



Hurricane Sandy Follow-up and Vulnerability Assessment and Adaptation Analysis

Heather Holsinger

Federal Highway Administration

NYMTC PFAC Meeting

January 23, 2014



Today's Roadmap

- Overview of FHWA's adaptation work
- NY-NJ-CT Hurricane Sandy Follow-up and Vulnerability Assessment and Adaptation Analysis Project



Photo: Flooding of the Hugh L. Carey Tunnel in NYC due to Hurricane Sandy. Source: MTA



President's Climate Policy

- Announced major speech and action plan on climate change June 25, 2013
- Cut Carbon Pollution
 - New and existing power plants – EPA under Clean Air Act
 - Renewable energy on federal lands
 - Heavy duty vehicle fuel economy standards, renewable fuels standard
 - Efficiency standards for appliances
- **Prepare for the Impacts of Climate Change**
 - **Remove federal policy barriers**
 - **Encourage climate resilient investments through grants, technical assistance, research performance measures, etc.**
 - **Provide tools for climate resilience to help state and local governments**
 - **Rebuild and learn from Superstorm Sandy**
- Lead International Efforts
- **Executive Order on Climate Preparedness Nov. 1, 2013**



Climate Change Adaptation at FHWA

- **Goal:** Systematic consideration of climate change vulnerability and risk in transportation decision making, at system and project level.
- **Approach:** Develop and share information on tools and methodologies that state DOTs and MPOs can use to assess risk, analyze adaptation options, and prioritize actions. FHWA funding can be used for climate adaptation.
- **Consistent with US DOT policy statement:** “DOT shall integrate consideration of climate change impacts and adaptation into the planning, operations, policies, and programs of DOT in order to ensure that taxpayer resources are invested wisely ...” June 2011.



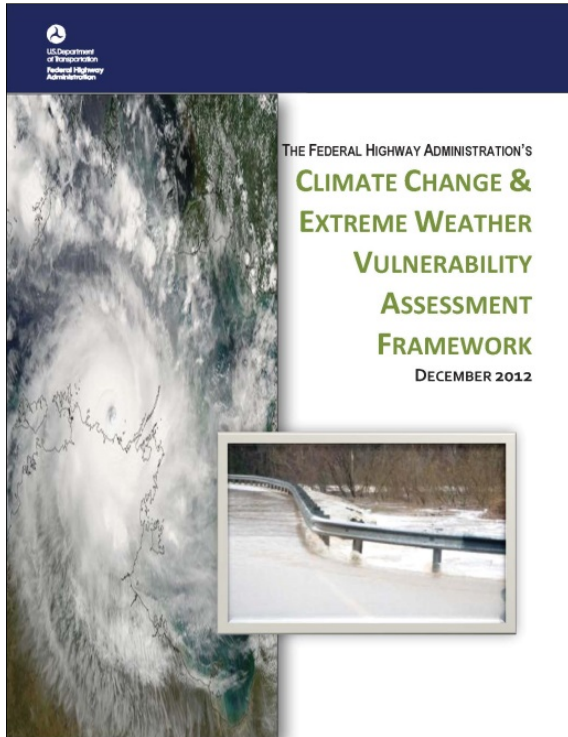
Houston after Tropical Storm Allison



NJ 287 collapse from Hurricane Irene



FHWA Climate Change & Extreme Weather Vulnerability Assessment Framework



1. DEFINE SCOPE

IDENTIFY KEY

CLIMATE VARIABLES

- Climate impacts of concern
- Sensitive assets & thresholds for impacts

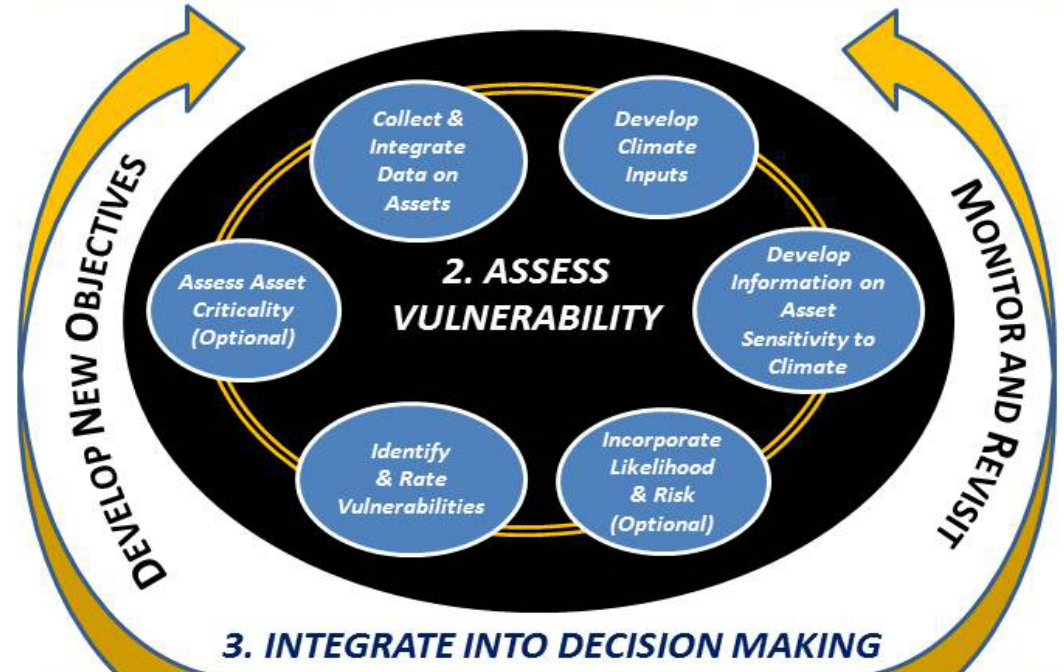
ARTICULATE OBJECTIVES

- Actions motivated by assessment
- Target audience
- Products needed
- Level of detail required

SELECT & CHARACTERIZE

RELEVANT ASSETS

- Asset type
- Existing vs. planned
- Data availability
- Further delineate



3. INTEGRATE INTO DECISION MAKING

- INCORPORATE INTO ASSET MANAGEMENT
- INTEGRATE INTO EMERGENCY & RISK MANAGEMENT
- CONTRIBUTE TO LONG RANGE TRANSPORTATION PLAN
- ASSIST IN PROJECT PRIORITIZATION

- IDENTIFY OPPORTUNITIES FOR IMPROVING DATA COLLECTION, OPERATIONS OR DESIGNS
- BUILD PUBLIC SUPPORT FOR ADAPTATION INVESTMENT
- EDUCATE & ENGAGE STAFF & DECISION MAKERS



2013-2014 Climate Resilience Pilot Program

Pilots using and building on FHWA's *Climate Change & Extreme Weather Vulnerability Assessment Framework*

19 Pilots

Tennessee	Iowa
Maine	Minnesota
Michigan	California
Arizona	Washington
Alaska	NCTCOG
Oregon	CAMPO (Austin)
Connecticut	Hillsboro MPO
New York	South Florida MPOs
Maryland	MTC (San Francisco)

- Vulnerability and/or adaptation
- Broad geographic coverage and range of impacts
- Furthering the state of practice in the emerging area of resilience to climate changes
- FHWA will use lessons learned to turn the vulnerability assessment framework into an adaptation and resiliency framework



Example 2013-2014 Pilots



CAMPO (Austin, TX)

- Extreme heat, flooding, drought, wildfire
- Regional symposium
- Incorporate into 2040 RTP

South Florida

- SLR, flood, storm surge maps
- Method for prioritizing impacted infrastructure
- Incorporate into decisions



TDOT

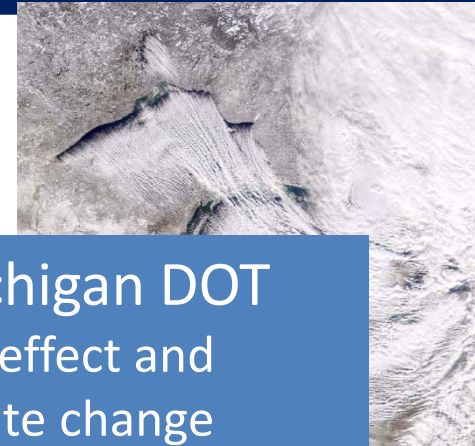
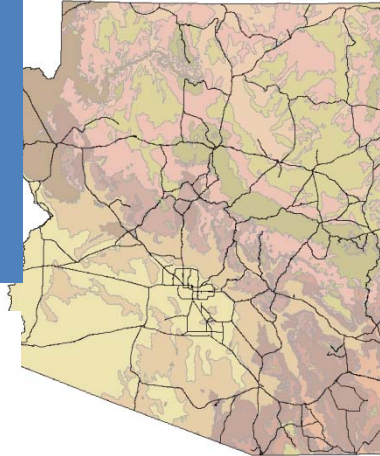
- Statewide with MPOs
- Multimodal
- Quantitative loss and damage estimation



Example 2013-2014 Pilots

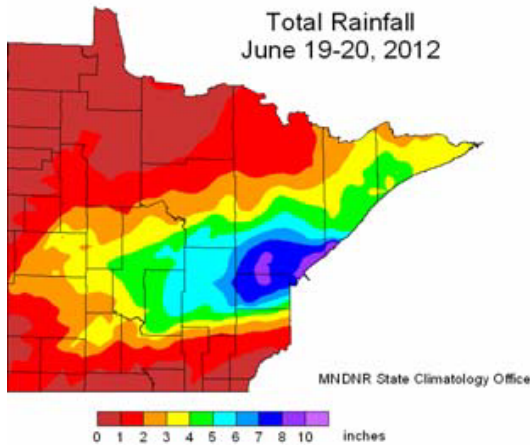
Arizona DOT

- Extreme surface temps
- Floods
- Dust storms
- Species Migration



Michigan DOT

- Lake effect and climate change
- Improve statewide, systematic approach to addressing risk



MnDOT

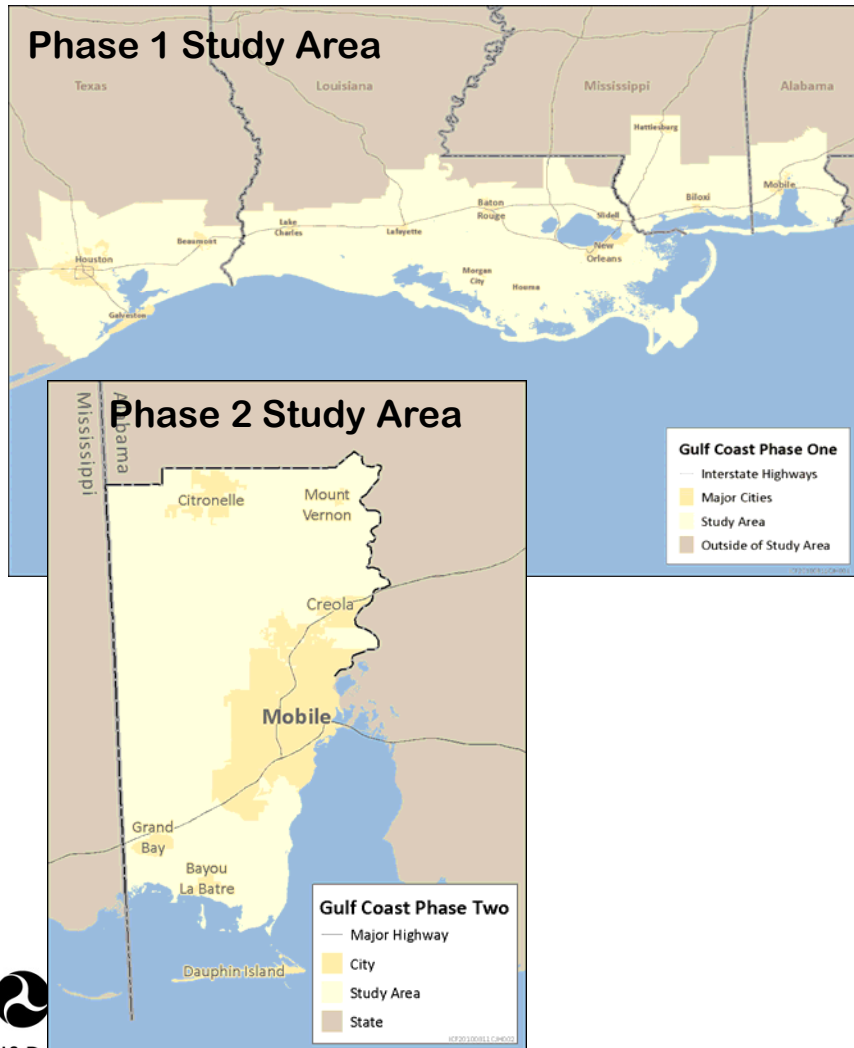
- Flash Flooding
- Asset Management

MassDOT

- Impacts to the Central Artery
- Solutions



Gulf Coast 2 Project (Mobile, AL)



- **Gulf Coast 2 project** is an in-depth vulnerability assessment of transportation system in Mobile, AL
- **Climate changes examined:**
 - **Temperature** and **precipitation** statistically downscaled from GCMs
 - **Relative sea level rise** scenarios based on range of recent global SLR scenarios plus local subsidence
 - **Storm surge** modeling looked at range of storm intensities and included **wave** modeling
- Detailed engineering analysis of select assets
- Developing tools that can be used by MPOs and DOTs around the country
- Complete Spring 2014



Gulf Coast 2 Transferable Tools Developed

Tools include:

- Vulnerability Assessment Scoring Tool (VAST)
- CMIP Climate Data Processing Tool
- Sensitivity Matrix
- Criticality Assessment guide

Sensitivity of Transportation to Climate Change (Stressor 1 of 1)

Asset Type: Bridges

Climate Stressor	Information Type	Physical Infrastructure	
		Bridge (Superstructure—Girders, Bridge Deck, Railings)	
Sea Level Rise/Extreme High Tides	Relationship	Sea level rise will increase impacts to the coast by a storm of a given magnitude by increasing the baseline water level for extreme storms. Because many coastal bridges were designed to withstand erosion produced by storm surges having a 1% annual chance of occurrence (that is, 100-year storm surge), as sea level increases the statistics used to design these structures change. For example, a 50-year storm surge following an increase in sea level could scour a bridge as severely as would the current 100-year storm surge (Froehlich, 2003). See the Storm Surge section on Bridges for more information.	Sea level rise will increase the baseline water level for extreme storms. Because many coastal bridges were designed to withstand erosion produced by storm surges having a 1% annual chance of occurrence (that is, 100-year storm surge), as sea level increases the statistics used to design these structures change. For example, a 50-year storm surge following an increase in sea level could scour a bridge as severely as would the current 100-year storm surge (Froehlich, 2003). See the Storm Surge section on Bridges for more information.
	Threshold(s)	Information limited or unavailable.	Information limited or unavailable.
	Indicator(s)	Indicators include the elevation of the bridge deck and approach relative to sea level, as well as the condition of the bridge deck and approach.	Indicators include the elevation of the bridge deck and approach relative to sea level, as well as the condition of the bridge deck and approach.

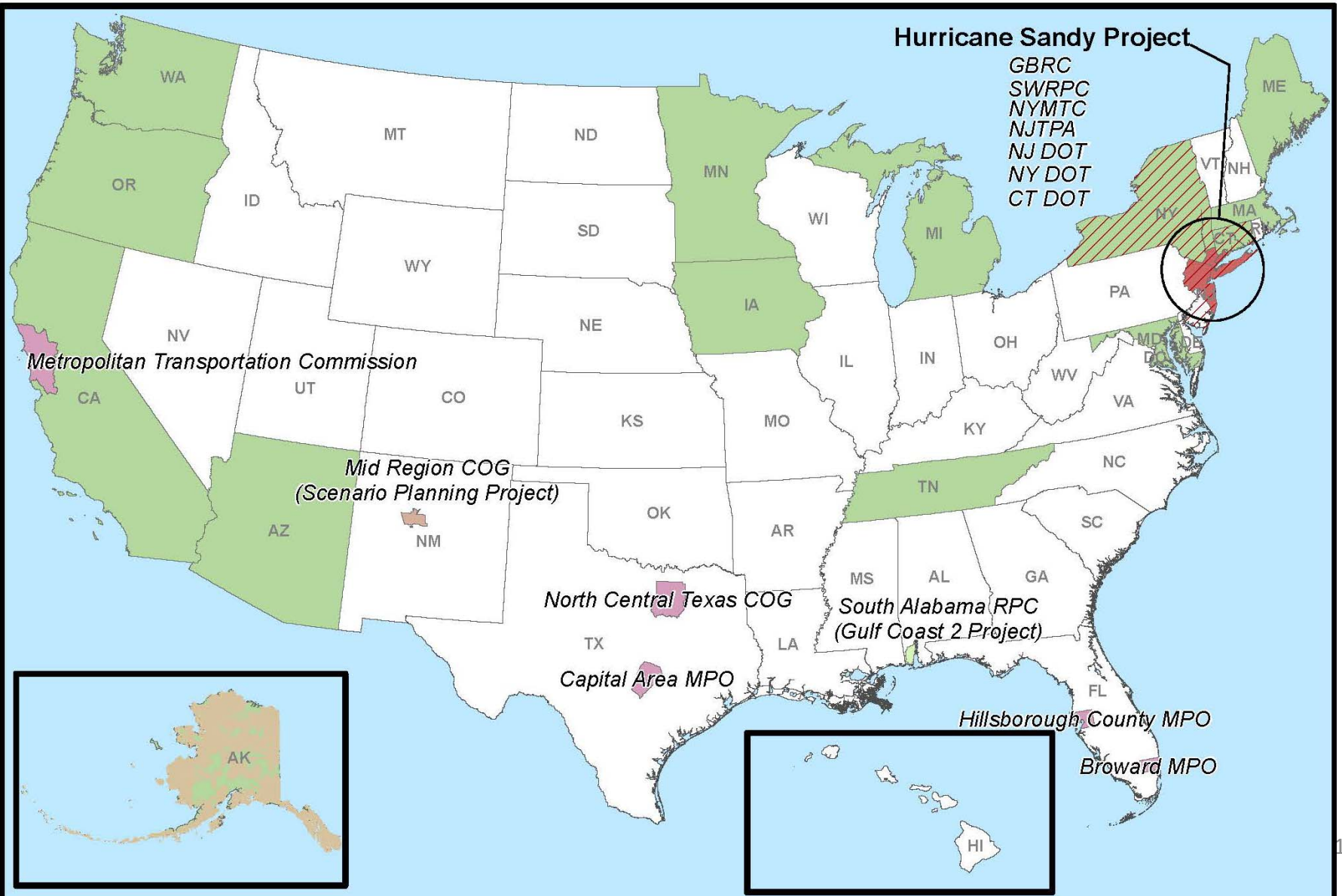
U.S. DOT Coupled Model Intercomparison Project (CMIP) Climate Data Processing Tool

Directions

- Follow all steps in the instructions document to request and save all data. Note that it is very important that all data have been saved in the correct folders.
- Answer the following six questions about the data you downloaded.
 - Describe the location you selected
 - Did you download data from CMIP3 or CMIP5?
 - How many climate models did you select (i.e., how many boxes did you check in Step 2.6?)
 - How many grid cells did you download?
 - In addition to the projected values for each variable, the tool will provide the range in values given a certain confidence interval. What confidence interval would you like to see?
 - (Optional) Describe the emissions scenario(s) you chose

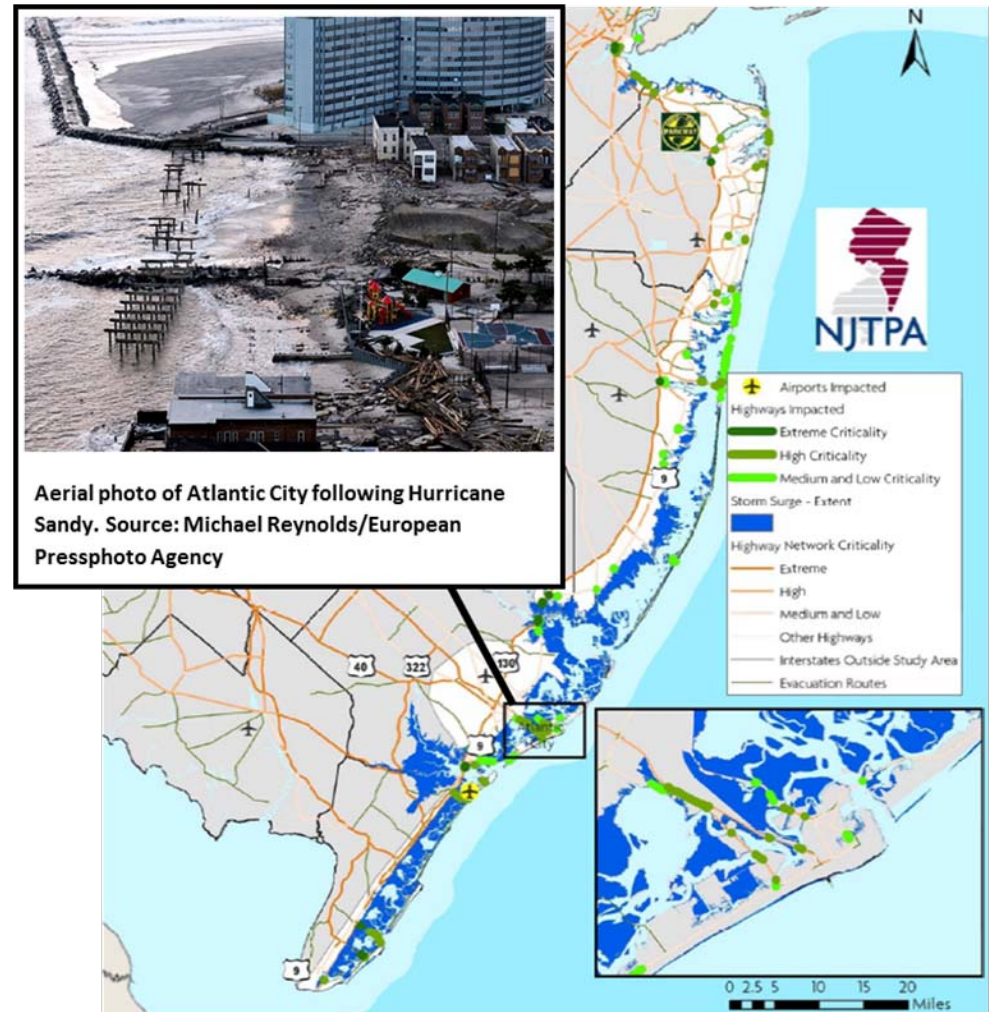


Pilot & Other Project Locations for 2013-2014



Sandy Follow-Up & Adaptation Analysis Project

- **Sandy project** builds on the 2011 NJ pilot
- Purpose: Learn from experience of Sandy and identify strategies to improve the resiliency of the transportation system to extreme weather and climate change



Sandy Project Major Partners

- Project Partners:
 - FHWA
 - FTA
 - NY, NJ, and CT DOTs
 - Metro area MPOs: NYMTC, NJTPA, SWRPA, and GBRC
 - MTA
 - Port Authority

- Project Consultants:
 - Cambridge Systematics (prime)
 - AECOM
 - Stratus Consulting
 - Office of Radley Horton



Sandy Project Major Tasks

- Assessment of damages from Hurricane Sandy & other recent storms, lessons learned, gaps in climate analysis
- Engineering-based analysis of adaptation options for up to 10 transportation assets
- Region-wide multimodal vulnerability assessment



Extreme Weather Impacts Assessment

- Objectives:
 - Collect and analyze historical data from recent storm-related damage and disruption to transportation infrastructure:
 - Hurricanes Sandy (2012) – *primary emphasis*
 - Irene (2011)
 - Tropical Storm Lee (2011)
 - Halloween Nor'easter (2011)
 - Collect information on climate projections used by governments and academic institutions in the tri-state region
 - Conduct gap analysis - information collected will allow us to look at modeled impacts versus observed impacts and will inform our assessment of future scenarios

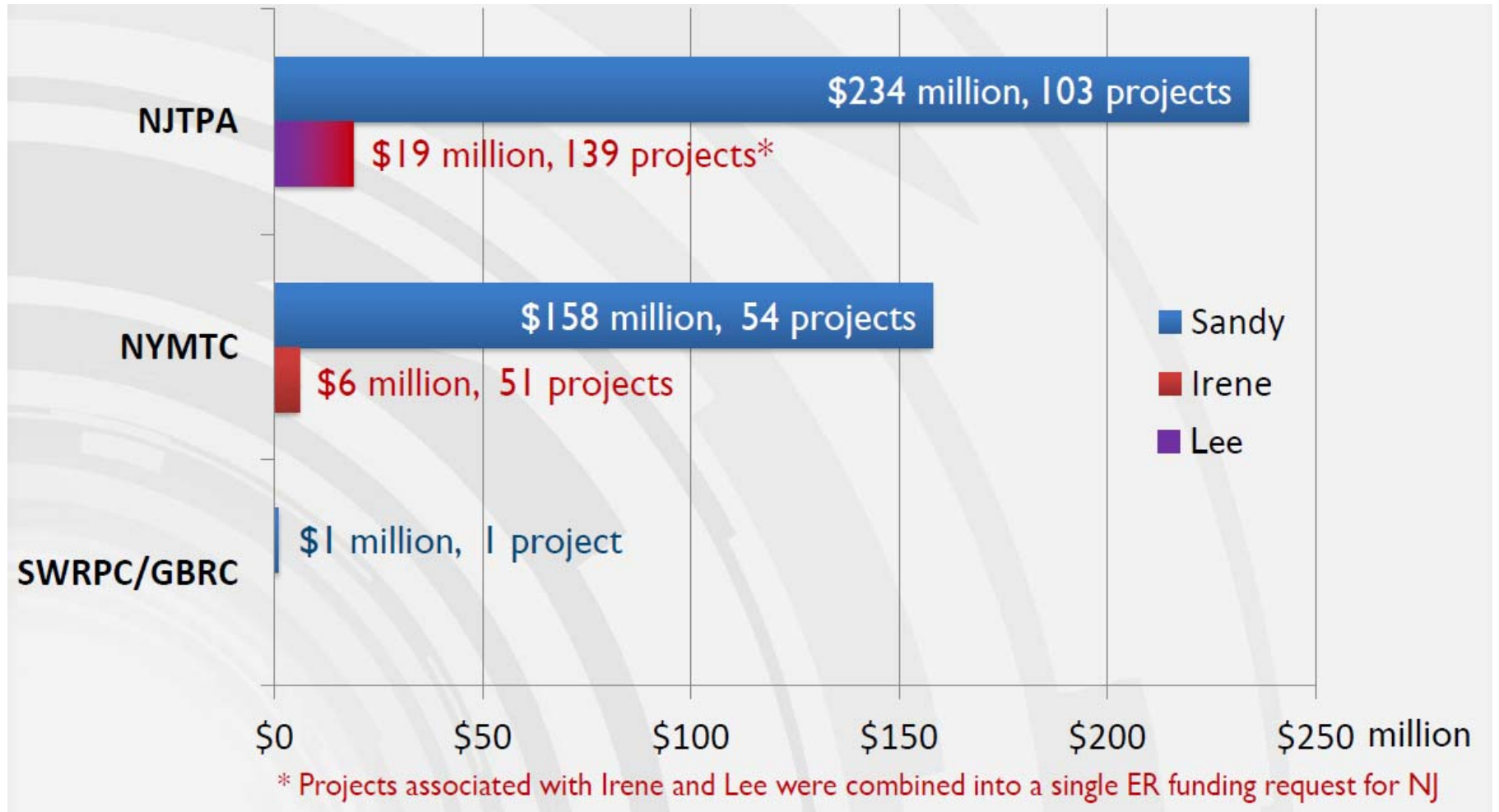


Regional Damage Assessment: Data Sources

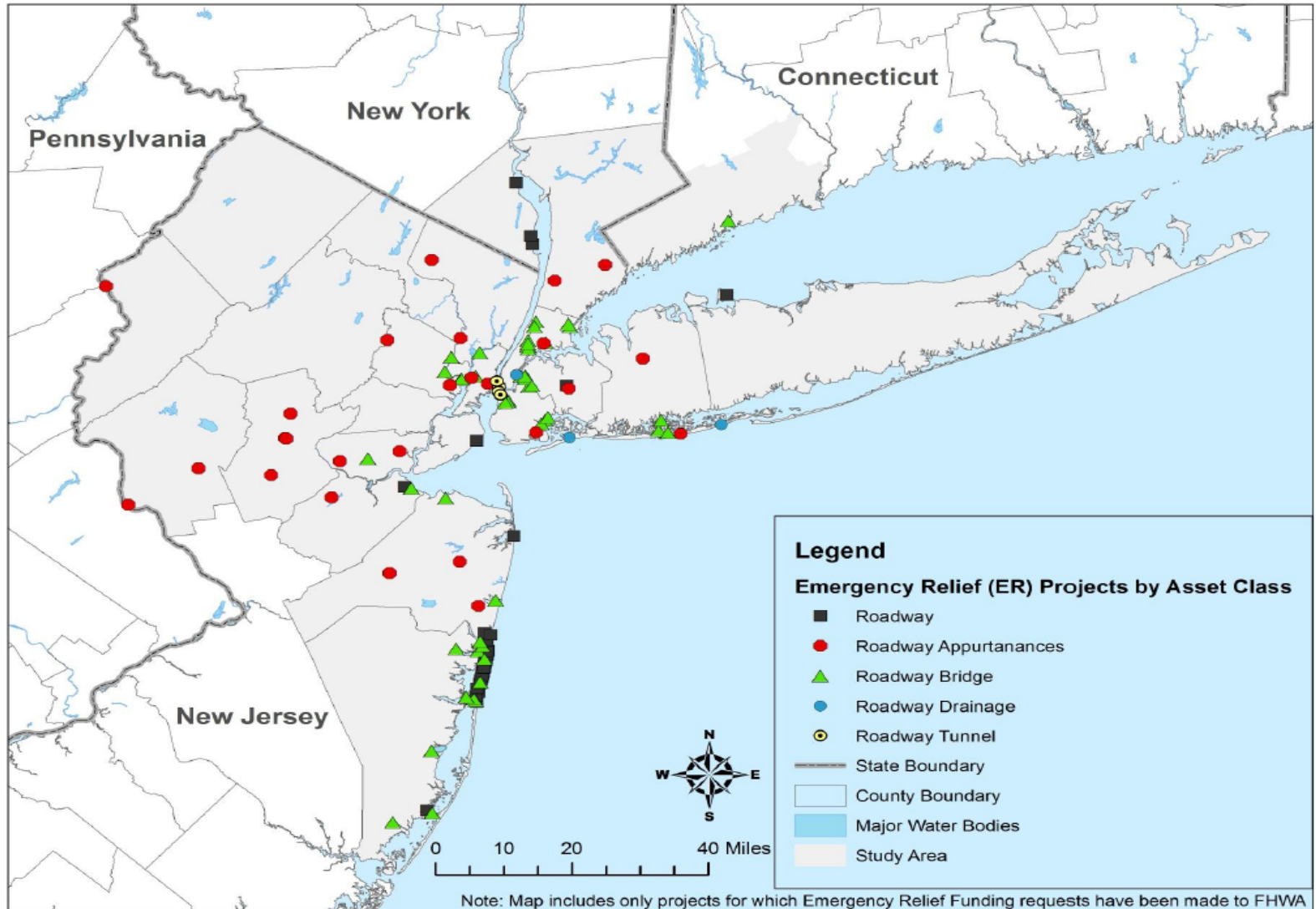
Surface Transportation Facilities	Source	Project info current as of
Roads and Bridges on Federal Aid Highways	FHWA ER Funding Requests submitted to FHWA Division offices (NJ-NY-CT)	September 2013
Self-funded bridges, tunnels, and terminals	MTA and PANYNJ	October 2013
Other roads and bridges	FEMA Public Assistance Public Projects Database	October 2013
Transit facilities	FTA report: "Superstorm Sandy Public Transit Projects – Review of Cost Estimates Draft Final Report"	January 2013
Amtrak NE Corridor	Joe Boardman Testimony to U.S. Senate	December 2012



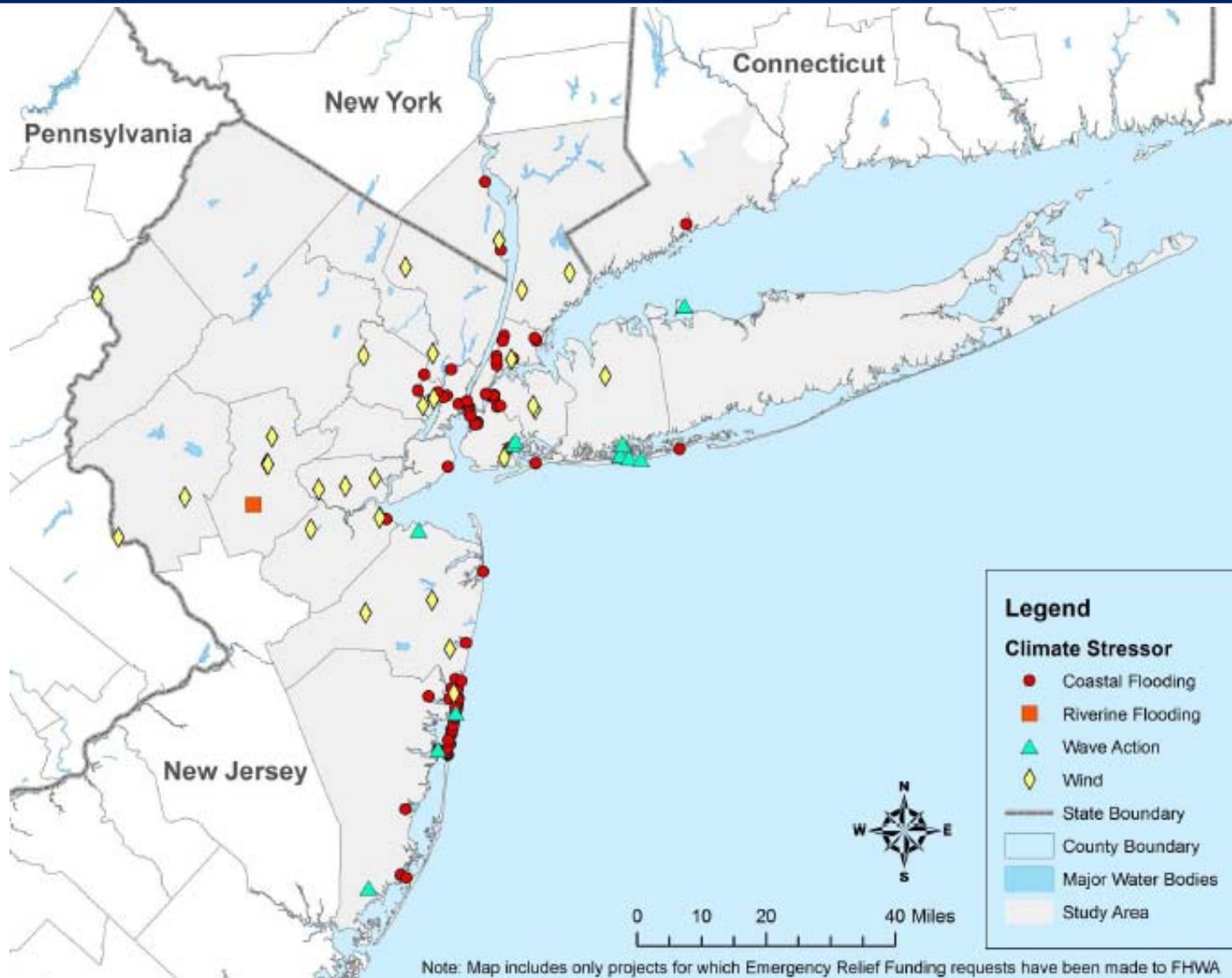
Summary of FHWA ER Projects (*DRAFT*)



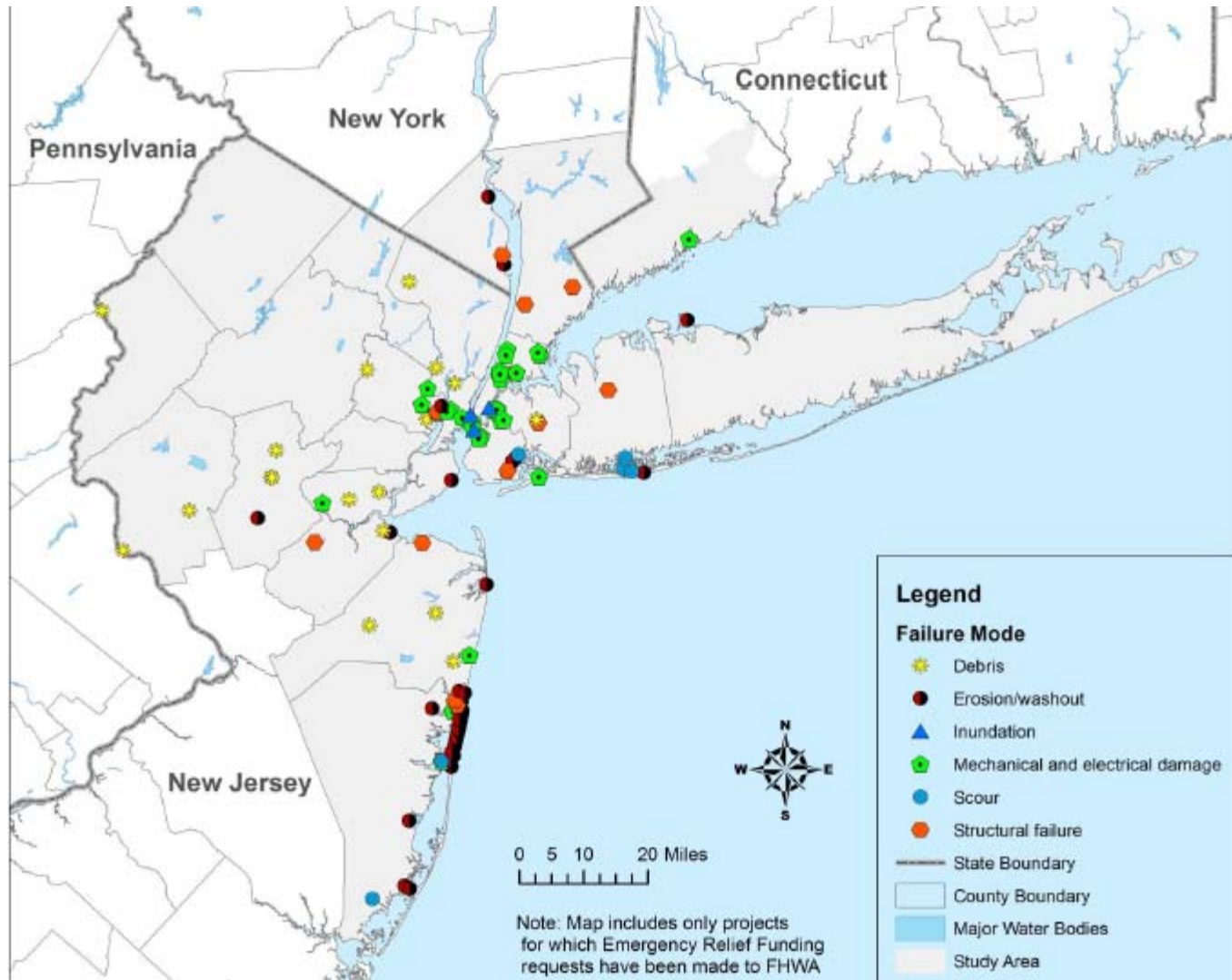
FHWA Relief Projects by Asset Class (*DRAFT*)



FHWA Relief Projects by Climate Stressor (*DRAFT*)



FHWA Relief Projects by Failure Mode (*DRAFT*)



Review of Existing Climate Info and Gap Analysis

- Identified climate stressors of concern for region:
 - Storm surge
 - Heavy rain and inland flooding
 - High temperature events
 - High wind events
- Reviewed existing projections
- Some supplementation likely required for the purposes of the gap analysis

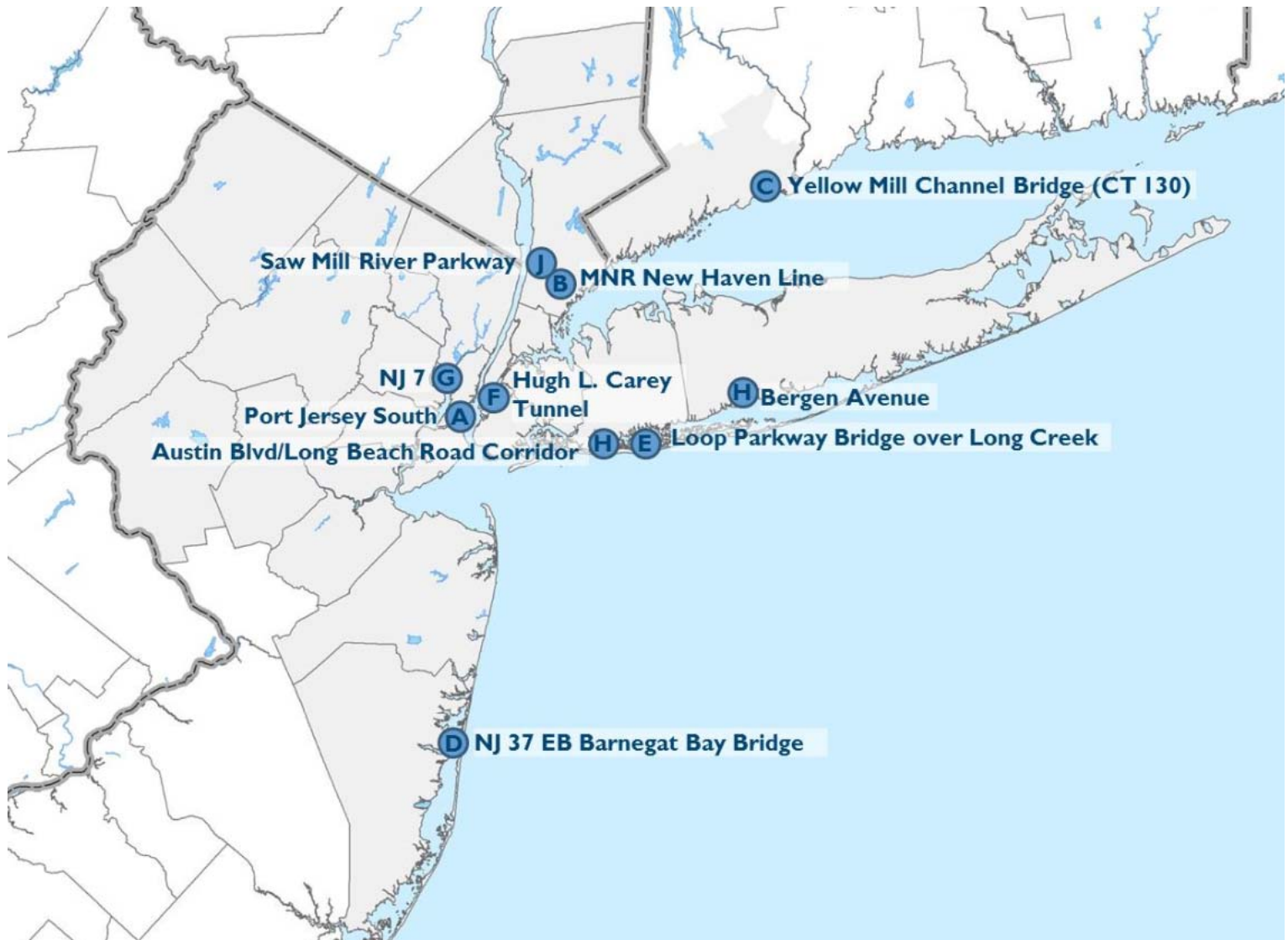


Engineering-Based Adaptation Analysis

- Objectives:
 - Identify up to 10 representative assets for an engineering-based analysis of adaptation options
 - Develop a process for conducting the assessments
 - Test the process on one asset and make refinements
 - Conduct assessments on remaining assets in conjunction with asset owners



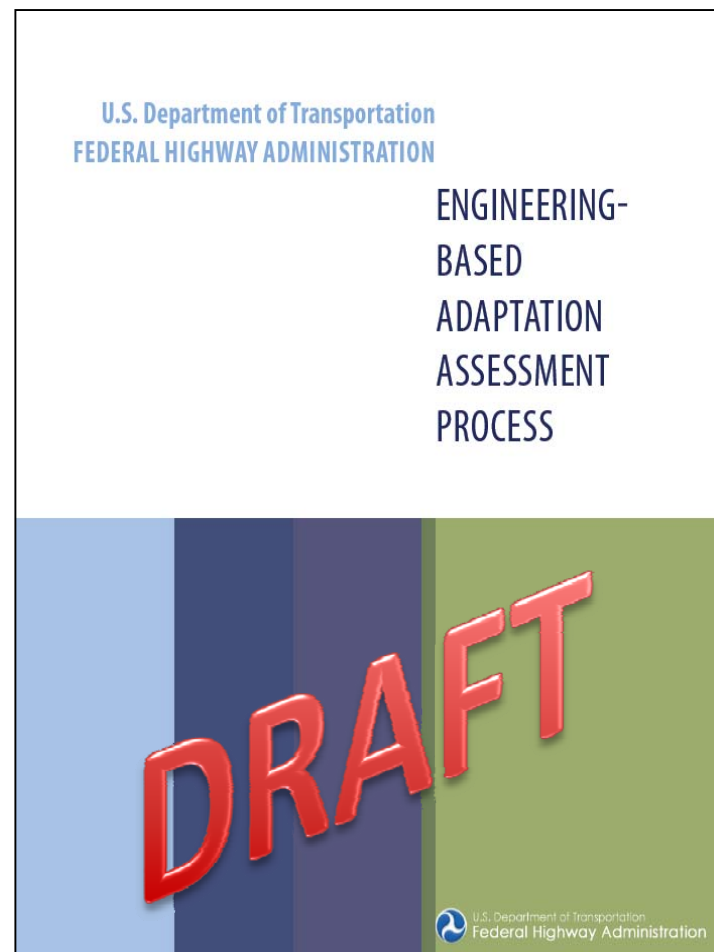
Assets Selected for Engineering Analysis



Engineering-Based Adaptation Assessment Process

Divided into 4 modules:

- **Module 1:** Define Climate Impacts
- **Module 2:** Define Asset and Assess Vulnerability
- **Module 3:** Assess Risk—Likelihood and Consequence
- **Module 4:** Develop and Select Adaptation Strategies



Regional Vulnerability Assessment

- **Objective:** Assist regional transportation agencies in assessing their vulnerabilities to current and future climate conditions and support intelligent, cost-effective adaptation-based decision-making
- **Tasks:**
 - Identify future climate effects for analysis
 - Update regional climate projections
 - Develop illustrative future event scenarios for planning
 - Conduct vulnerability assessment of transportation assets in the region building on previous project work
 - Identify and map critically vulnerable sub-areas in the region
 - Conduct a planning-level assessment of adaptive capacity
 - Systems-level adaptation analysis for transportation assets in vulnerable subareas



Thank you!

The screenshot shows the FHWA website's "Climate Change Adaptation" page. The top navigation bar includes "About", "Programs", "Resources", "Briefing Room", "Contact", and "Search FHWA". The page title is "Climate Change Adaptation" with sub-tabs for "Mitigation", "Adaptation", "Sustainability", and "Energy". The main content area is titled "Resources and Publications" and includes a breadcrumb trail: "FHWA → Environment → Climate Change → Adaptation". Below this, there is a section for "DOT" with a list of three publications:

- [FHWA Climate Change & Extreme Weather Vulnerability Assessment Framework](#) (December 2012) - This document is a guide for transportation agencies interested in assessing their vulnerability to climate change and extreme weather events. It gives an overview of key steps in conducting vulnerability assessments and uses in-practice examples to demonstrate a variety of ways to gather and process information. (PDF 2.2 MB)
- [A Framework for Considering Climate Change in Transportation and Land Use Scenario Planning: Lessons Learned from an Interagency Pilot Project on Cape Cod](#) (July 2011) - FHWA and the Volpe Center have developed a guidebook that discusses the steps taken during the pilot project and presents lessons learned and recommendations that will guide other areas in pursuing a similar multi-agency approach to reduce greenhouse gas emissions and plan for climate change impacts through integrated transportation and land use scenario planning. (PDF 2.2 MB)
- [The Use of Climate Information in Vulnerability Assessments](#) (January 2011)

The third item in the list is partially cut off in the image. A sidebar on the left contains navigation links such as "Ongoing & Current Research", "Resources & Publications", "Policy & Guidance", "Webinars", "Workshops & Peer Exchanges", "Newsletter", "Contacts", and "Feedback". The "Feedback" section lists contact information for Robert Kafalenos, Robert Hyman, Rebecca Lupes, Heather Holsinger, and Tina Hodges.

www.fhwa.dot.gov/environment/climate_change/adaptation/

Heather.Holsinger@dot.gov 202-366-6263



Memo on Using FHWA Highway Funds for Adaptation Work

- Released September 2012
- Clarifies the use of Federal-aid and Federal Lands funding for adaptation activities to address extreme weather events and climate change impacts
- Clarifies existing eligibility for planning, design, construction, and asset management – not a new policy
- Developed jointly by three FHWA offices:
 - Planning, Environment, and Realty
 - Infrastructure
 - Federal Lands



Integrating Results into Decision-making: Example from New York City Special Initiative for Rebuilding and Resiliency

<http://www.nyc.gov/html/sirr/html/report/report.shtml>

- NYC performed risk assessment. Used data on damage from Sandy, 100yr floodplain, NYPCC climate data
- Developed 18 initiatives for transportation, in addition to coastal protection plan

Examples of initiatives

Protect assets to maintain system operations

- Reconstruct and resurface key streets damaged by Sandy to upgraded resiliency
- Elevate traffic signals & provide backup power
- Protect NYCDOT tunnels in Lower Manhattan from flooding
- Install watertight barriers to protect moveable bridge machinery

Prepare to restore service after events

- Plan temporary transit services and HOV requirements in event of subway system suspension

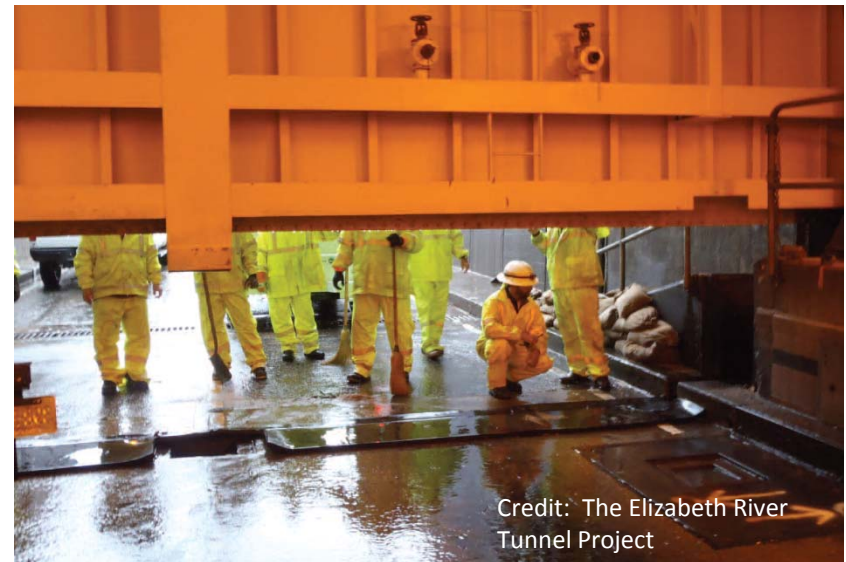
Increase system flexibility and redundancy

- Expand ferry services
- Expand Select Bus Service network



Credit: NYCDOT

Battery Park Underpass flooding from Hurricane Sandy



Credit: The Elizabeth River Tunnel Project

Closeable flood doors, Elizabeth River Tunnels, Portsmouth, VA

