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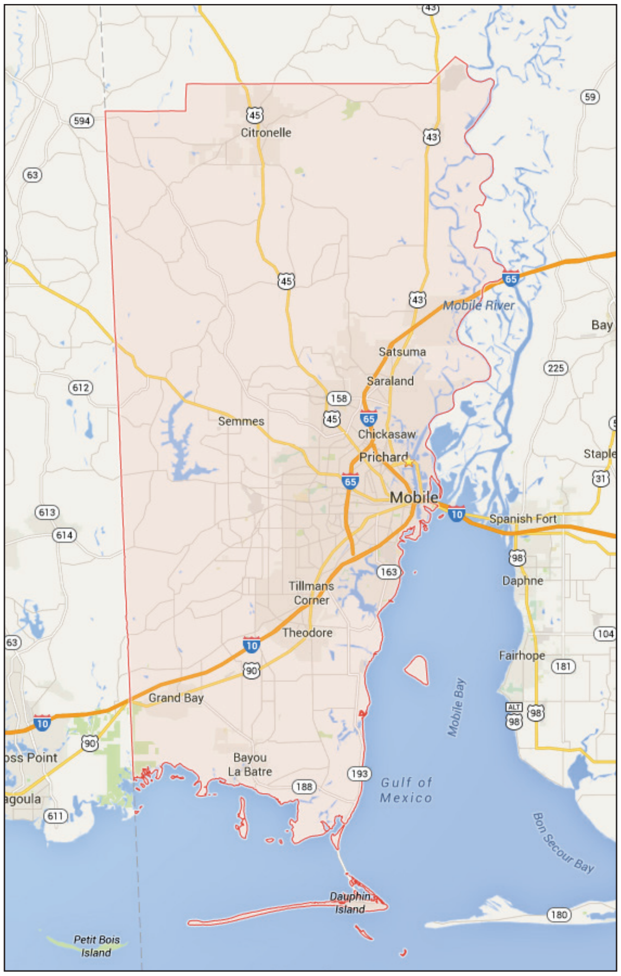
U.S. Department of Transportation
Federal Highway Administration

U.S. DOT Gulf Coast Study, Phase 2

Task 3.2: Conduct Detailed Engineering Assessments

Support for Impacts of Climate Change and Variability on Transportation Systems and Infrastructure: Gulf Coast Study Phase 2 developed methodologies for evaluating vulnerability and adaptation measures for local transportation systems. These transferrable methodologies were pilot tested in Mobile, Alabama. The project team evaluated the impacts on six transportation modes (highways, ports, airports, rail, transit, and pipelines) from projected changes in temperature and precipitation, sea level rise, and the surges and winds associated with more intense storms.

After transportation agencies complete a high-level vulnerability screen of the broader system, the next step may include detailed engineering assessment of assets that have been identified as vulnerable. Engineering assessments are conducted to evaluate vulnerabilities of the structural integrity of the assets from changes in climate and the effectiveness of specific adaptation measures. Task 3.2 applied a framework for conducting detailed engineering assessments to 11 case studies of assets in Mobile.



Map of Study Area

Objectives

- Develop and test a detailed climate impact assessment process to evaluate the climate vulnerabilities of specific transportation assets and evaluate possible adaptation strategies.
- Explain and document Mobile-specific findings, including any findings that may apply more generally to engineering practices, or other lessons learned.

Approach

The project team developed the 11-Step *General Process for Transportation Facility Adaptation Assessments* (the *Process*). The *Process* is intended to be general enough to be applied to multiple transportation modes and asset types, both existing and proposed facilities, and various climate stressors. The 11 steps are:

1. **Describe the Site Context** – Describe location-specific details to characterize the broader transportation network and the surrounding environmental, economic, and social context.

2. **Describe the Existing / Proposed Facility** – Describe facility-specific details.

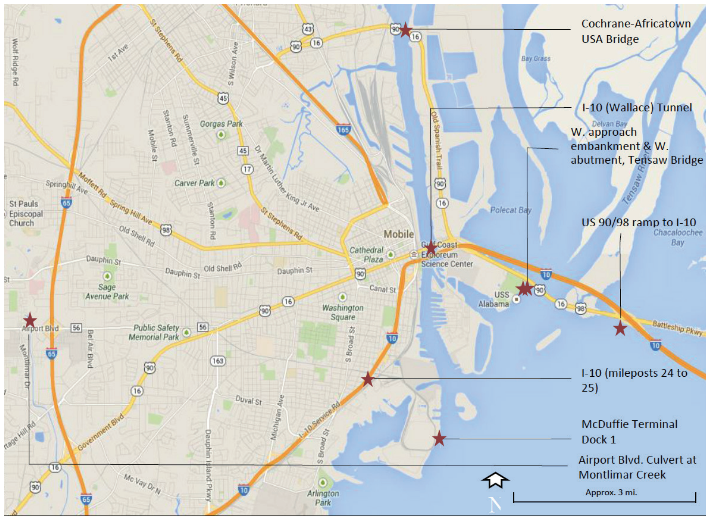


Figure 1: Map of case study locations. Source of base map: Google Maps (as modified)

3. Identify Climate Stressors that May Impact Infrastructure Components – Identify climate-related variables that are typically considered in planning and design of the facility type.

4. Decide on Climate Scenarios and Determine the Magnitude of Changes – Describe climate model projections that are used.

5. Assess Performance of the Existing / Proposed Facility – Assess whether the facility is performing as expected under current climate data and design assumptions and whether it will continue to do so under each of the possible future climate scenarios.

6. Identify Adaptation Option(s) – Identify potential adaptation options that could be used to address climate risks to the facility.

7. Assess Performance of the Adaptation Option(s) – Assess the performance of each adaptation option under each potential climate scenario.

8. Conduct an Economic Analysis – Evaluate how the benefits of undertaking a given adaptation option compare to its incremental costs under each of the possible climate scenarios.

9. Evaluate Additional Decision-Making Considerations – Identify and evaluate other factors that should be considered before a final decision is reached.

10. Select a Course of Action – Consider both economic and non-economic factors, weighing all the information presented, and select a course of action.

11. Plan and Conduct Ongoing Activities – Identify, plan for, and conduct ongoing activities.

The project team piloted the *Process* across a range of transportation asset types and climate change stressors. Each of the 11 case studies of assets followed the same general 11-Step *Process*, with the specific of the methodologies tailored to each asset-stressor combination.

Key Results & Findings

The engineering assessment case studies examined a wide range of facilities and analyses. The findings are too numerous to fully describe in this document, but a few example results include:

- **Economic Analysis.** Benefit-cost analyses of adaptation options are greatly influenced by what is included within the bounds of the analysis.
- **Marine Transport.** Given the wide range of feasible adaptation options, port and transportation planners should begin monitoring sea level rise and its potential constraints on ship navigation.
- **Bridges and Ports.** The worst case storm surge scenario does not necessarily translate to the worst effect on the facility, as wave impacts can be diminished if the deck is completely submerged.
- **Pavement design.** It would be better to monitor temperature changes, periodically update historical temperature records, and use climate projections where appropriate rather than using existing historical data currently used by pavement design software.
- **Operations and Maintenance.** O&M personnel in the Gulf Coast region and elsewhere need to be prepared for the challenges of extreme weather, particularly when it comes to cooperation between organizations.

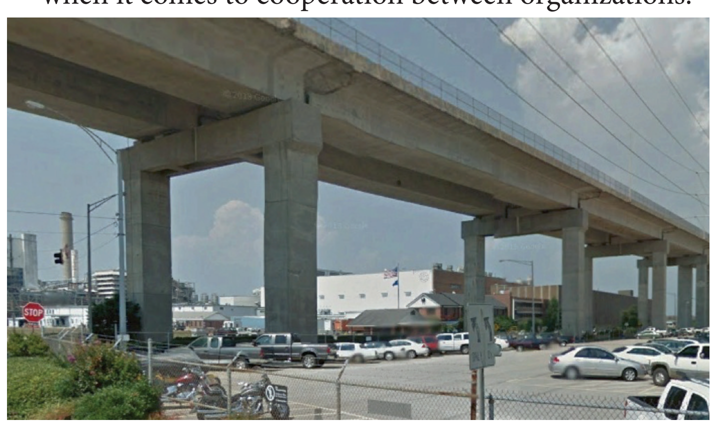


Figure 2: Image of Typical Bent Configuration for Bents 1 to 15 and Bents 18 to 32 on the Cochrane-Africatown USA Bridge. Source: Google Street View

Lessons Learned

The *Process* can be successfully applied across different types of assets and for a range of climate change stressors. The *Process* provides a consistent analytical approach across the various engineering disciplines involved in the analyses for this study.

A design process that reflects projected changes in climatic conditions has to account for possible *changes* in the values of the design variables beyond simply relying on historical data. This is a significant shift from standard engineering design practice. In order to do so, input data must be provided at a scale appropriate to the design process.

For the sake of a robust design process, it is important that a range of climate change-related variables be considered, simply to make sure that even the lower estimates do not require corrective design action, and that a reference alternative is presented for the scenario analyses of the higher stresses on the assets.

Basing future storm scenarios on the experience of a historical weather events and then altering characteristics to reflect possible future permutations provides relatable results to local stakeholders.

Tools and Resources for Gathering and Processing Climate Information

The specific methodologies in each case study can be used as a starting point for practitioners planning to conduct analyses for similar asset-stressor combinations. The details of the case studies and additional information on the 11-Step *Process* can be found in *The Gulf Coast Study, Phase 2 Engineering Analysis and Assessment Final Report, Task 3.2.*

Figure 3: Oblique Aerial Image of the South Side of the US 90/98 Tensaw-Spanish River Bridge West Abutment. Source: Google Maps

For More Information

Resources:

Gulf Coast Study:
http://www.fhwa.dot.gov/environment/climate_change/adaptation/ongoing_and_current_research/gulf_coast_study/

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