



U.S. Department
of Transportation
**Federal Highway
Administration**

FHWA Climate Change Vulnerability Assessment Pilot Project: Washington State Department of Transportation

In 2010, the Federal Highway Administration (FHWA) selected **five pilot teams** from across the country to test a climate change vulnerability assessment model. This conceptual model guided transportation agencies through the process of collecting and integrating climate and asset data in order to identify critical vulnerabilities. During this year-long pilot program, the pilot teams formed a community of practice, exchanged ideas, presented draft results, and participated in a series of webinars and peer exchanges. FHWA used the feedback and lessons learned from the pilot projects to revise the draft conceptual model into the Climate Change & Extreme Weather Vulnerability Assessment Framework. The framework is available on the [FHWA website](#).

The Washington State Department of Transportation (WSDOT) believes that understanding future conditions is essential to its mission of keeping people and business moving. In keeping with this spirit, one of the agency's strategic goals is to "identify WSDOT facilities vulnerable to the effects of climate change and to evaluate and identify possible strategies to reduce risk." As part of the FHWA pilot program, WSDOT developed a structured, stakeholder-based approach to qualitatively assess facility risk. The project team held 14 workshops in all regions of the state in which WSDOT staff rated all state-owned highways and other transportation assets for climate vulnerability. This focus on a simple, inexpensive, and replicable assessment process is one of the reasons why WSDOT's approach is an attractive model for other state Departments of Transportation.



**Washington State
Department of Transportation**

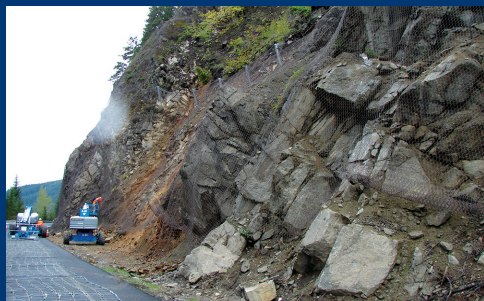
Scope

All WSDOT-owned and -managed assets across all six WSDOT regions in Washington state, including:

- Over 7,000 centerline miles of roadway
- Over 8,500 bridge structures
- 22 ferry terminals
- 4 freight rail lines
- 16 airports

Objectives

- Assess the vulnerability of state-owned transportation infrastructure.
- Test the FHWA conceptual model and provide FHWA with recommendations for improvement.



Rock scaling and slope stabilization on US 12 White Pass vicinity to reduce the potential for future rockslides. Photo courtesy of WSDOT.



Box culvert in place replaced a small culvert on SR 542, improving drainage and fish passage. Photo courtesy of WSDOT.



Drilled shafts support new bridge at Gold Creek on I-90, improving resistance to high-velocity flooding. Photo courtesy of WSDOT.

Approach

WSDOT conducted the vulnerability assessment using a qualitative, climate scenario planning approach. The project team facilitated workshops across the state, during which participants used asset maps, climate scenarios, and their local knowledge to assess vulnerability.

Compile asset inventory. To help workshop participants identify assets that may be exposed to climate change, WSDOT compiled an asset inventory and mapped asset locations. During this process, the project team collected data from multiple data sources that varied widely in level of detail and completeness. Integrating data from disparate sources (such as asset and maintenance management systems) proved to be an unexpected challenge for the project team.

Collect climate data. A series of state laws passed since 2007 encourages state agencies to develop integrated climate response strategies that rely on climate data produced by the University of Washington Climate Impacts Group (CIG). In addition, CIG made technical expertise and data available to WSDOT for use in the pilot. This close partnership allowed the agency to draw heavily on in-state expertise and existing data sources. The project team included a presentation from CIG staff in the workshop orientation video to provide a consistent summary of the climate projections.

The Department also used CIG data to produce impact maps illustrating sea level rise, temperature change, precipitation, wind, and fire threats to WSDOT infrastructure. These maps effectively communicated historical trends and projections to workshop participants.

WSDOT identified climate scenarios that considered 2-, 4-, and 6-foot sea level rise; shifts in the timing and type of precipitation; temperature extremes; increased severe storms; and wildfires.

Information Type	Source
Climate scenarios	University of Washington's Climate Impacts Group (CIG)
Asset inventory	WSDOT's State Highway Log WSDOT's Bridge Engineering Information System

Organize vulnerability assessment workshops.

WSDOT's qualitative vulnerability assessment relied on 14 structured workshops that collected and mapped institutional knowledge about vulnerability. The total number of workshop participants exceeded 200, including maintenance staff; regional office staff; and state ferry, aviation, and rail system managers.

Capturing Local Knowledge and Insights

The workshop process enabled WSDOT to capture the expertise of people who had the best local knowledge about how each asset is used and what climate-related issues currently exist. The workshops brought together:

- WSDOT subject matter experts in materials, hydrology, geology, and landscape architecture
- WSDOT staff with local knowledge and experience, including Area Maintenance Superintendents and Environmental Managers

At the start of each workshop, the project team presented a video about climate impacts on infrastructure, the CIG climate change scenarios, and impact maps. A Geographic Information System (GIS) specialist was on hand to overlay detailed asset inventories with climate impact data. Workshop participants then used a qualitative scoring system to assess roadway segments (or other assets) for criticality and to rate the effect that projected changes in climate would have on WSDOT infrastructure.

"Keep it simple. Get to the basic questions about impacts, but don't get bogged down by uncertainty. You need the science, but don't make the science the center point."

-Mark Maurer, WSDOT

WSDOT's workshop approach was highly successful at building relationships within the agency and eliciting institutional knowledge on climate vulnerabilities. One of WSDOT's best practices was asking participants, "what keeps you up at night?" This question helped participants quickly identify major existing concerns or issues, and led to the next question: "what happens if the climate-related conditions get worse?"

WSDOT synthesized the results from each workshop by producing a series of maps for each region showing the vulnerability ratings for road segments, airports, ferries, and rail lines.

Establish vulnerability assessment methodology.

WSDOT’s vulnerability assessment considered two factors: asset criticality and the potential impacts of the CIG climate change scenarios. The project team used a 1 to 10 rating scale to articulate the relative criticality and impact for each asset. Workshop participants scored criticality based on the asset’s character, its general function, and use. Similarly, participants defined climate impacts based on the anticipated impact of a given climate scenario on a specific asset. The impact-asset criticality matrix in Figure 1 is a visual representation of the relationship between these two factors.

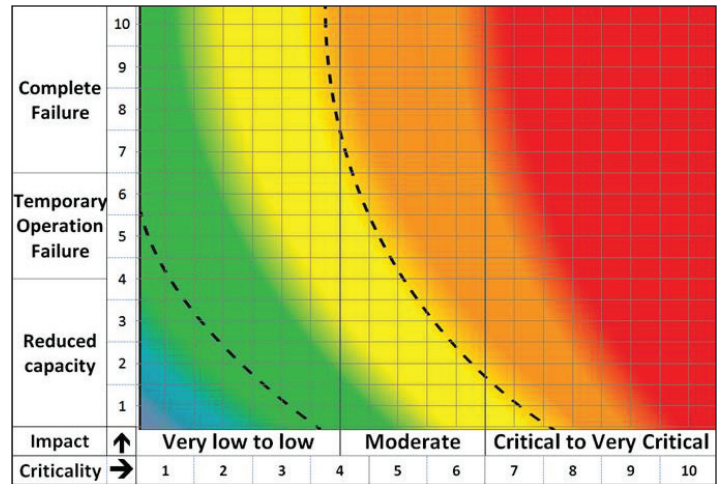


Figure 1: Impact-Asset Criticality Matrix or “Heat Sheet”

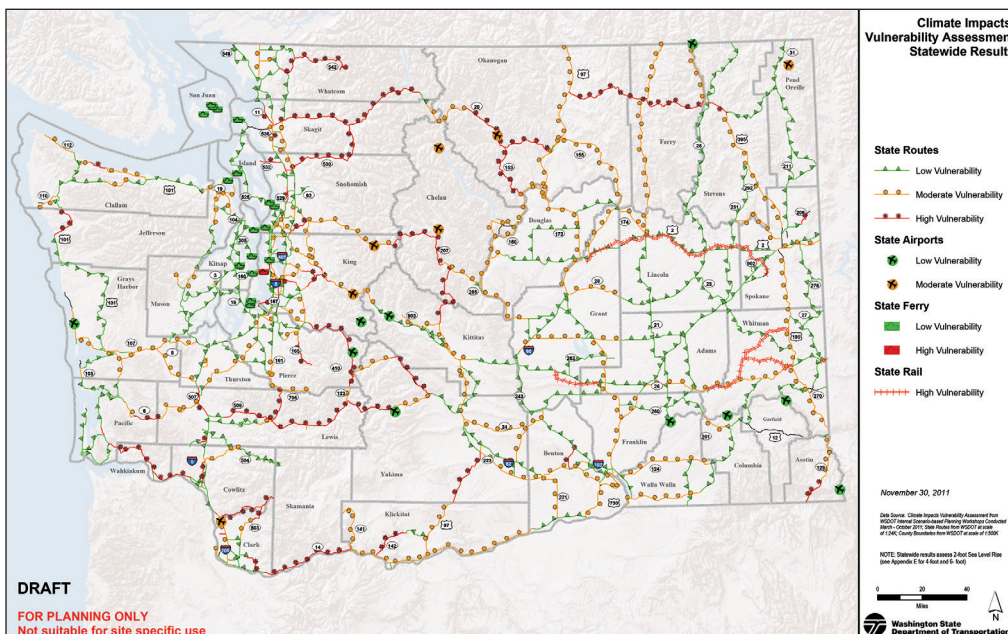
Key Results & Findings

Areas of resilience. The vulnerability assessment found that most WSDOT assets are resilient to climate change impacts. Many “no-regrets” improvements made for other reasons have bolstered infrastructure resilience to extreme weather events. For example, seismic retrofits may boost a bridge’s ability to withstand strong winds, and fish passage improvements widen or replace culverts and may reduce exposure to flooding.

Areas of vulnerability. The assessment found that climate change will exacerbate existing conditions such as unstable slopes, flooding, and coastal erosion.

Furthermore, areas where climate-related impacts are anticipated are already experiencing problems.

The vulnerability ratings gathered from the workshops were mapped for all modes across the state. In WSDOT’s vulnerability map (Figure 2), red denotes roads where one or two areas along that segment are vulnerable to catastrophic failure as a result of climate change impacts; yellow denotes roads that are vulnerable to temporary operational failures at one or more locations; and green indicates roads that may experience reduced capacity somewhere along the segment. Generally, areas rated with high impact to climate change effects are:



- In the mountains
- Either above or below steep slopes
- In low-lying areas subject to flooding
- Along rivers that are aggrading due to glaciers melting
- In low-lying coastal areas subject to inundation from sea level rise

Figure 2: Statewide Climate Vulnerabilities

Lessons Learned

Utilize existing resources and information. Effective use of resources can leverage limited project funds.

- WSDOT worked with experts at CIG to communicate existing regional climate data rather than gathering new datasets. Data was sufficient for describing a series of potential climate scenarios.
- Discussions of current weather events were valuable. WSDOT is already facing changes in river dynamics due to melting glaciers and extreme high tides. Discussing these observed changes made it easier for workshop participants to assess future vulnerabilities.

Integrate institutional knowledge. The workshop format was an appropriate method for assessing regional vulnerability, particularly because the analysis was qualitative rather than quantitative.

- Participation and knowledge from local staff was important for accurately rating the criticality and potential impacts of each asset.
- The workshop format builds organizational capacity and relationships within an agency.
- The agency sought active participation by keeping the workshops small and conducting them in the regions and maintenance areas.
- WSDOT evaluated lessons learned from the initial workshop and took steps to improve subsequent workshops.

Incorporating Findings into Planning and Management

WSDOT actions and recommendations. WSDOT is integrating the results of its vulnerability assessment into many areas of transportation decision making, including planning, environmental review, design, and asset management. For example:

- The Environmental Procedures Manual notes that all projects subject to National and State Environmental Policy Acts (NEPA and SEPA) must consider climate change. Soon after the report was published in late 2011, WSDOT updated its NEPA/SEPA guidance for considering climate change and extreme weather events in project-level environmental reviews. Now, project teams use the results in their environmental studies—including environmental impact statements (EIS). For example, the Mukilteo Multimodal Terminal EIS evaluated the impacts of sea level rise and increased precipitation.
- The State Route 520 Multimodal Corridor plan noted that the study area is rated as low risk overall, but identified one area that may be at risk of more frequent flooding in the future.

Contribution to statewide adaptation efforts.

The findings from the pilot project informed a series of statewide and sector-wide recommendations for identifying vulnerable infrastructure in the Washington State Integrated Climate Change Response Strategy, published in May 2012.

For More Information

Resources:

[WSDOT Climate Impacts Vulnerability Assessment](#)
[WSDOT Adapting to a Changing Climate Webpage](#)

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