



U.S. Department  
of Transportation

**Federal Highway  
Administration**

# Incorporating Resilience into Agency Initiatives: Vermont Agency of Transportation

The Vermont Agency of Transportation (VTrans) is involved in initiatives with transportation resilience components aimed at emergency management, post-disaster recovery, and transportation planning. These initiatives include developing transportation planning tools, participating in intra- and inter-agency working groups, and updating the *Town Highway Road and Bridge Standards*.

## Key Takeaways

- VTrans has initiated several resilience activities since Tropical Storm Irene, including multidisciplinary committees, integrated tools, and disaster response protocols.
- VTrans has developed and piloted the web-based Transportation Resilience Planning Tool (TRPT) in three watersheds and is expanding it across the state.
- The TRPT is a watershed-scale platform to help users assess roadway vulnerability to flood damage, estimate transportation criticality, assign risk and identify mitigation options.

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## Resilience Context

Vermont is a mountainous state subject to increasingly intense and frequent rainfall, so VTrans is incorporating resilience into its operations and long-term planning and project selection activities to mitigate the vulnerability of the state's roads, bridges, and culverts to inundation, erosion, and deposition (debris build-up). The severity of Tropical Storm Irene in 2011 on natural resources, infrastructure, and urban and rural communities contributed to a state- and agency-wide effort toward a more integrated resilience strategy.

As a VTrans staff member recently said, resilience is the ability to “bounce back” from meteorological hazards such as ice, wind, and rainstorms. Figure 1 illustrates VTrans' approach to integrating emergency management with the transportation planning, programming, and project delivery process.



Figure 1. VTrans' integration of emergency management and transportation project and service delivery. Photo credit: VTrans.

VTrans improved its disaster data collection, updated its *Hydraulics Manual*, *Hydraulic Standard*, and *Town Highway Road and Bridge Standards*, created an incident command system (ICS) structure, and enhanced statewide collaboration in resilience and disaster planning. As a member of a multiagency steering committee led by Vermont Emergency Management (VEM), VTrans worked on the state's *Hazard Mitigation Plan*, which considered numerous existing threats and risks, such as climate and extreme weather events. The committee determined that susceptibility to flooding and erosion were the hazards of highest concern. Other transportation-related concerns included seismic resilience for bridges and cyber security in transportation architecture.

# VTrans' Resilience and Durability Initiatives

## Coordinated Disaster Data Collection and Hazard Mitigation Planning

VTrans collaborates with VEM, the Vermont Agency of Natural Resources, and several other state agencies to improve natural disaster-related emergency response through coordinated collection of damage information. Immediately after a disaster, VTrans leads a multiagency team to collect, compile, and assess data on the amount and extent of damage and to estimate the costs of repair. VTrans uses a mobile tool to photograph, assess, cost, and plot multivariable data geospatially and share a unified picture with other users, such as local road crews. This tool will, over time, facilitate identification of recurring loss damage sites, allowing VTrans to conduct more rigorous and accurate benefit-cost analyses when considering possible mitigation initiatives.

VTrans sends the damage assessment to VEM to manage the public assistance program. The state determines if the costs are high enough to justify a Presidential Declaration request to free up Federal Emergency Management Agency (FEMA) monies and, if so, Vermont's Emergency Relief and Assistance Fund can help defray the share of costs incurred by the local community. VTrans can submit for reimbursement of the costs of addressing damage to federal-aid highways to the Federal Highway Administration (FHWA), through its Emergency Relief program. For addressing damage to other roads or infrastructure, such as town roads, municipalities can recover costs through the FEMA Public Assistance program.

## Updates to *Hydraulics Manual*, *Hydraulic Standard*, and *Town Highway Road and Bridge Standards*

To improve recovery and mitigation, VTrans updated its *Hydraulics Manual* and its *Hydraulic Standard* to incorporate sediment flow data and bank-full width. The updated design standard, specifically for bridges and culverts, better reflects likely sediment flow based on the natural width of each channel. VTrans also updated the *Town Highway Road and Bridge Standards* for voluntary adoption by municipalities. Municipalities that adopt the standards and implement other flood mitigation policies are eligible for a greater portion of the state cost share of non-federal matching funds required for FEMA Public Assistance grants.<sup>1</sup> Adoption of the *Town Highway Road and Bridge Standards*, along with adherence to the standards for normal, non-disaster construction projects, also ensures that FEMA Public Assistance funds will cover the additional costs of rebuilding previously substandard roads and structures damaged during a flood to a more durable, resilient standard. For municipalities that do not adopt the standards, or do not have other standards of their own, FEMA will reimburse only the cost to replace the infrastructure to its previous "in-kind," substandard condition.

## Incorporating Flood Resilience into Project Selection and Prioritization

The Vermont General Assembly established a legal statute requiring VTrans to include resilience as one of the criteria in the project selection and prioritization process used to develop the annual VTrans Capital Program.<sup>2</sup> VTrans developed a Flood Resilience Scoring Framework. The resilience score is based on the asset's flood vulnerability and transportation criticality and is determined by the weighting criteria listed in **Error! Reference**

	Criticality High - 10 (Top 2.5%, > 0.07)	Criticality Medium - 6 (0.025 to 0.07)	Criticality Low - 2 (0.0007 to 0.025)	Not Critical - 0 (< 0.0007)
Flood Vulnerability High - 10 (Maxscore 9 and 10)	10	8	6	5
Flood Vulnerability Medium - 6 (Maxscore 5-8)	8	6	4	3
Flood Vulnerability Low - 2 (Maxscore 1-4)	6	4	2	1
Not Vulnerable	5	3	1	0

Figure 2. Flood Resilience Score Framework. Source: VTrans

<sup>1</sup> Other requirements include participation in the National Flood Insurance Program, adoption of a Local Emergency Operations Plan, adoption of a Local Hazard Mitigation Plan, and land use regulations that protect river corridors.

<sup>2</sup> VTrans does not have a separate prioritization process for projects on the Statewide Transportation Improvement Program.

**source not found.** The score is a proxy for risk, generally defined as the probability that an event will occur and the resulting consequence. In this case, the vulnerability of a bridge, road embankment, or culvert to flood damage represents the probability of failure, and the transportation criticality of the associated road segment represents the consequence of the disruption to general travel and access to emergency services and other critical infrastructure systems.

Over the next few years, VTrans will incorporate the resilience scoring and weighting system into the project selection and prioritization process to help ensure that, when considering two otherwise equally important projects, the less resilient project is selected first. Adding the resilience score is a significant change from VTrans' prior prioritization process, so it is being applied slowly and in close coordination with Vermont's one Metropolitan Planning Organization and 10 regional planning commissions (RPCs). **Figure 2Error! Reference source not found.** illustrates the flood risk for road embankments, bridges, and culverts on Vermont's state highway system.

One of the resilience initiatives is Flood Ready Vermont, a partnership between VTrans and other agencies to naturally manage flooding, design buildings and infrastructure that are less susceptible to damage, and protect natural flood prevention assets.

### Other Resilience Initiatives

Given the need for resources and time to rebuild infrastructure, VTrans expects that much of the state and local road network will remain extremely vulnerable to flood damage for many years. The ability to effectively respond to and recover from the impacts of disasters is essential to providing a resilient transportation system. Toward this end, VTrans has adopted and implemented an incident management system (IMS) to facilitate communication and coordination within VTrans and externally with partner agencies and the State Emergency Operations Center. VTrans can use the ICS component to manage and direct its overall response and recovery priorities, modulate information flow, allocate resources, and make tactical decisions. ICS is flexible and scalable by incident size and complexity and agency requirements. VTrans staff have volunteered in various ICS roles and taken regular required training, including participation in a statewide, multiday emergency response exercise. VTrans leadership learned about IMS during Tropical Storm Irene and quickly recognized the necessity of implementing an ICS to manage the response and recovery. The Tropical Storm Irene experience also resulted in VTrans developing emergency contracting protocols and emergency permitting, especially for work in rivers.

Another resilience initiative is the Continuity of Operations Plan, which involves assessing all agency mission-essential functions and analyzing how to continue carrying out these functions safely, efficiently, and effectively in the long term. This was demonstrated in June 2018 when a fire required relocating hundreds of VTrans headquarters staff and more recently in managing the agency's response to the coronavirus pandemic.

## Transportation Resilience Planning Tool

The Vermont Transportation Resilience Planning Tool (TRPT) is a web-based application that identifies bridges, culverts, and road embankments that are vulnerable to damage from floods, estimates risk based on the vulnerability and

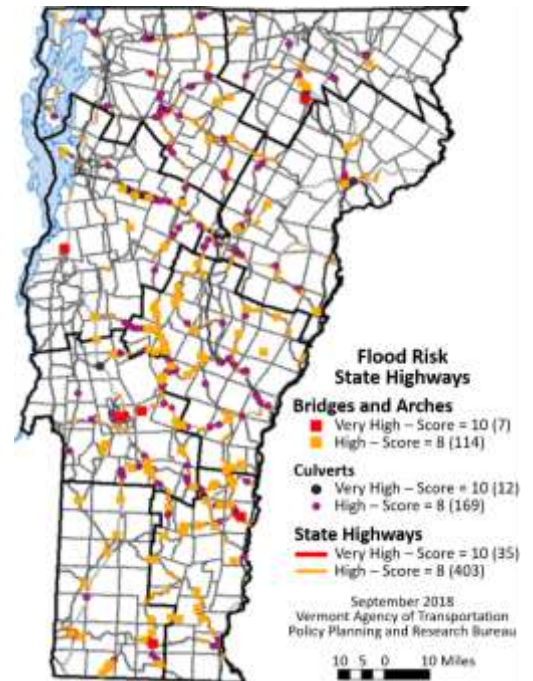


Figure 2. A map of scoring flood vulnerability of Vermont culverts and bridges. Photo credit: VTrans.

criticality of roadway segments, and identifies possible mitigation measures based on the factors driving the vulnerability. The TRPT combines river science, hydraulics, and transportation planning methods and is applied at a watershed scale. The TRPT was tested in three pilot watersheds and is ready to be applied in these watersheds to inform project scoping, capital programming, and hazard mitigation planning for state and local highways. VTrans, in partnership with RPCs, will complete the TRPT statewide by the end of 2021. Again, much of VTrans' effort after Tropical Storm Irene focused on improving its emergency response and recovery capabilities to more quickly restore transportation functionality after a disaster. The TRPT is intended to identify vulnerabilities proactively to avoid or mitigate against the impacts of future damage in the most critical, highest risk locations.

VTrans uses a statistical method to assess vulnerability and identify variables at sites that have and have not been damaged by flooding. The type of flood vulnerability (inundation, erosion, or deposition) affects the magnitude and severity of damage, so each site is ranked differently in the scoring. Inundation prioritization scores are capped at 5 (moderate vulnerability), while erosion and deposition scores, which can cause significant damage and longer-term road closure, range from 1 (low vulnerability) to 10 (high vulnerability).

## Next Steps

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VTrans will complete the TRPT statewide by the end of 2021 and is building staff capacity to apply and sustain the tool. The agency received a FEMA Pre-disaster Mitigation Grant application submitted in January 2020 for a standalone construction project to address a high-risk flood damage site, identified using the TRPT, on Route 9 in Brattleboro, an important east-west corridor connecting Vermont with New Hampshire and New York. VTrans will also keep the various ICS positions staffed, train the staff, and practice deployment through periodic table-top and full-scale exercises.

## Resources

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- **Vermont Agency of Transportation:**  
<https://vtrans.vermont.gov/>  
This website provides links to several tools, maps, projects, and informational sites.
- **Transportation Resilience Planning Tool:**  
<https://vtrans.vermont.gov/planning/transportation-resilience>  
This website walks users through the TRPT basics and provides links to the web application and user guide.
- **Flood Ready Vermont:**  
[https://floodready.vermont.gov/find\\_funding/emergency\\_relief\\_assistance](https://floodready.vermont.gov/find_funding/emergency_relief_assistance)  
This website provides links to information about the Emergency Relief and Assistance Fund, steps that eligible communities can take to adopt mitigation measures, Vermont bylaws, statewide standards, and more.

### Transportation Resilience and Durability Case Study Series

The Federal Highway Administration is developing a series of case studies exploring resilience and durability efforts at transportation agencies across the United States. The case studies are developed through in-depth interviews with a geographically diverse range of transportation agencies. These case studies explore how resilience and durability factor into various phases of transportation decision-making, the scales and types of resilience and/or durability projects at the agencies, and the types of resilience addressed.