Screening Transportation Assets for Vulnerability

Impacts of Climate Change and Variability on Transportation Systems & Infrastructure

(Gulf Coast Study, Phase 2)

FHWA Office of Planning Environment and Realty

Climate Change Work Group Meeting
August 21, 2013
Meeting Overview

- Welcome and Introductions
- General Project Update
- Update on Detailed Engineering Analyses
- Overview of Tools and Resources Being Developed
General Project Update
Gulf Coast Study: Purpose

- Comprehensive assessment of how climate change will affect transportation in the Gulf Coast area

- Phase 1 (complete)
  - Overview of climate change impacts on transportation infrastructure, and general options for addressing these challenges
  - Mobile to Houston, completed 2008

- Phase 2 (underway)
  - Seeks to develop:
    - More definitive information about multimodal impacts at the local level in a single MPO
    - Precise tools and guides on how to adapt to climate impacts; determine vulnerability for key links for each mode; assess risk
  - Test in Mobile area, with emphasis on “replicability” in other MPOs
Gulf Coast Study, Phase 2: Project Status

- Task 1: Identify critical transportation assets in Mobile (complete)
- Task 2: Climate information (complete)
- Task 3: Determine vulnerability of critical assets (underway)
- Task 4: Develop risk management tool(s) (underway)
- Task 5: Coordination with planning authorities & the public (ongoing)
- Task 6: Information dissemination and publication (approx. early 2014)

Project ends March 2014. Thank you for all of your help so far!
Task 3: Determine vulnerability of critical assets

- System-wide vulnerability assessment complete! Results currently being written up

- Asset-specific engineering analyses currently underway (more on that later)
Task 4: Develop risk management tools

- Developing a set of tools that fit within FHWA’s vulnerability assessment framework
- The tools and resources include Excel-based tools, guidances, training videos, and more
- These resources are intended to assist other transportation agencies in conducting vulnerability assessments and developing adaptation plans

*More on these tools later....*
Task 5: Coordination with planning authorities & the public

- Additional stakeholder meetings to occur in the Fall/Winter to discuss big picture findings, what it means for Mobile, and appropriate next steps
Task 6: Information dissemination and publication

- Final project report will synthesize and summarize key findings and discuss potential next steps
Update on Detailed Engineering Analyses
(Task 3)
Recap of purpose and approach

- The purpose of this phase of the study is to develop and present an approach to dealing with climate change impacts on the infrastructure.

The intended audience includes:

- Departments of Transportation (DOTs) and Metropolitan Planning Organizations (MPOs)
- Planning and engineering staff
- Risk managers
- Metropolitan Planning Organization staff and leadership
- Private facilities owners/operators (airports, marine ports, rail)
- Political stakeholders needing technical support
• Point of View
  ▪ “Here are the climate impacts that I might expect; how will they affect my facility and how do I go about planning for and addressing these effects?”

• Structure
  ▪ Studies common assets (culvert, bridge, pavement, etc.) of multiple types of facilities (roads, rail, airports)
  ▪ General adaptation approaches
  ▪ Case studies
  ▪ Pilot study
General Adaptation Process

- Determine climate factors of concern
- Decide on climate scenarios
- Develop preliminary adaptive designs
- Consider non-engineering factors
- Select a design
- Post – design activity
Case Studies Under Consideration

- **Bridge**
  - Sea-level rise (deck structure, vertical clearances)
  - Storm surge (scour depths)

- **Culvert**
  - Precipitation increase

- **Asphalt and Concrete Pavement**
  - Temperature increase

- **Causeway**
  - Sea level rise and slope erosion

- **O&M**
  - Stress on infrastructure, operations changes

- **Rail**
  - Temperature increase
Pilot Study

• Airport Boulevard Culvert (Vulnerability asset R9)
Pilot Study: Airport Blvd. Culvert

- Man-made channel surrounded by urban development
- Trapezoidal channel with grassy vegetation on the side slopes
- Approximate top width of 120 ft. and an approximate depth of 10 ft.
- Total drainage area to the culvert is 3.34 square miles
Pilot Study: Airport Blvd. Culvert

- Climate scenario
  - Observed precipitation values (1980-2009),
  - NOAA (Atlas 14) 90% Upper Confidence Limit, and
  - “Wetter Narrative” precipitation ranges developed under this project using downscaled climate data for Mobile County

- 24-hour precipitation depths.
- 2-, 5-, 10-, 25-, 50-, and 100-year storm.

| 24-hour Storm Event Return Period | NOAA Baseline (inches) | Observed 1980-2009 (inches) | NOAA 90% Upper Conf. Limit | Wetter Narrative
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3. Source: Spreadsheet titled “Precipitation Projection Data from Task 2 for Warmer and Hotter Climate Narratives” supplied by Beth Rodehorst of ICF on June 18th, 2013.
4. NOTE SOURCE

- Pilot Study: Airport Blvd. Culvert
- Climate scenario
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- 24-hour precipitation depths.
- 2-, 5-, 10-, 25-, 50-, and 100-year storm.
# Pilot Study: Airport Blvd. Culvert

## Hydrology

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Pilot Study: Airport Blvd. Culvert

- Hydraulics – Existing Culvert

![Graph showing flow rate vs. headwater elevation with key points labeled: 7845 cfs - 100-yr Wetter, 5713 cfs - 25-yr Wetter, 4485 cfs - 25-yr NOAA, 3045 cfs - 25-yr Observed.}]
• Alternatives development guidelines
  ▪ Keep the solution within the existing easement and right-of-way to the extent practical
  ▪ Make use of the existing facilities to the extent practical
  ▪ Keep the footprint of the alternative as small as practical
Alternatives

- Watershed management
- Bridge
- Add one 12’x8’ on each side
- Remove the existing crossing and install four cells, each with a 21’ span x 9’ rise
### Pilot Study: Airport Blvd. Culvert

<table>
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<tr>
<th>Possible Alternatives</th>
<th>Description</th>
<th>Pros</th>
<th>Cons</th>
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<tbody>
<tr>
<td>Regional drainage area management</td>
<td>• Perform drainage area analysis to determine best management procedures</td>
<td>• Reduces runoff rate and volume to existing values for selected design storm runoff at roadway crossing and farther downstream</td>
<td>• Large project undertaking compared to the culvert option</td>
</tr>
<tr>
<td></td>
<td>• Consider restrictions or constraints for future development</td>
<td>• No traffic delay on Airport Blvd.</td>
<td>• Possible zoning changes required that would restrict development (reverse condemnation)</td>
</tr>
<tr>
<td></td>
<td>• Acquire RW for and construct one or more detention/retention facilities to attenuate runoff AND volume to existing downstream capacity</td>
<td></td>
<td>• Acquisition of large amounts of property required for facilities</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>• Large capital and maintenance costs</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Lengthy project development time</td>
</tr>
<tr>
<td>Bridge</td>
<td>• Replace culvert with a single-span bridge</td>
<td>• Increases crossing capacity</td>
<td>• Large project undertaking compared to the culvert option</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Increases hydraulic efficiency</td>
<td>• Structure depth requires raising the roadway for a horizontal distance of about 600 ft. on each side of the culvert</td>
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<td>• Provides increased protection to surrounding properties for existing and future runoff amounts</td>
<td>• Long period of traffic disruption</td>
</tr>
<tr>
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<td></td>
<td>• Increases flow rate and volume downstream</td>
</tr>
<tr>
<td></td>
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<td>• Large capital and maintenance cost</td>
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## Pilot Study: Airport Blvd. Culvert

<table>
<thead>
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<th>Culvert modification (Option 1)</th>
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<tbody>
<tr>
<td>• Add one cell on each side of the existing crossing.</td>
<td>• Increases crossing capacity</td>
<td>• Disrupts traffic</td>
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<tr>
<td></td>
<td>• Headwater elevation meets criteria for the 25-yr. NOAA rainfall value</td>
<td>• Increases flow rate and volume downstream</td>
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<tr>
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<td>• Provides increased protection to surrounding properties for existing and future runoff amounts</td>
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<td></td>
<td>• Keeps within the existing easement and right-of-way</td>
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<td></td>
<td>• Uses the existing facility (sustainable)</td>
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<td></td>
<td>• Smallest footprint</td>
<td></td>
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<td>• Lowest capital cost alternative</td>
<td></td>
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<td></td>
<td>• Shortest project development time</td>
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</table>
# Pilot Study: Airport Blvd. Culvert

| Culvert modification (Option 2) | • Replace the existing crossing with largest crossing that will fit within the space available | • Increases crossing capacity  
• Keeps the 100-yr. Wetter precipitation runoff at the edge of pavement – not overtopping the roadway  
• Provides increased protection benefit to surrounding properties for existing and future runoff amounts over Option 1 | • Longer period of traffic disruption than Option 1  
• Increases flow rate and volume downstream more than Option 1  
• Higher capital cost than Option 1 |
Next Step In the Pilot
- Perform the economic analysis
- Recommend an alternative based on the analysis

Next Steps in the Engineering Study
- Complete the narrative on the general assets
- Complete the remaining case studies
- Document lessons learned
- Identify needs for future research
Overview of Tools and Resources Being Developed
(Task 4)
Task 4 Overview

• Objective: Convert experiences and lessons learned from the Gulf Coast Study into tools and resources for State DOTs and MPOs around the country

• Approach: Developing “Virtual Framework”
  - New portion of FHWA website
  - Organized around the FHWA Vulnerability Assessment Framework
  - Will include guidance for each step, training videos, case studies, tools, and links to related resources

• Timeline:
  - Tools under development through Fall 2013
  - “Virtual Framework” website launched Spring 2014
Virtual Framework will have different modules for the key steps of this 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

**2. ASSESS VULNERABILITY**
- Collect & Integrate Data on Assets
- Develop Climate Inputs
- Develop Information on Asset Sensitivity to Climate
- Identify & Rate Vulnerabilities
- Incorporate Likelihood & Risk (Optional)
- Assess Asset Criticality (Optional)

**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

**FHWA Vulnerability Assessment Framework**
Module Content

- Overview of each “phase”
  (articulate objectives, select assets, assess vulnerabilities)
- Key steps in each phase
- Case studies
- Videos
- Tools (under development)
- Links to related resources

Intended Audience for “Virtual Framework”

State DOTs, MPOs, and other agencies involved in planning, building, or maintaining transportation systems
Tool #1: Criticality Assessment Process

• Describes the process of identifying which transportation assets are critical to evaluate for vulnerability

• Includes sample criticality assessments and matrix of criteria to assess criticality
Tool #2: Sensitivity Matrix

- Matrix describing how transportation assets and systems may respond if exposed to climate change
- Identifies thresholds and indicators of climate sensitivity
- Expanded to nationally applicable asset types and climate stressors
Tool #3: Climate Model “Translator”

- Excel-based resource
- Translates downscaled climate model outputs into more relatable terms:
  - Change in number of very hot days
  - Change in 1% precipitation events
- User selects their location on a map, downloads data, pastes into tool
- Tool outputs changes in “derived variables”
Tool #4: Vulnerability Scoring Tool

- **Spreadsheet-based framework for conducting a vulnerability assessment of selected assets**
  - Any number or type of assets – from full transportation system to only culverts
  - Any type of climate impact
- **Quantitative vulnerability tool – each asset gets a vulnerability “score”**
Tool #5: Engineering Case Studies

• Project-level climate vulnerability and adaptation assessment

• Subcontractor Parsons Brinckerhoff is reviewing design of specific transportation assets to evaluate:
  ▪ Whether projected changes in climate would be problematic
  ▪ Which adaptation measures could be employed to make the asset more resilient
  ▪ How to choose among adaptation options using engineering and benefit/cost analyses

• These are the case studies just discussed under Task 3
Questions?
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