BUILDING RESILIENT TRANSPORTATION

EXTREME WEATHER EVENTS DISRUPT U.S. TRANSPORTATION

State and regional transportation agencies across the country are facing extreme weather events that damage roads and bridges and cost large sums to repair, not to mention the cost to the economy from disrupted travel. These events—including heat waves, drought, tropical storms, high winds, storm surges and heavy downpours—are becoming more frequent and severe as the climate changes.

FHWA IS RESPONDING

These climate risks threaten the considerable federal investment in transportation infrastructure and FHWA is responding:

- FHWA issued an order committing the agency to integrating climate risk considerations into the delivery and stewardship of FHWA programs.
- Climate adaptation activities are eligible for FHWA funding, including vulnerability assessments and design and construction of projects or features to protect assets from damage associated with climate change.
- FHWA's updated emergency relief program guidance reflects climate resilience.
- FHWA implemented transportation law passed in 2012 which requires states to develop risk-based asset management plans and to consider alternatives for facilities repeatedly needing repair or replacement with federal funding.
- FHWA implemented transportation law passed in 2015 requiring the transportation planning process to include resilience as a planning factor and for metropolitan areas to develop resilience strategies.
- FHWA developed tools and guidance for systematic consideration of climate risks at transportation system and project levels.

WHAT CAN TRANSPORTATION AGENCIES DO TO BUILD RESILIENCE?

Know your vulnerabilities

Departments of transportation (DOTs), metropolitan planning organizations (MPOs), and others can begin with a vulnerability assessment for their area using FHWA's Vulnerability Assessment Framework, a guidebook and online resource detailing key steps and in-practice examples. Based on the experience of pilot projects and other work, each step of the framework has tools, case studies, videos and other resources associated with it. For instance, FHWA's Climate Data Processing Tool processes publicly available, but large and unwieldy data sets into local temperature and precipitation projections tailored to transportation practitioners.

Flood waters from Hylebos Creek impacted this segment of Interstate 5 near Tacoma, WA in 1990, 2003, 2009, and 2015. As part of the SR 167 highway completion project, which will include an interchange with I-5 in this area, Washington State DOT (WSDOT) is restoring the creek and reconnecting it to its natural floodplain. The stream restoration will not only manage runoff from the new highway project, but will also redirect floodwaters into restored wetlands, thus reducing flooding of I-5 while at the same time creating habitat for numerous species.

When completed, the Hylebos Creek restoration program will resemble this nearby wetlands restoration site. WSDOT analyzed the impacts of sea level rise and heavy rainfall on the SR 167 project and found that the restoration program is a far more practical means of accommodating both current and future conditions than a traditional closed conveyance and detention basin system

U.S. Department of Transportation
Federal Highway Administration

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Transportation Agencies Using FHWA Resources to Build Resilience

FHWA has partnered with state DOTs, MPOs and others across the country to assess vulnerabilities and analyze opportunities to improve resilience. Projects vary in scope and emphasis and include: state-wide vulnerability assessments, analyses of engineering options for improving resilience of specific road segments, analysis of opportunities to protect assets by mimicking nature, incorporating climate risks into asset management, and deploying and monitoring adaptation solutions. Many projects were led by our partners, while others were cooperative projects led by FHWA.

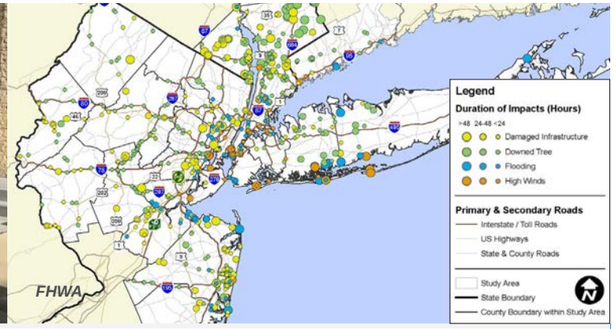
- State DOT Pilot
- MPO Pilot
- Cooperative Projects

Utah Highway Patrol

Utah DOT is developing metrics and thresholds to incorporate annual risk information into transportation planning and investment decisions. Threats included in the analysis are wildfires, floods, and earthquakes.

PS Flood Barriers

Massachusetts DOT (MassDOT) under an earlier pilot developed a probabilistic flood risk model incorporating sea level rise and storm surge for Boston Harbor. The model helps determine when different strategy levels are necessary to protect the Central Artery highway tunnels and associated assets, such as ventilation buildings and electronic controls. MassDOT's current pilot is deploying and testing flood barriers, such as the type pictured above. Using the USDOT Hazard Mitigation Cost Effectiveness Tool, MassDOT found its benefit cost ratio for the temporary flood barriers is 58:1.

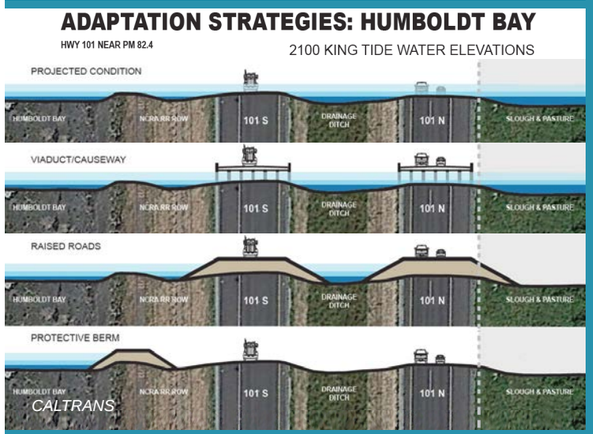


FHWA

Following Hurricane Sandy, FHWA partnered with the tri-state region on a multi-jurisdictional vulnerability assessment and analysis of adaptation solutions.

DNREC Wetland Monitoring and Assessment Program

Delaware DOT developed a design to protect a section of the State Route 1 corridor from coastal flooding using oyster reefs to break waves, marsh and dune plantings to prevent erosion and a tide flap on the stormwater outfall to prevent backflow. Some of the techniques are similar to those of a living shoreline project in the Delaware Inland Bays, pictured above.



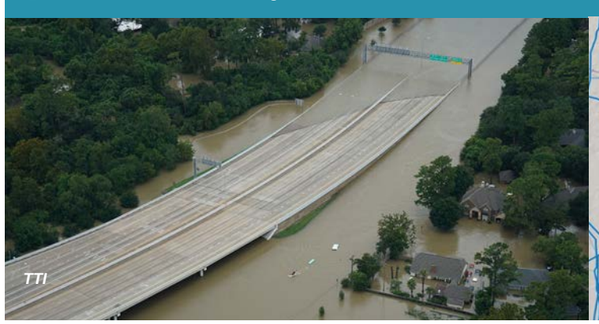
CALTRANS

The California Department of Transportation (Caltrans) analyzed the vulnerability of over 16,000 assets in Caltrans District 1 (northern CA). Caltrans then developed adaptation strategies for four prototype locations. To address sea level rise along Highway 101 on Humboldt Bay, Caltrans considered increased armoring/flood walls, elevated infrastructure, and relocated structures.

TDOT

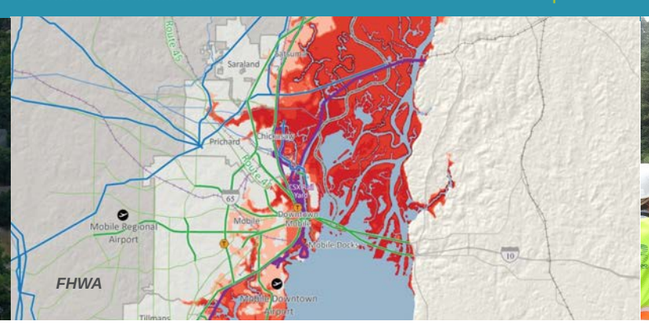
Tennessee DOT conducted a multimodal vulnerability assessment for the state, obtaining key information for asset management. Landslides, tornados, and river flooding are risks.

Flooding from Hurricane Harvey in Texas, 2017. Texas DOT is working on a pilot with FHWA to integrate extreme weather and climate risk into asset management.



TTI

The U.S. DOT Gulf Coast Study included sophisticated storm surge modeling under sea level rise and stronger hurricane scenarios.

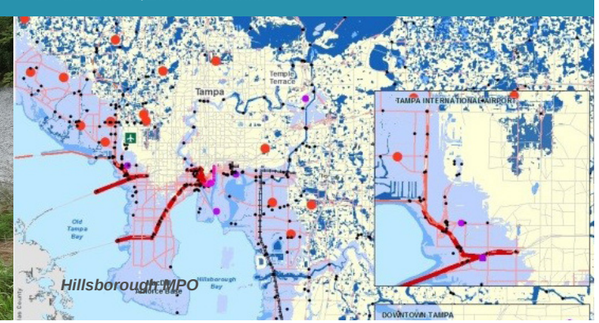


FHWA

To contain landslides along I-77 in Carroll County, VA, Virginia DOT built the below soil nail supported toe wall, as a first step in an adaptive response to the slide that includes building additional walls, higher on the slope, if needed. FHWA's TEACR project evaluated the potential impacts of projected changes in precipitation and freeze-thaw cycles on slope stability at this location to assist in decision-making.

VDOT

The MPO for Tampa, FL included climate resilience analysis in their transportation plan, finding that adaptation actions would cost $31M, but avoid $265M in losses.



Hillsborough MPO

Use the transportation planning process

The metropolitan and statewide transportation planning process provides key opportunities for taking climate change into account. Resilience and sustainability should be considered early during decision-making at the systemwide level, when options and priorities are considered for transportation investments to meet multiple community goals. FHWA is developing resources, including a white paper, case studies, and a handbook, on options and real world examples for integrating resilience into the transportation planning process.

Built in 1936, this culvert is at the end of its useful life and Minnesota DOT plans to replace it in 2020. MnDOT analyzed four options: a base case replacement designed to today's standards, and three alternative options, each designed to perform optimally in the year 2100 under three different climate precipitation scenarios. These alternatives included a larger two-cell culvert and two different bridge designs. If the costs of detours and injuries are included, an expanded two-cell culvert is the most cost-effective design under all future precipitation scenarios.

Incorporate climate risks into design and asset management

Transportation agencies can consider climate impacts when planning new assets or rehabilitating existing assets. Risk based asset management involves identification of a sequence of actions to manage and preserve assets over the long term, and provides a platform for inventorying assets, evaluating risks to those assets, and prioritizing capital improvements to make them more resilient to future environmental conditions. FHWA supported six States to pilot methods for addressing resilience in asset management and is developing a guidebook on this topic.

Transportation agencies can also take advantage of Synthesis of Approaches for Addressing Resilience in Project Development (2017), developed to support project-level adaptation work. It provides key lessons learned for a range of engineering disciplines developed from more than two dozen engineering-informed adaptation studies.

Agencies can use FHWA's Adaptation Decision-making Assessment Process (ADAP) for engineering transportation assets to be more resilient to climate impacts, which was developed under Phase II of the Gulf Coast Study, and refined in the Post-Hurricane Sandy Transportation Resilience Study as well as engineering studies developed to support the synthesis report. The process includes consideration of multiple alternatives and cost benefit analysis

Agencies can prioritize "no regrets" actions that improve resilience of assets to existing stressors, have co-benefits, or cost little relative to the overall value of the asset. They can build flexibility into designs to allow for changes in the future given inevitable uncertainty regarding future emissions levels and precise timing and severity of impacts. For example, agencies can design flood walls that can be heightened in the future with minimum additional expense.

FHWA's updated Hydraulic Engineering Circular (HEC) 25: Highways in the Coastal Environment, includes guidance on estimating future sea levels and storm surges along with designing protection measures such as revetments, beach nourishment, and bridge deck elevation. FHWA also provides guidance on how to incorporate information on changing precipitation patterns in HEC 17: Highways in the River Environment - Floodplains, Extreme Events, Risk, and Resilience (2016). Finally, FHWA is providing information on how transportation agencies can use nature-based strategies -- such as restoration of beaches, dunes, wetlands, and reefs – to protect roads from coastal flooding while also benefiting the environment.

FHWA Emergency Relief (ER) funds can be used to rebuild a damaged asset more resiliently if consistent with current standards or if economically justified. As shown in the photo above, an articulated concrete block revetment system protected segments of US 98 along the Gulf Coast of Florida from the Category 4 storm surge of Hurricane Michael in 2018. Where the engineered revetment system was not in place, Hurricane Michael washed the road away. Florida DOT is working closely with the FHWA Florida Division office on adding the protection to additional segments to prevent damage in the future.

Operations and maintenance

Operations and maintenance strategies can also lessen climate impacts on transportation. Examples include more frequent cleaning of storm-drains, improved plans for weather emergencies, closures and rerouting, traveler information systems, debris removal, early warning systems, prepositioning materials, damage repairs, and performance monitoring. See FHWA's guide on this topic for more information.

FHWA will continue partnering with federal, state and local agencies on the shared goal of a transportation system that provides safe mobility under current and future conditions, supporting the nation's economy and quality of life.

LEARN MORE

FHWA's resilience website offers publications, policies, guidance, webinar recordings, and tools for assessing vulnerabilities and building resilience.
https://www.fhwa.dot.gov/environment/sustainability/resilience/

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