accurate. Example: In absence of data for alternative routes, Adaptive Capacity relies on surrogate measures.
• Data formats - transportation assets in vector format	• Raster data format can be a more accurate way to capture exposure to flooding or precipitation
• Computations	• Available computational processes are impacted by the data formats and data resolution and therefore can be more efficient

- **This is a screening-level assessment and is not intended to be used to develop location-specific recommendations for the following reasons:**
  - While this screening-level assessment narrows the universe of transportation infrastructure for further review, **it does not replace** the need for the **collection of more precise location-specific data** to develop location-specific recommendations.
  - The transportation system is one of the many infrastructure components impacted by the forecasted vulnerabilities. Therefore, it would be advisable to conduct a more comprehensive area-wide assessment for all components of physical and other infrastructure as some vulnerability mitigation strategies might require systematic solutions.
- **These known and other unknown limitations present opportunities for continuous improvement**
  - Several on-going and planned work will likely improve accuracy of the draft results in the near future.

### Focus on Continuous Improvement

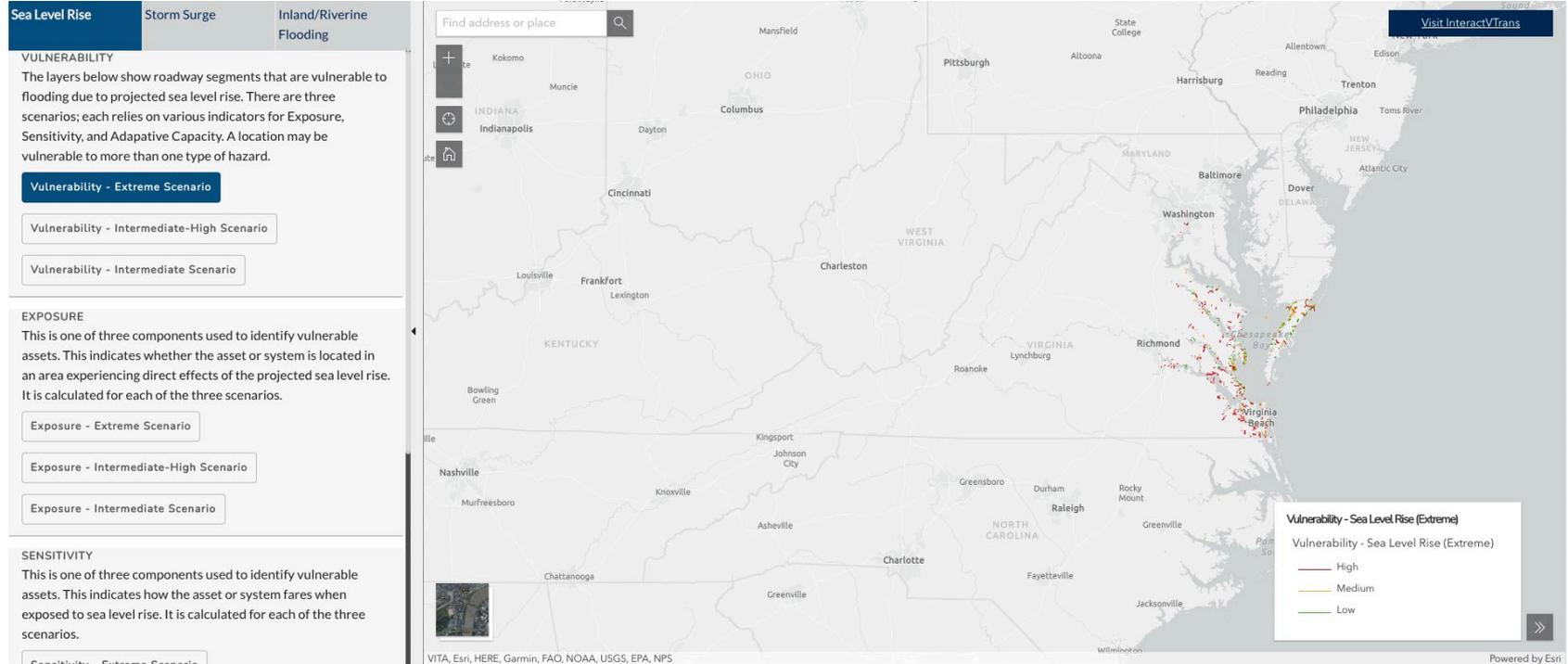
Research methods, techniques, and the **connections between the findings and policy** are likely to improve.





## DRAFT RESULTS

- Draft results for VTrans Vulnerability Assessment are available on [VTrans.org](https://www.vtrans.org) > Long-term Planning > [Vulnerability Assessment webpage](#)



- Draft results can be queried using InteractVTrans [InteractVTrans](#)
  - Identify locations that are vulnerable to both sea level rise AND inland/riverine flooding

The screenshot displays the InteractVTrans web application interface. At the top, the logo for VTRANS (Virginia's Transportation Plan) is visible, along with a search bar and navigation tabs for 'About', 'Vision and Actions', 'Mid-Term Planning', 'Long-Term Planning', and 'Meetings and Updates'. The main content area is split into a search results panel on the left and a map on the right. The search panel shows a query for 'Draft VTrans Vulnerability Assessment' with results for various road segments, each with a unique ID and vulnerability details. The map shows the state of Virginia with colored overlays representing vulnerability data, primarily concentrated in the coastal and inland riverine regions.

**Search Results:**

ID	Vulnerability - Sea-level Rise (Extreme)	Vulnerability - Storm Surge (Category 4)
108899	High	High
254486	High	High
10202808	High	High
131452	High	High
254816	High	High
120387	High	High
131720	High	High

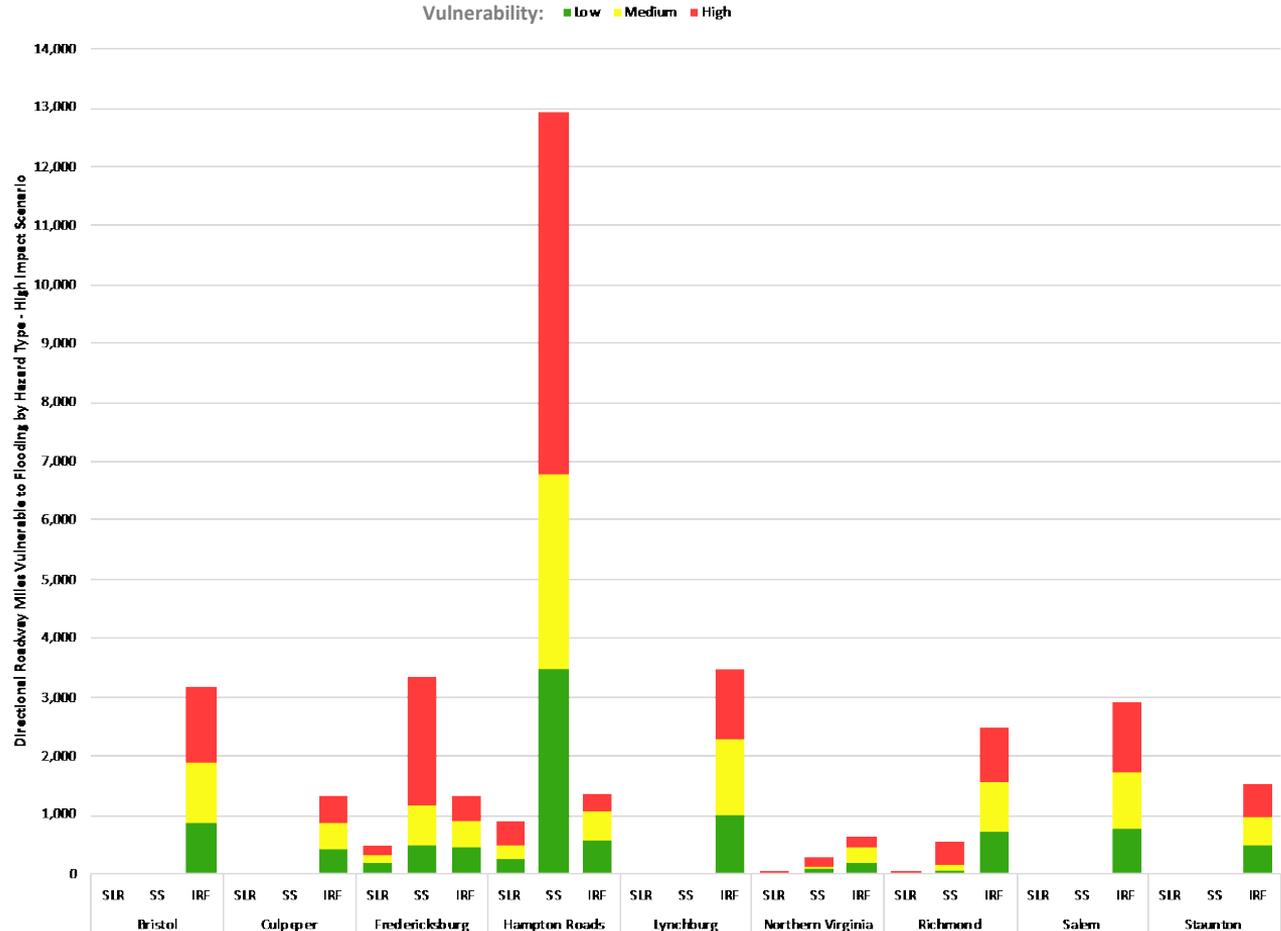
- **An indicator-based approach offers opportunities and limitations – it is challenging to reflect different perspectives on vulnerability in one definitive set of weightings.**
  - Example 1: Weighting framework for emergency planning can be very different than that for asset preservation.
  - Example 2: Also for a location-specific planning, only Exposure values might be needed as project planning can be used to collect location-specific data related to Sensitivity and Adaptive Capacity.
- **To minimize these limitations, an interactive online tool is being developed.**
  - It will allow stakeholders to modify weighting for the three components (exposure, sensitivity, and adaptive capacity) and obtain revised results.
  - It will serve the purpose of education/awareness as well as that of capacity-building.



# DRAFT RESULTS | SUMMARY STATISTICS – HIGH IMPACT SCENARIO

- This graph shows number of directional miles exposed to the **high impact scenario** for three hazards:

- Sea level rise (SLR)
- Storm surge (SS)
- Inland/Riverine Flooding (IRF)



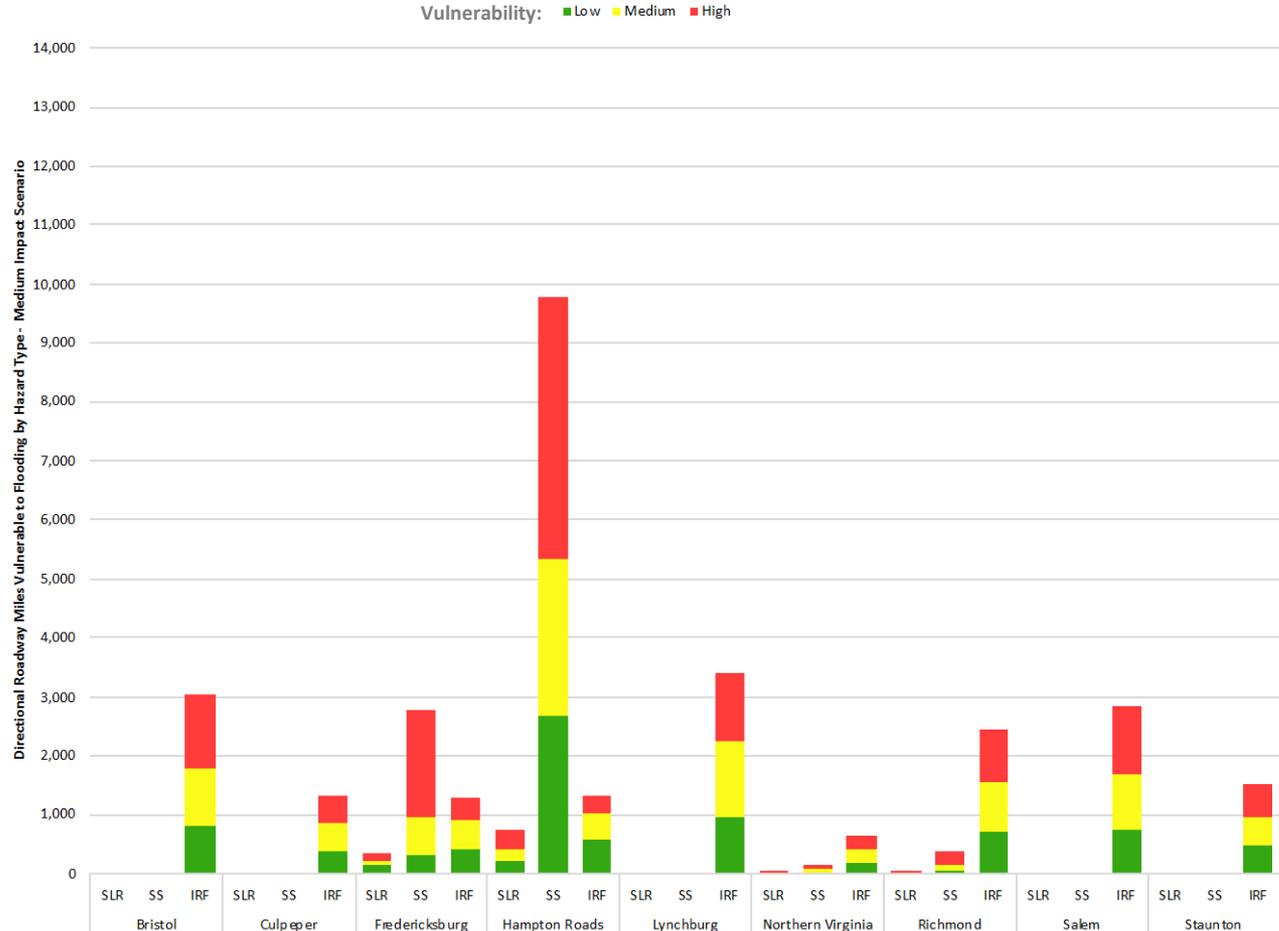
*Note that depending on breaks in data values, directional Mileage for High, Medium, and Low can be more or less than one-third, as mentioned in the Technical Memorandum.*

# DRAFT RESULTS | SUMMARY STATISTICS – MEDIUM IMPACT SCENARIO

- This graph shows number of directional miles exposed to the **medium impact scenario** for three hazards:

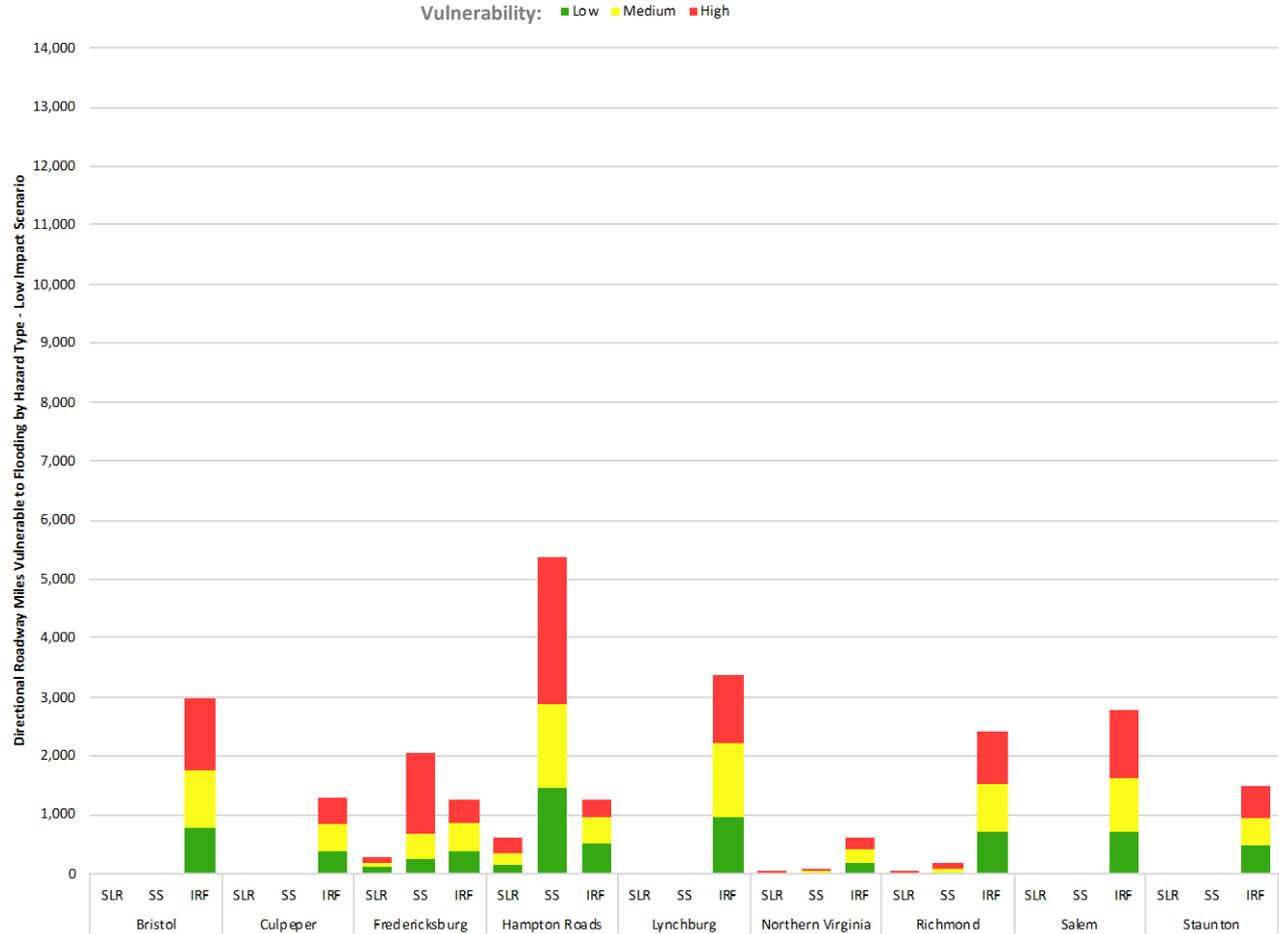
- Sea level rise (SLR)
- Storm surge (SS)
- Inland/Riverine Flooding (IRF)

*Note that depending on breaks in data values, directional Mileage for High, Medium, and Low can be more or less than one-third, as mentioned in the Technical Memorandum.*



# DRAFT RESULTS | SUMMARY STATISTICS – LOW IMPACT SCENARIO

- This graph shows number of directional miles exposed to the **low impact scenario** for three hazards:
  - Sea level rise (SLR)
  - Storm surge (SS)
  - Inland/Riverine Flooding (IRF)



Note that depending on breaks in data values, directional Mileage for High, Medium, and Low can be more or less than one-third, as mentioned in the Technical Memorandum.



## RELATED WORK BY STATE ENTITIES

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- **Several state agencies and departments are conducting work related to this subject. To provide an overarching view of this work in the context of other on-going work, a few examples are included below. Please note that this is not a comprehensive or an authoritative list.**
  - Virginia Department of Transportation
    - Coastal Virginia Transportation Infrastructure Inundation Study (a.k.a the VIMS Study)
    - VDOT At-Risk Infrastructure Report (being combined with the VIMS Study)
    - Enhancement to Precipitation Estimates
  - Department of Conservation and Recreation (DCR)
    - Coastal Resilience Master Plan
  - Other Efforts
    - Joint Subcommittee on Coastal Flooding, Report
    - Commonwealth Center for Recurrent Flooding Resiliency
    - Joint Commission on Technology and Science – Coastal Areas: Study on Economic Consequences of Weather-Related Events
- **In addition to the state entities, several regional entities are also performing related work.**

- **Coastal Virginia Transportation Infrastructure Inundation Study (a.k.a. the VIMS Study)**

- Budget Bill Item 446.F directs VDOT, with the assistance of the Virginia Institute for Marine Science (VIMS), to provide an annual update on the status of the Coastal Virginia Transportation Infrastructure Inundation Study. The report shall include at a minimum:
  - An up-to-date identification of at-risk rural, suburban and urban infrastructure, and planning and options to mitigate or eliminate the identified risks; and
  - A report on what work remains to be completed and estimated time frame for the completion of its work.
- Timeframe: VDOT shall [submit an update](#) to the Chairs of the House Appropriations and Senate Finance and Appropriations Committees, House and Senate Transportation Committees, Chair of the Joint Subcommittee on Coastal Flooding and Adaptation, and the Secretaries of Transportation and Natural Resources [no later than December 1 of each year](#).
- VDOT, VIMS and Secretary of Natural Resources entered into an MOU with the project commencing on July 1, 2019. That study is to:
  - Identify public transportation infrastructure that is at risk of flooding or deterioration due to recurrent wind or tide flooding. This infrastructure includes roads, docks, bridges, wharfs, ditches, outfalls, drainage right-of-way, and signage. The infrastructure should be classified by location – urban, suburban, rural and rural coastal and,
  - Recommendations of the agency to address at-risk infrastructure.
- Timeframe: Completion in approximately 5 years
- Contact information for this study:
  - Cathy McGhee, Director of Research and Innovation, [Cathy.McGhee@VDOT.Virginia.gov](mailto:Cathy.McGhee@VDOT.Virginia.gov)
  - Mike Fitch, Deputy Director of Research, VTRC, [Michael.Fitch@VDOT.Virginia.gov](mailto:Michael.Fitch@VDOT.Virginia.gov)

- **VDOT At-Risk Infrastructure Report**

- **This study is being combined with the VIMS Study.**
- Directs VDOT, in collaboration with the Commonwealth Center for Recurrent Flooding Resiliency, to:
  - Identify roads and bridges under the jurisdiction of VDOT at risk of deterioration due to flooding in Northern Virginia;
  - Develop recommendations for managing such assets; and,
  - Report its findings and recommendations.
  
- Timeframe:
  - VDOT shall complete meetings by November 30, 2021 and the Commissioner shall submit a report to the Chairs of House and Senate Transportation Committees no later than the first day of the 2022 Regular Session of the General Assembly.
  
- Contact information for this study:
  - Cathy McGhee, Director of Research and Innovation, [Cathy.McGhee@VDOT.Virginia.gov](mailto:Cathy.McGhee@VDOT.Virginia.gov)
  - Mike Fitch, Deputy Director of Research, VTRC, [Michael.Fitch@VDOT.Virginia.gov](mailto:Michael.Fitch@VDOT.Virginia.gov)

- **Enhancement to Precipitation Estimates**

- Current precipitation estimates used in hydraulic design are out of date
- Service life of drainage infrastructure and bridges can be 20 to 100+ years
- Through collaboration with the Special Assistant for Coastal Adaptation and Protection, the Virginia Transportation Research Council (VTRC), VDOT is:
  - o Funding with partners (Department of Environmental Quality) a statewide effort as a part of a 4 state effort (VA, NC, DE, MD) to update NOAA Atlas 14 to **current day** precipitation estimates
  - o Funding with partners (Commonwealth Center for Recurrent Flooding Resilience, and Chesapeake Bay Trust) a statewide effort to develop **predictive precipitation estimates** in future decades
- Both current and future estimates **will be available to regional and local entities.**
  - o This will allow for uniformity statewide to address climate change
- Completion year?
  - o Atlas 14 VOL 13 - Fall 2023.
  - o Predictive IDF Modeling is complete and should be released by the end of June 2021.
    - Data will be hosted on the Northeast Regional Climate Center website.
- Contact information for this study:
  - o Cathy McGhee, Director of Research and Innovation, [Cathy.McGhee@VDOT.Virginia.gov](mailto:Cathy.McGhee@VDOT.Virginia.gov);
  - o Mike Fitch, Deputy Director of Research, VTRC, [Michael.Fitch@VDOT.Virginia.gov](mailto:Michael.Fitch@VDOT.Virginia.gov)

- **Virginia Coastal Resilience Master Plan ([More Information on the Plan Website](#))**
  - Directed by Governor Ralph S. Northam in [Executive Order Number 24](#) on November 2, 2018.
  - [Virginia Coastal Resilience Master Planning Framework](#) (the Framework), released October, 2020, lays out key actions and processes that will take the Commonwealth to a full Master Plan. It is based on 4 primary goals and 5 guiding principles:
    - The four Master Planning Framework Primary Goals are:
      - Identify priority projects to increase the resilience of coastal communities, including both built and natural assets at risk due to sea level rise and flooding
      - Establish a financing strategy, informed by regional differences and equity considerations, to support execution of the plan
      - Effectively incorporate climate change projections into all of the Commonwealth’s programs addressing coastal region built and natural infrastructure at risk due to sea level rise and flooding
      - Coordinate all state, federal, regional, and local coastal region adaptation and protection efforts in accordance with the guiding principles of this Framework
    - The five Master Planning Framework Guiding Principles are:
      - Acknowledge climate change and its consequences, and base decision-making on the best available science.
      - Identify and address socioeconomic inequities and work to enhance equity through coastal region adaptation and protection efforts.
      - Recognize the importance of protecting and enhancing green infrastructure like natural coastal barriers and fish and wildlife habitat by prioritizing nature-based solutions.
      - Utilize community and regional scale planning to the maximum extent possible, seeking region-specific approaches tailored to the needs of individual communities.
      - Understand fiscal realities and focus on the most cost-effective solutions for protection and adaptation of our communities, businesses and critical infrastructure.
  - Expected completion
    - The first Virginia Coastal Resilience Master Plan will be completed November, 2021
  - Contact person for more information
    - Special Assistant for Coastal Adaptation and Protection , Rear Admiral (Ret) Ann C Phillips, USN. ([More Information](#))

- **Joint Subcommittee on Coastal Flooding, Report**

- Joint Subcommittee (legislative subcommittee) shall complete meetings the first year by November 30, 2020, and the second year by November 30, 2021. Chairman shall submit and executive summary of findings and recommendations to Division of Legislative Automated Systems (DLAS) no later than the first day of the next Regular Session of the General Assembly for each year.

- **Commonwealth Center for Recurrent Flooding Resiliency**

- Directs the Center to evaluate the development of a Flood Resiliency Clearinghouse Program and to work with DCR to evaluate solutions that manage both water quality and flooding and emphasize nature-based solutions. The Center is to report its findings and recommendations to the Chairs of House Agriculture, Chesapeake and Natural Resources and Senate Agriculture, Conservation and Natural Resources Committees by November 1, 2021. (HB 2187)

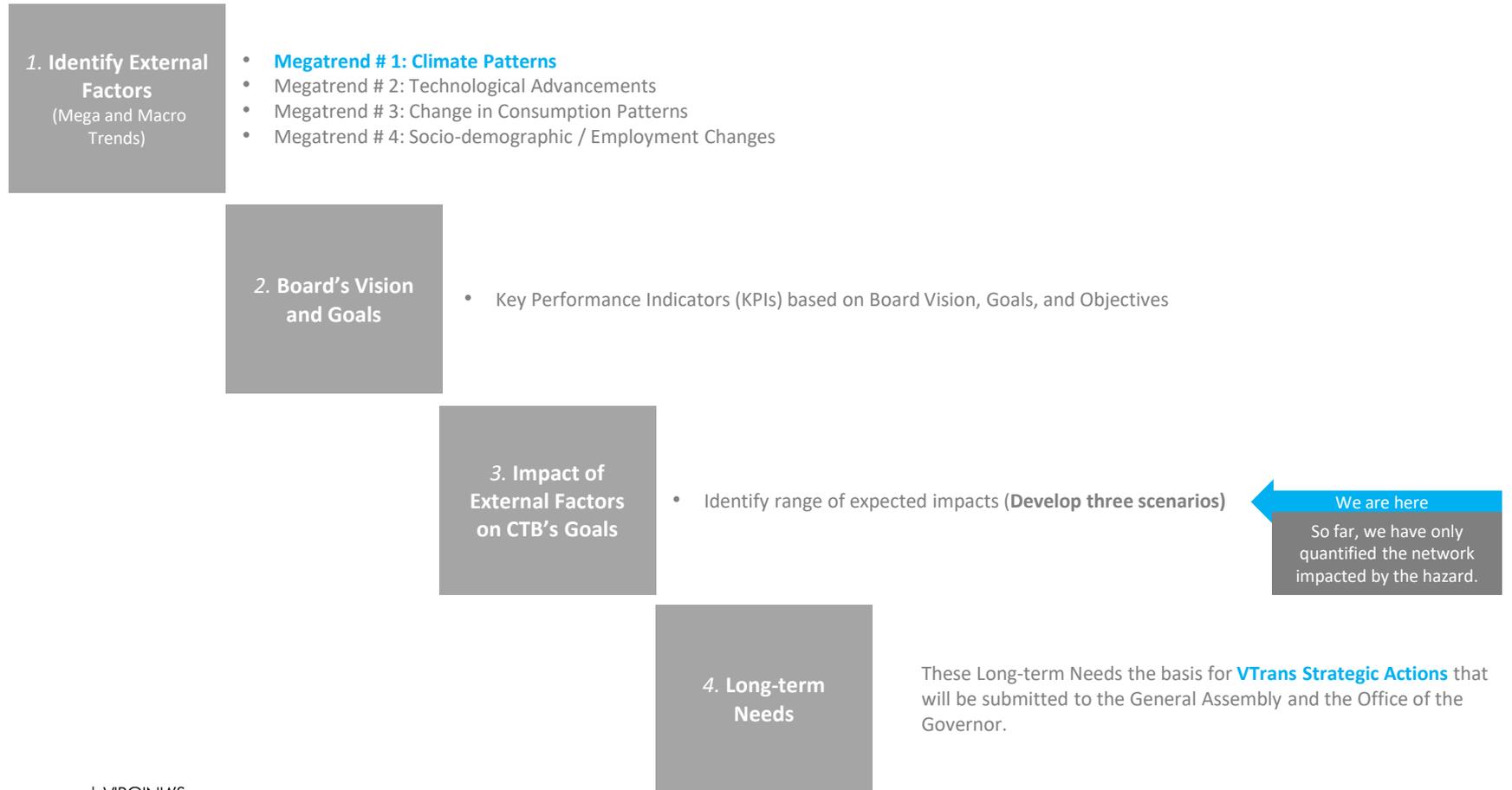
- **Joint Commission on Technology and Science--Coastal Areas; Study on Economic Consequences of Weather-Related Events**

- Directs Joint Commission on Technology and Science (JCOTS) (legislative Joint Committee) to study the safety, quality of life, and economic consequences of weather and climate-related events on coastal areas in Virginia. In conducting its study, JCOTS shall examine:
  - The negative impacts of weather, and geological and climate-related events, including displacement, economic loss, and damage to health or infrastructure;
  - The area or areas and the number of citizens affected by such impacts;
  - The frequency or probability and the time dimensions, including near-term, medium-term, and long-term probabilities of such impacts;
  - Alternative actions available to remedy or mitigate such impacts and their expected cost;
  - The degree of certainty that each of these impacts and alternative actions may reliably be known; and,
  - The technical resources available, either in state or otherwise, to effect such alternative actions and improve our knowledge of their effectiveness and cost.
- Report was due first day of 2021 General Assembly but has been delayed and is expected in June of 2021.



## NEXT STEPS

# NEXT STEPS | HOW VULNERABILITY ASSESSMENT INFLUENCES DEVELOPMENT OF LONG-TERM NEEDS



- Based on guidance from the CTB, the **impact of this Macrotrend, Increase in Transportation System's Vulnerability due to Flooding**, along with the impact of others macrotrends, **will be used to identify Long-term Needs**.
- Over the next few months, OIPI will:
  - Present information to the CTB members for their guidance and feedback.
  - As needed, incorporate feedback received on the draft results.
  - Develop an initial list of long-term needs for coordination
    - The initial list of long-term needs will be used to coordinate efforts with various state entities to ensure synergy and consistency.
    - The transportation system is one of the many infrastructure components impacted by the forecasted vulnerabilities. Therefore, coordination is essential.
  - Share initial list of long-term needs for feedback
    - [Register for the July 27<sup>th</sup> webinar here](#)
  - Develop and share a list of VTrans Strategic Actions that address Long-term Needs.
  - As directed by the CTB, submit the entire plan along with this work to the General Assembly and the Office of the Governor as directed per [§ 33.2-353](#).

Step 3: Impact of External Factors (Flooding) on CTB's Goals

Goal A

Economic Competitiveness and Prosperity

Goal B

Accessible and Connected Places

Goal C

Safety for All Users

Goal D

Proactive System Management

Goal E

Healthy / Sustainable Communities

- **Please review the following and [provide comments by June 29](#):**
  - Draft definitions of vulnerability
  - Draft definitions of resiliency
  - Draft methodology for the vulnerability assessment
  - Draft vulnerability assessment results
- **Please note that these are draft results and are likely to change based on the feedback received and additional refinements.**
  - The purpose of sharing the results as a draft is to incorporate feedback early in the process.
  - As noted earlier, there are known limitations. Statewide datasets that allow us to overcome these known or any unknown limitations will be helpful.



## NEXT STEPS

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- **Subscribe to [VTrans Newsletter](#) to get three to five emails and updates.**
- **Please use the following contact information to share comments.**

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**Questions?**