



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

FHWA Climate Resilience Pilot Program:

Washington State Department of Transportation

The Federal Highway Administration's (FHWA)'s Climate Resilience Pilot Program seeks to assist state Departments of Transportation (DOTs), Metropolitan Planning Organizations (MPOs), and Federal Land Management Agencies (FLMAs) in enhancing resilience of transportation systems to extreme weather events and climate change. In 2013-2015, nineteen pilot teams from across the country partnered with FHWA to assess transportation vulnerability to extreme weather events and climate change and evaluate options for improving resilience. For more information about the pilot programs, visit: http://www.fhwa.dot.gov/environment/climate_change/adaptation/.

Washington State Department of Transportation (WSDOT) examined adaptation options in the Skagit River Basin (Basin), a highly vulnerable area of the state. The Basin was the focus of a major flood risk reduction study by the U.S. Army Corps of Engineers (Corps). WSDOT worked with the Seattle District of the Corps and the Skagit County Public Works Department to identify vulnerabilities and opportunities for flood risk reduction. This pilot demonstrated the importance of coordinating transportation adaptation planning with other ongoing flood risk reduction efforts like the Skagit River Flood Risk Management General Investigation Study (GI study).



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Scope

WSDOT identified the project area as highly vulnerable in its 2011 statewide climate vulnerability assessment. The area encompassed the lower Skagit River Basin, located in northwestern Washington State, including the cities of Burlington, Mount Vernon, and Sedro-Woolley, as well as sections of Interstate 5 and State Routes (SR) 9, 20, 11, 534, 536, and 538 (see Figure 1). The project focused on adaptation strategies that would increase resilience of major transportation infrastructure to flood risk.

Objectives

- Engage with federal and local entities during a major flood study and integrate results into adaptation planning.
- Develop a replicable methodology using federal data overlaid with state highway data sets.
- Develop a set of adaptation strategies for the state-owned and state-managed transportation infrastructure within the Basin.



Stakeholders take a tour of the GI study area in July 2013. Photo credit: WSDOT



Flood-fighting efforts in Mount Vernon. Photo credit: WSDOT



WSDOT Pilot team workshop with Skagit County. Photo credit: WSDOT

Approach

Compile climate and flooding data. The WSDOT pilot team began by reviewing results from the 2011 Climate Impacts Vulnerability Assessment (CIVA) and then conducted a series of interviews and workshops to gather additional information about the study area. Data collection efforts included:

- *Meetings with county and city staff.* The team gathered historical data and verified or updated the data collected in the CIVA study. County staff provided data on existing conditions, an infrastructure at-risk map, GIS depth files for all floods, and a basemap with elevations for the Basin.
- *Meetings with internal and external stakeholders.* The pilot team conducted interviews with local tribes, diking districts, City planning and public works staff, County emergency response staff, regional planners, and WSDOT maintenance staff. With their help, the team identified initial “areas of concern” regarding flood hazards and anticipated extreme weather event impacts.
- *Pilot team workshops.* After engaging partners and gathering data, the team held a series of workshops over several months to: identify what climate threats or extreme weather impacts most affect the Basin; compare potential scenarios under existing conditions with the proposed Corps project; understand the potential impacts of the Corps’ tentatively selected plan (TSP); identify the WSDOT-managed assets of primary concern; and determine how to define focus areas.

Review Corps’ GI Study. In June 2014, the Corps released their GI study and draft Environmental Impact Statement (EIS), which provided detailed information on existing conditions and conceptual information about the action alternatives and the Future without Corps’ Project. WSDOT reviewed these resources and found a wealth of information on water movement in the Basin, including output from the Corps’ FLO-2D floodplain model that included water surface elevation and depth grids for flood scenarios of various return interval floods and levee failures. The Corps was not able to provide model output data for the “no action” or TSP alternative, but plans to provide them once complete.

Analyze Corps’ Flood Model data. WSDOT Geographic Information System (GIS) and hydraulics experts worked together to process the data into information that would be useful in determining impacts to transportation infrastructure. The pilot team identified 35 data sets in the GIS database and overlaid them on the

23 areas of concern from the interviews. This analysis revealed that there were many individual areas of concern that were impacted by similar events. In addition, the areas of concern were connected by a highway segment, and when one area of concern was affected on that segment, the same event affected other areas of concern as well. The team refined the list to 11 highway segments for further consideration. By calculating the inundation of the assets, they found that most of the areas of concern identified during the interview process were consistent with the flood analysis results. For each of the 11 segments, the pilot team created a site-specific vulnerability profile. Each profile describes the key features of the segment in terms of highway location and functions, drainage issues, updated vulnerability assessment given Corps’ hydraulic data; and discussion of the team’s brainstorm of adaptation strategies. Figure 1 shows the results of the flood analysis.

Develop adaptation strategies. The team developed structural and non-structural strategies to address the issues identified through analysis of the flood model data. The strategies included general broad structural actions (design and construction) and nonstructural solutions (planning, detour routes, and partnerships). A hydrologist and stormwater engineer analyzed the structural strategies to assess their feasibility. The team then refined the strategies based on their feedback.



Figure 1. Map of the pilot study area with the flood hazard locations for the 1% (blue), 2% (green), 4% (red), and 10% (black) Corps’ annual chance of exceedance (ACE) floods. Areas of concern are denoted with a green asterisk.

Key Results & Findings

Flooding impacts. The project allowed WSDOT planners and hydraulic engineers to delve deeply into the Corps’ new data on existing conditions. WSDOT estimated the impacts associated with the Corps’ action alternative (which is designed to reduce urban flood hazard by improving and raising existing levees and adding new levees). The team’s analysis found that 90 percent of I-5 in Skagit County, as well as the rest of the highway system, is estimated to be at risk of flooding without the TSP. The TSP could eliminate issues seen during the existing 1% ACE flood on the southern and central portions of I-5. The TSP is anticipated to direct floodwaters to some sections that were not

identified as highly vulnerable in the qualitative assessment and to maintain or worsen conditions in some areas.

Adaptation strategies. The pilot team concluded that the right adaptation strategies for WSDOT may change depending on whether the Corps builds or doesn’t build the TSP. With that in mind, WSDOT identified “no regrets” strategies that would improve transportation infrastructure resilience regardless of future work by the Corps. WSDOT identified five strategies categorized as “no regrets” by the end of the study. Examples of some of the brainstormed strategies are shown in Table 1.

Table 1. Examples of conceptual strategies identified for 3 of the 11 vulnerable highway segments.

Highway Segments – The Project Team Brainstormed the Following Options	Strategies		
	Future without Corps’ Project	Tentatively Selected Plan	No Regrets
Segment 1: Central I-5 Anderson Road to George Hopper Road			
<ul style="list-style-type: none"> Work with local agencies and the Corps to purchase additional storage capacity behind the dams run by Puget Sound Energy and Seattle City Light. 	X	X	X
<ul style="list-style-type: none"> Work with the City of Mount Vernon to extend the floodwall to protect state highways. 	X		X
<ul style="list-style-type: none"> Raise I-5 above the flood elevation. 	X		
Segment 2: SR 20 East of Burlington to Sedro-Woolley			
<ul style="list-style-type: none"> Reroute traffic onto Cook Road or F&S Grade Road. 	? ¹	X	X
<ul style="list-style-type: none"> Raise the road (or portions) through this segment and install sufficient culverts or bridges to allow the water to pass from the Skagit River over to Joe Leary Slough. 	X	X	? ¹
<ul style="list-style-type: none"> A high number of culvert ends are identified in this segment; it is possible that the other end may be buried or obstructed and not operating properly. If those culverts are not functioning properly now, fixing them might relieve flooding issues in smaller floods. 			X
Segment 3: SR 538 Nookachamps Basin – SR 9 to I-5			
<ul style="list-style-type: none"> Raise the road (or portions). It appears that this could be done to alleviate flooding for the more frequent flood events but may be difficult for the 2% and 1% ACE flood. 	X	X	X

¹ A “?” indicates that more information or analysis of potential benefits is needed.

Lessons Learned

Collaborate with and leverage local and federal flood hazard mitigation planning efforts. WSDOT found that collaboration with flood risk managers is critical for transportation agencies as they develop adaptation strategies. During adaptation strategy development, specific examples were uncovered where WSDOT could have invested in the wrong place if the team had been

unaware of the Corps’ TSP or local flood improvements. Similarly, WSDOT flood adaptation strategies could affect assumptions in the Corps’ study. Partners can also provide useful data to share. For example, flood modeling data from the Corps served as a tool for WSDOT to analyze flood impacts and levee breach scenarios under existing and changing climate conditions.

Knowing what data are available and what is still unknown can help streamline the timeline for the analysis. It can also eliminate the dependence on others' timelines. It is preferable and simpler if existing studies are complete and all data are available before beginning analysis. Transportation agencies do not need to wait for a new flood study to be undertaken; however, they can look at past studies and augment the prior work with climate change data from other sources.

The FHWA Climate Change and Extreme Weather Vulnerability Assessment Framework was useful for navigating the process. It helped tie the first vulnerability assessment to the more detailed Skagit River Basin study.

Workshops and interviews with stakeholders were effective. The analysis validated the workshop and interview process. Through a GIS and hydraulic analysis, the pilot team found that most of the areas of concern

identified during the 2011 qualitative vulnerability assessment and the interview process for this pilot were consistent with the flood analysis results. The analysis also identified additional vulnerable locations that the interviews did not. Both processes complement each other and should be used together for watershed-level adaptation strategy development.

Project teams should provide local knowledge and the right technical skills. Having staff on the team who knew the local area and the people involved in climate adaptation work was critical for the success of this project. WSDOT also learned the importance of having staff available with the right technical skills (e.g., flood data analysis and GIS) as well as capacity to dedicate to the project. During hydraulics analyses, WSDOT used staff with resource-specific understanding and local familiarity to better understand data gaps.

Next Steps

Continue working to integrate climate into decisions. WSDOT will work with the community on integrated long-range transportation/land use and emergency planning in Skagit County. At a state level, WSDOT will integrate what they have learned from this project into corridor planning and transportation studies (particularly in other vulnerable basins with ongoing flood hazard reduction efforts).

Lead by example in fostering greater integration of related local, state, and federal planning efforts.

- The pilot team is working with the state departments of Commerce and Ecology to develop guidance for local vulnerability assessments.
- The team hopes to coordinate with local governments on adding climate considerations into their Growth Management Act compliance and long-range planning efforts.
- WSDOT will monitor the progress of the Corps' TSP and local investments and continue to assess opportunities to partner with the Corps and local governments. Across the country, similar site-specific flood studies are available to the public and can be used by transportation agencies in their adaptation planning. WSDOT recommends that at the federal level, U.S. DOT and the Corps work together to develop a strategy for integrating agency-sponsored planning efforts (e.g., by ensuring FHWA Division offices or state DOTs are invited to participate in major flood studies).

"Transportation agencies must collaborate with flood risk managers during adaptation strategy development. We uncovered specific examples where WSDOT—if we had been unaware of the Corps' tentatively selected plan or local flood improvements—could have invested in the wrong place."

– WSDOT Pilot Team

For More Information

Final report available at:

www.fhwa.dot.gov/environment/climate/adaptation/2015pilots/

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