



U.S. Department of Transportation
Federal Highway Administration

FHWA Approaches to Resilience

ASTM

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Resilience – what is it, and why should I care?

- **Resilience:** the ability to anticipate, prepare for, and adapt to changing conditions and withstand, respond to, and recover rapidly from disruptions [see: FHWA Order 5520]
- Protect public safety
- Save financial resources



Hurricane Harvey, Beaumont, TX (photo credit: Donna Burton for US CBP)



Hurricane Maria, Puerto Rico, 9/23/17 (photo credit: Kris Grogan for US CBP)

FHWA and Resilience

- Adaptation activities [eligible](#) for FHWA funding
- FHWA requires resilience to be considered in:
 - [Asset management plans \(23 CFR 515\)](#)
 - [Transportation plans \(23 USC 134, 23 CFR 450\)](#)
 - Emergency relief ([23 CFR 667](#))
 - FHWA programs and policies ([Order 5520](#))
- Extensive FHWA research and technical assistance available.
- FHWA Resilience Website: <https://www.fhwa.dot.gov/environment/sustainability/resilience/>



Flooding from Hurricane Harvey, Credit: TTI

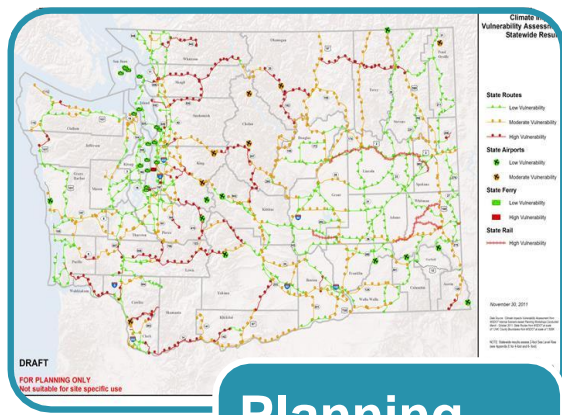


April 2017 flooding in Washington State, Credit: WSDOT

Integrating Resilience

Goal: Integrate consideration of resilience in transportation decision making

- In support of 23 U.S.C. § 503(b)(3)(B)(viii), which directs the U.S. Department of Transportation “to carry out research and development activities ... to study vulnerabilities of the transportation system to ... extreme events and methods to reduce those vulnerabilities.”



Planning

- Long Range Transportation Plans
- Asset Management Plans

Credit: WSDOT



Project Level

- Environmental Processes
- Engineering
- Design

Credit: CDOT




Operations and Maintenance

- Emergency Relief
- Snow Removal Programs

Credit: Nashville MTA


FHWA Resilience Resources

Gulf Coast 2 Study


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Resilience Pilots with State DOTs & MPOs

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Hurricane Sandy Project

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Credit: NYC DOT


Engineering Assessments

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Credit: Brian Reucler

<https://www.fhwa.dot.gov/environment/sustainability/resilience/>


Vulnerability & Adaptation Framework

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Engineering Guidance (HEC-25 & 17)

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Project Development

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Operations & Maintenance

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Nature-Based Solutions

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What is a “Vulnerability Assessment”?


Goal: Identify, assess resilience concerns, adaptation options

- Where are the highest risk locations?
 - How might future changes in precipitation, sea levels, temperatures impact the transportation system? Key facilities?
 - Options for improving resilience
- Scale
- System level vulnerability assessment (city or region)
 - Project level


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Resilience and Durability Pilots To Date

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2018 Resilience and Durability Pilots

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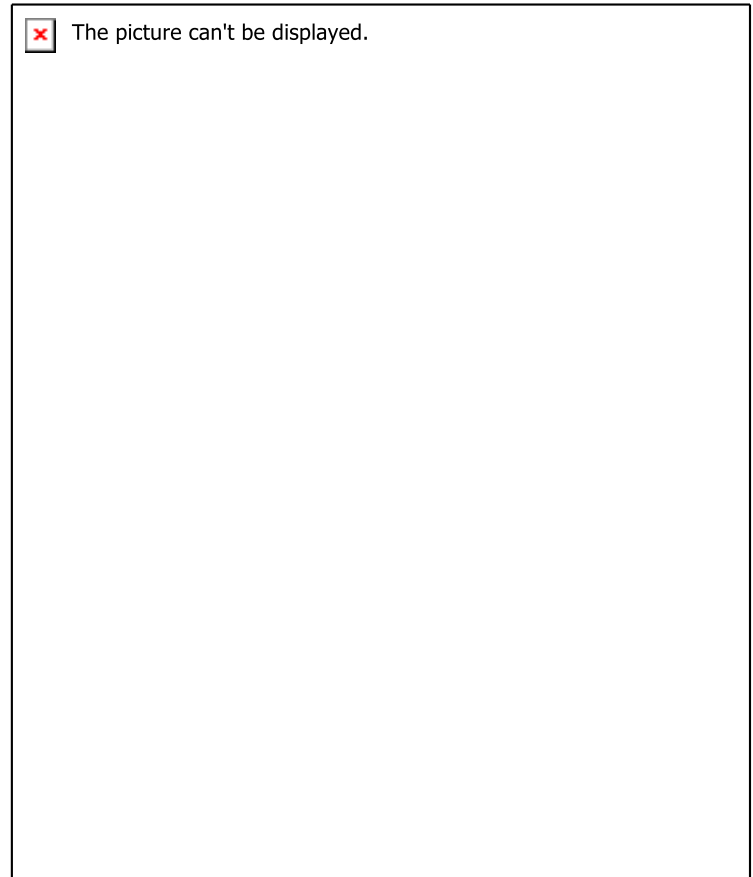
Resilience in Asset Management

- State DOTs are required to develop **asset management plans** that identify and address risks, including current and future environmental conditions, to National Highway System (NHS) pavements and bridges and the performance of the NHS (23 CFR 515)
- Resilience in Asset Management **Pilots** (2017-19): Arizona, Texas, Kentucky, Maryland, Massachusetts, New Jersey
- Forthcoming **handbook** (expected in 2020):
 - Developing asset inventory informed by natural hazard/vulnerability assessments
 - Identifying and managing risks (Risk Register)
 - Conducting life cycle planning
 - Creating resilient investment strategies and financial plans

www.fhwa.dot.gov/asset/pilot

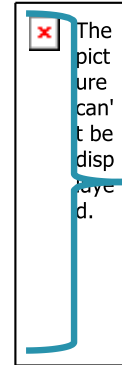
Synthesis of Approaches for Addressing Resilience in Project Development

- Lessons learned, etc., for four engineering disciplines
 - Coastal Hydraulics
 - Riverine Hydraulics
 - Pavement and Soils
 - Mechanical & Electrical Systems
 - Overall Lessons learned for engineering
- Addressing resilience in the project development process
- Economic analysis

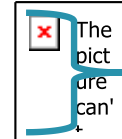


Project-level Resilience Analysis

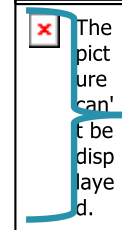
1. Understand the site context
2. Document Existing or Future Base Case Facility
3. Identify Climate Stressors
4. Develop Climate Scenarios
5. Assess Performance of the Facility
6. Develop Adaptation Option(s)
7. Assess Performance of the Adaptation Options
8. Conduct an Economic Analysis
9. Evaluate additional decision-making considerations
10. Select a course of action
11. Develop a Facility Management Plan



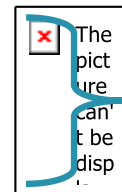
Understand site context, future conditions



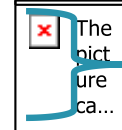
Test asset against future scenarios



Develop, Evaluate, select adaptation options

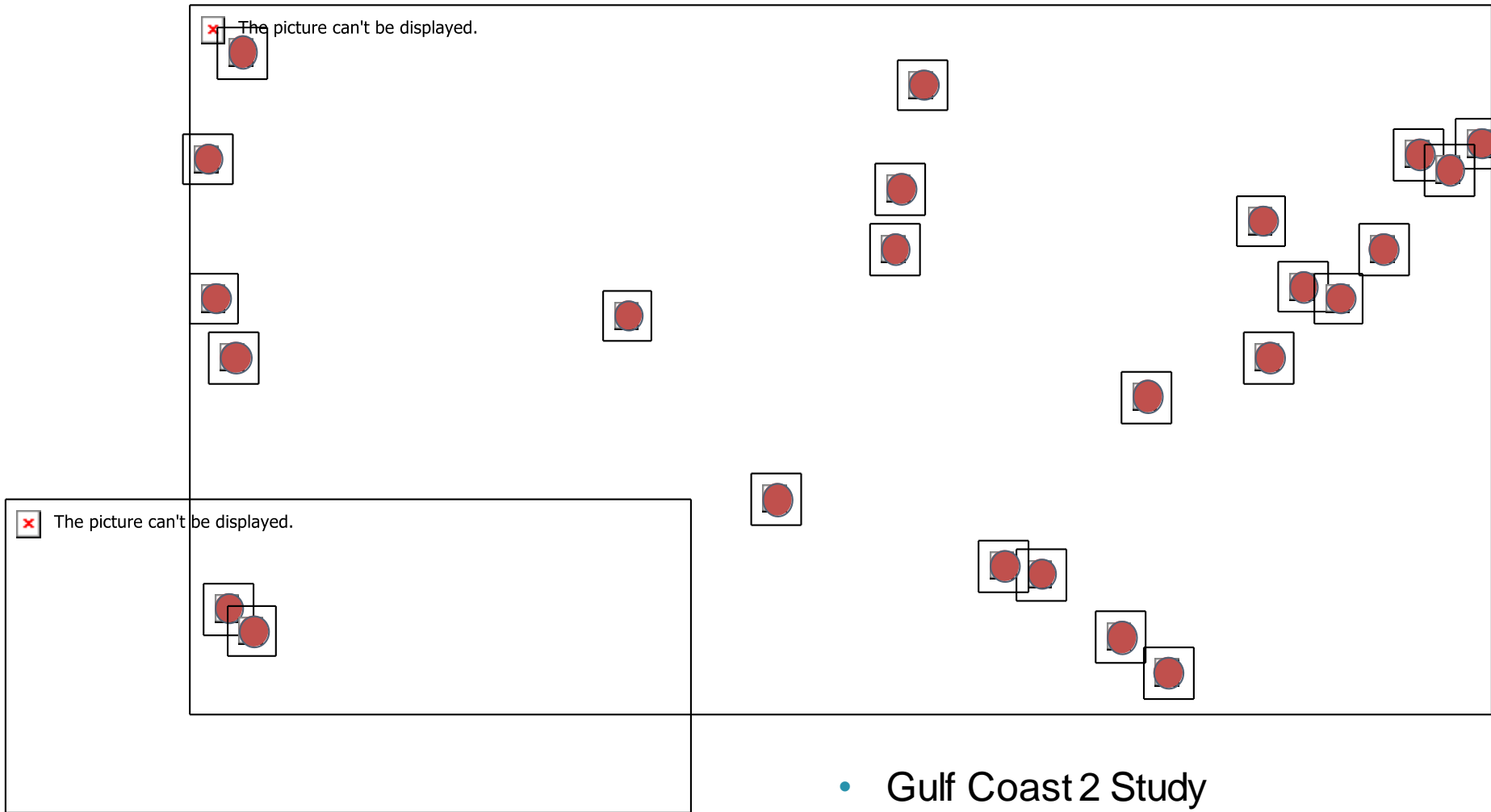


Review additional considerations



Monitor and revisit

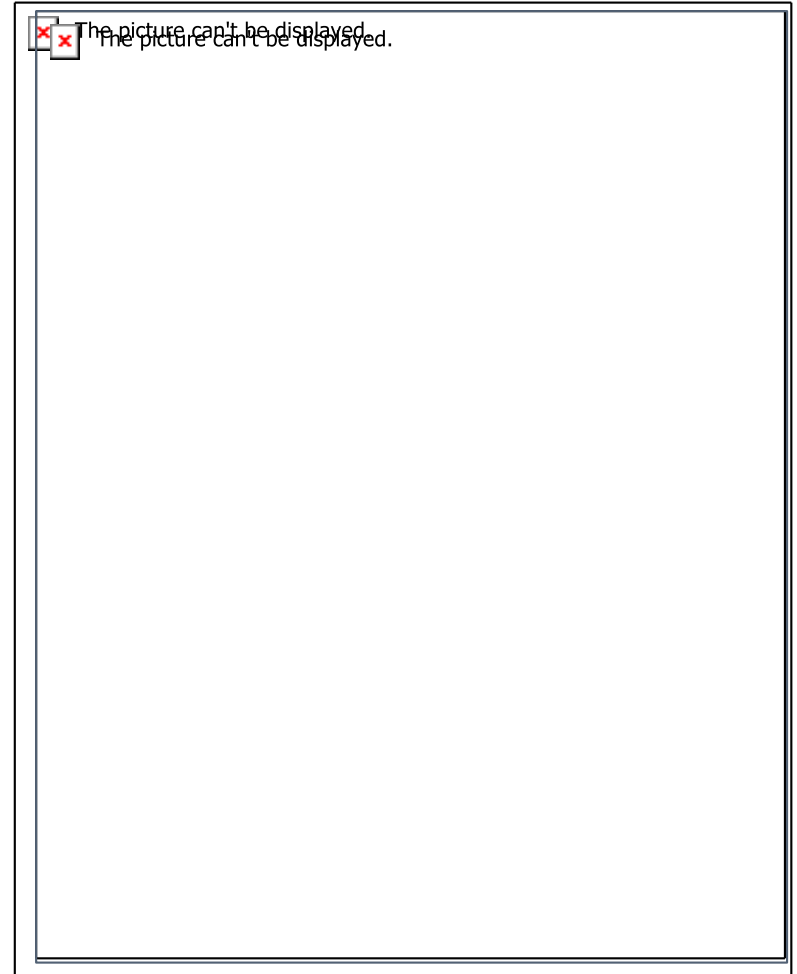
Engineering-Focused Case Studies



- Gulf Coast 2 Study
- Adaptation Pilots
- Post-Sandy Resiliency Study
- TEACR

Coastal Hydrology

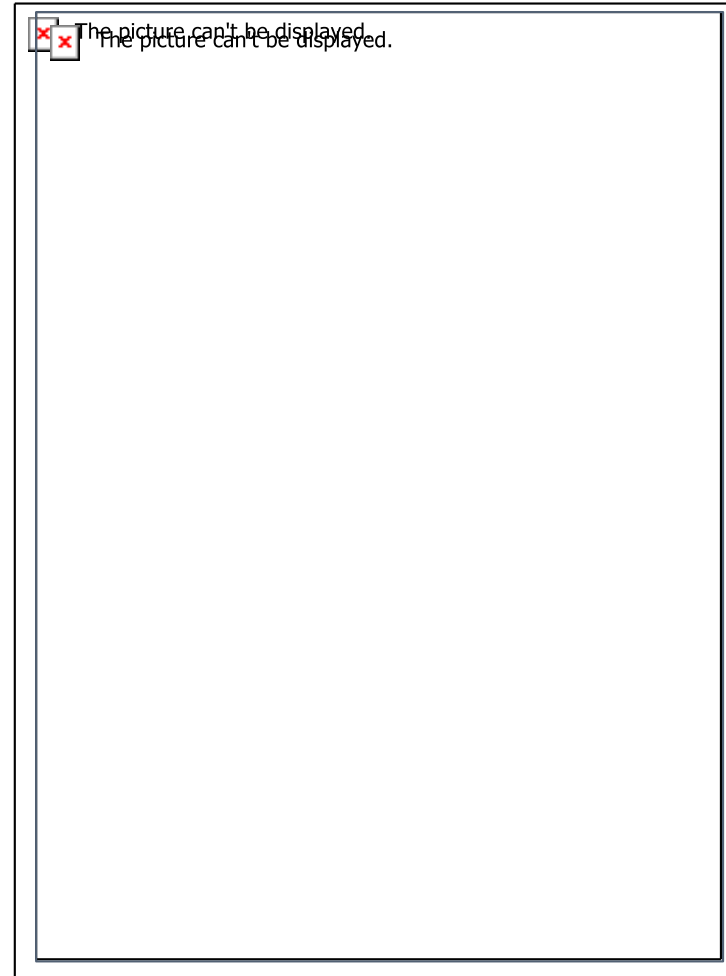
- **Hydraulics Engineering Circular 25, Volume 2**
Highways in the Coastal Environment: Assessing Extreme Events, October 2014.
- Currently being updated



Riverine Hydrology


- **Hydraulics Engineering
Circular 17**

Highways in the River
Environment - Floodplains,
Extreme Events, Risk, and
Resilience (Second Edition),
June 2016



FHWA Nature-based Solutions

- **FHWA Goal:** Provide research and technical assistance to transportation agencies on how they can use nature-based solutions (such as wetlands, dunes, beaches, and reefs) to reduce coastal flood and erosion risks to highways.
- **FHWA Products:**
 - 5 pilot projects, 2018
 - Regional peer exchanges, 2018
 - [Implementation Guide](#), 2019
- **Funding Opportunity:** FHWA is [collaborating with NOAA on Effects of Sea Level Rise research grant program \(2021\)](#). Include focus on how nature-based solutions can improve transportation resilience.

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CMIP Climate Data Processing Tool (Version 2.1)

- Update to the existing CMIP tool (Excel based)
- Downscaled Climate & Hydrology Projections (DCHP) website
- New Version
 - ✦ Localized Constructed Analog (LOCA) dataset
 - ✦ Statistical downscaled (1/16th degree ~ 6x6 km)
 - ✦ Calculation of future return period precipitation (NCHRP 15-61 methods)

NHI Resilience Course (2021)

- ***Addressing Resilience in Highway Project Development & Preliminary Design (2021)***
- Content:
 - Addressing resilience in engineering decision-making (Pavements and Geohazards, Inland Flooding, Coastal Hydraulics)
 - Accessing, using climate projections
 - Integrating resilience into project development
- Audience: Engineering, design, project development/ NEPA staff (etc.).
- Source material: *Synthesis of Approaches for Addressing Resilience in Project Development*(2017) & project assessments, Hydraulic Engineering circulars -17 & -25.

Coming Soon (Under Development)

- Addressing Resilience in Transportation Asset Mgt
- HEC 25, Highways in the Coastal Environment, 3rd Ed.
- Geohazards, Extreme Events and Resilience Manual
- Integrating Natural Hazard Resilience into the Transportation Planning Process
- 2018-2020 Resilience and Durability Pilot program

Thank you

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www.fhwa.dot.gov/environment/sustainability/resilience/