



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

# Texas Resilience and Planning Workshop: Summary Report

Austin, Texas  
June 21, 2017

## CONTENTS

Introduction .....	1
Background .....	2
Overview Presentations.....	3
Examples in Practice .....	5
Summary of Discussions .....	9
Conclusion.....	13
Appendix A: Agenda.....	14
Appendix B: Workshop Participants .....	15

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## INTRODUCTION

This report summarizes a Federal Highway Administration (FHWA) workshop that was held on June 21, 2017 at the Texas Department of Transportation (TxDOT) in Austin, Texas. The purpose of the workshop was to identify opportunities for metropolitan planning organizations (MPOs) and other transportation agencies in Texas to assess and address their vulnerabilities to climate change and extreme weather, and incorporate resilience into the transportation planning process. The FHWA Office of Natural Environment, FHWA Office of Planning, FHWA Texas Division, and the FHWA Resource Center planned the workshop.

Presentations and discussions at the workshop focused on actions that MPOs and other transportation agencies in Texas can take to meet new requirements in the Fixing America's Surface Transportation (FAST) Act and increase their resilience to climate change and extreme weather. Appendix A includes the workshop agenda. 47 people attended the workshop, representing 10 MPOs, TxDOT, FHWA, the Federal Transit Administration (FTA), universities, and consultants. Appendix B lists the workshop participants.

## BACKGROUND

Extreme weather events, including heat, drought, storms, and flooding, are already affecting transportation systems and infrastructure, and these impacts are expected to be more frequent and significant in the future. FHWA Order 5520, Transportation System Preparedness and Resilience to Climate Change and Extreme Weather Events, states that it is FHWA policy to strive to identify the risks of climate change and extreme weather events to current and planned transportation systems and work to integrate consideration of these risks into its planning, operations, policies and programs. Order 5520 defines resilience as “the ability to anticipate, prepare for, and adapt to changing conditions and withstand, respond to, and recover rapidly from disruptions.”<sup>1</sup>

FHWA has been supporting State and regional transportation agencies in assessing their vulnerability to climate change and extreme weather through its [Vulnerability Assessment Framework](#) and through funding [pilot projects](#) at State Departments of Transportation (DOTs) and MPOs. Building off of vulnerability assessments, transportation agencies can identify strategies to build resilience and integrate climate considerations into the transportation planning and project development processes.

The FAST Act, which was signed into law on December 4, 2015, includes new requirements for State DOTs and MPOs to integrate resilience into the transportation planning process. Following the authorization of the FAST Act, FHWA and FTA updated their planning regulations<sup>2</sup> with a requirement that metropolitan transportation plans (MTPs) assess capital investment and other strategies that reduce the vulnerability of the existing transportation infrastructure to natural disasters (23 CFR 450.324(g)(7)). In addition, the planning rule states that MPOs should coordinate with officials responsible for disaster risk reduction when developing MTPs and Transportation Improvement Programs (TIPs) (23 CFR 450.316(b)). The updated planning final rule also added improving the resilience and reliability of the transportation system as a new planning factor for State DOTs and MPOs to consider and implement in the transportation planning process (23 CFR 450.206(a)(9) and 23 CFR 450.306(b)(9)).

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<sup>1</sup> <https://www.fhwa.dot.gov/legsregs/directives/orders/5520.cfm>

<sup>2</sup> The Final Rule for Statewide and Nonmetropolitan Transportation Planning and Metropolitan Transportation Planning can be accessed at <https://www.federalregister.gov/documents/2016/05/27/2016-11964/statewide-and-nonmetropolitantransportation-planning-metropolitan-transportation-planning>

## OVERVIEW PRESENTATIONS

Three overview presentations gave participants a shared understanding of the topics to be discussed at the workshop, including climate impacts and resilience efforts in Texas, the FAST Act and planning rule requirements related to resilience, and the concept of a vulnerability assessment.

### ***TxDOT Perspective on Resilience – Peter Smith, TxDOT***

Peter Smith, Director of Planning and Programming at TxDOT, described TxDOT's perspective on extreme weather and resilience. Texas experiences a wide variety of extreme weather events, including storm surge, river flooding, snow and ice storms, and drought. TxDOT began working on climate resilience in 2011 with its [Statewide Freight Resiliency Plan](#). The plan identified areas in the State that are at high risk for disruption to freight systems due to extreme weather. It found that risk is elevated in areas with large and growing populations. The Resiliency Plan is divided into three stages: prepare, detect and respond, and recover. Mr. Smith noted that the State emphasizes planning for disaster response and recovery, but has focused less on preparing for extreme events by evaluating vulnerabilities and opportunities for resilience.

Moving forward, TxDOT is starting to think of resilience at the systems level by looking not only at the design of individual roads and bridges, but also at critical links in the system and potential ways to build redundancy. Resilience strategies they are considering can be grouped into three categories: protect, accommodate, and retreat.

### ***Overview of Climate Resilience in Transportation Planning – Jill Stark, FHWA Office of Planning***

Jill Stark of FHWA's Office of Planning provided an overview of the new requirements in the transportation planning rule related to resilience (see "Background"). She also listed definitions of terms in the new planning rule, including:

- *Travel time reliability*: the consistency or dependability in travel times, as measured from day to day and/or across different times of the day.
- *Resilience*: the ability to anticipate, prepare for, and adapt to changing conditions and withstand, respond to, and recover rapidly from disruptions.

She noted that agencies can incorporate resilience in several components of the planning process, including:

- MTPs;
- TIPs;
- Public involvement and interagency consultation;
- Risk-based Transportation Asset Management Plans;
- Planning and Research Work Programs;
- Unified Planning Work Programs;
- Modal, subarea, and corridor planning; and
- Scenario planning.

Ms. Stark concluded her presentation by describing a new initiative that FHWA is involved with related to planning for emergencies. The Inter-Governmental Emergency Evacuation Planning Coalition will inventory agency policies and guidance to identify gaps, work to align policies and guidance across the agencies, and develop a toolbox that municipalities and other organizations can draw from to develop emergency evacuation plans. The multi-year initiative is beginning in summer 2017; agencies involved

include USDOT, the U.S. Department of Homeland Security, the U.S. Army Corps of Engineers, and the National Oceanic and Atmospheric Administration (NOAA).

**Vulnerability Assessments – Becky Lupes, FHWA Office of Natural Environment**

Becky Lupes of FHWA’s Sustainable Transportation and Resilience Team provided an overview of vulnerability assessments and FHWA’s [Climate Change and Extreme Weather Vulnerability Assessment Framework](#). The Framework is a guide for transportation agencies interested in assessing the vulnerability of their systems and assets to climate change and extreme weather. FHWA developed the Framework based on the experiences and lessons learned from five pilot vulnerability assessments that were conducted in partnership with State DOTs and MPOs in 2010-2011. 19 additional pilot projects tested the Framework in 2013-2015, and FHWA summarized lessons learned from these pilots in a [report](#).

The Framework details the three major steps of conducting a vulnerability assessment: define the project scope, assess vulnerabilities, and integrate results into decisionmaking (see Figure 1). Ms. Lupes walked through each step and then provided examples of how different agencies have used the Framework. These examples highlighted both qualitative and quantitative vulnerability assessments, as well as statewide and localized assessments. The examples also highlight how agencies are using the results of their assessments in decisionmaking. For example, Washington State DOT integrated the results of their vulnerability assessment into the State’s environmental review guidance by requiring that proposed projects in locations identified as highly vulnerable consider climate vulnerability during project development.

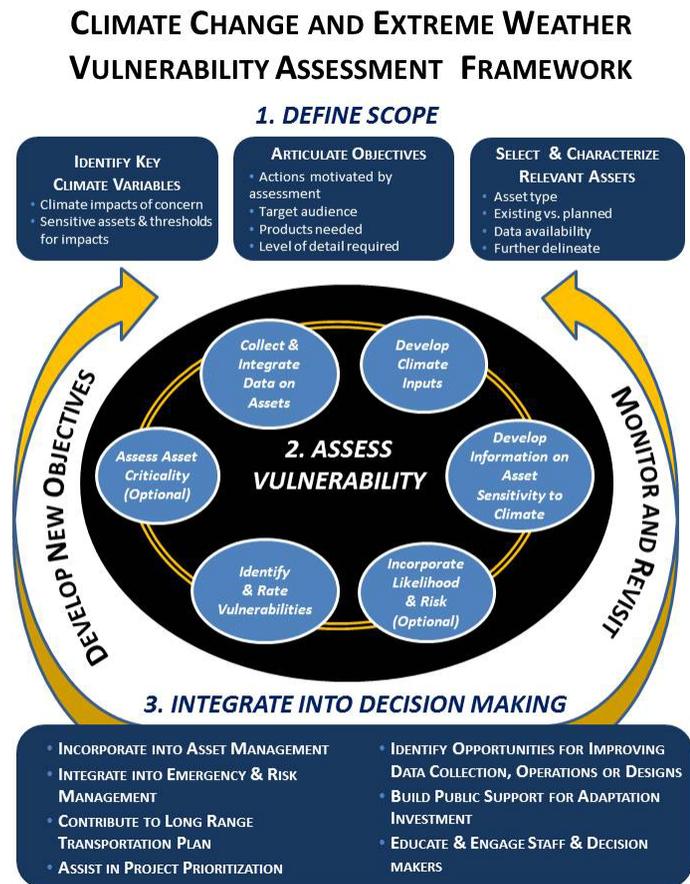


Figure 1: Overview of the steps in the FHWA Vulnerability Assessment Framework (Source: FHWA)

## EXAMPLES IN PRACTICE

The workshop featured presentations from transportation agencies in Texas that have assessed their vulnerabilities, developed strategies to build resilience, and considered resilience in their transportation planning efforts. This included presentations from two Texas MPOs and one regional planning agency. In addition, Jolanda Prozzi of the Texas A&M Transportation Institute (TTI) presented about a study of vulnerable freight infrastructure in Texas, and Jim Thorne of the FHWA Resource Center discussed examples of agencies from around the country that have incorporated resilience into the transportation planning process.

### ***Resilience in Transportation Planning in the Austin region – Kelly Porter, CAMPO***

The Capital Area MPO (CAMPO) is the MPO for the region around Austin, Texas. In 2011, it received funding from FHWA to conduct a [vulnerability assessment](#) using the FHWA Framework. The study focused on five climate impacts: flooding, drought, extreme heat, wildfire, and extreme cold and ice. CAMPO evaluated these impacts on 10 critical assets, including key roadway and transit facilities, and ranked risk as low, moderate, or high for each climate impact at each location (see Figure 2).

**Table 15 Risk Rating Summary**

ID	Asset	Flooding	Drought	Heat	Wildfire	Extreme Cold
2	MetroRail Red Line at Boggy Creek	Moderate-High	Inconclusive	Moderate	None	Low-Moderate
3	SH 71E at SH 21	High	Moderate-High	Low-Moderate	Moderate-High	Low-Moderate
4	I-35 at Onion Creek Parkway	Low	None	None	Moderate-High	Low-Moderate
5	US 290W/SH 71 - Y at Oak Hill	Moderate	Moderate	None	High	Low
6	Loop 360/RM 2222	Moderate	Moderate	None	High	Low-Moderate
7	FM 1431 at Brushy Creek/Spanish Oak Creek	None	Moderate	Low	Moderate-High	Low
8	US 281 and SH 29 Intersection	Moderate-High	Low	Low	Moderate	Low
9	US 183 north of Lockhart	Low-Moderate	High	Low-Moderate	Moderate-High	Low-Moderate
10	SH 80 (San Marcos Highway) at the Blanco River	Moderate	Low	Low	Moderate	Low

Figure 2: In its vulnerability assessment, CAMPO evaluated the risks of five climate stressors on 10 critical transportation assets. (Source: CAMPO).

CAMPO incorporated the results of its vulnerability assessment into the vision and goals section of its 2040 Long Range Transportation Plan (LRTP). It is currently developing the 2045 LRTP using an approach called “Platinum Planning,” which is a locally driven process to develop studies about particular locations and topics that will inform the LRTP. The approach incorporates a variety of interrelated topics, including housing, environment, economic development, equity, mixed-use development, and multi-modal transportation.

Several CAMPO studies and initiatives contribute to building resilience, and may be integrated into the 2045 LRTP:

- A land suitability and vulnerability analysis identifies areas that may be of concern when locating transportation projects. Factors considered include floodplains, wildfire threat, fault lines, endangered species habitats, environmental justice, and employment, among others.
- CAMPO is broadening its definition of vulnerable populations for its environmental justice analysis to include zero car households, households with school age children, seniors, and other characteristics, in addition to its traditional definition related to race and income.
- The Regional Arterial Study will identify improvements to evacuation routes, system redundancy, and roadway design and materials.
- The Incident Management and Operations Plan will identify opportunities to provide real-time information for drivers about incidents and emergencies, coordinate first responders and others, and provide additional technological improvements.

***Considerations for Integration of Infrastructure Resilience and Asset Management with Long-Range Planning in North Central Texas – Chris Klaus, NCTCOG***

In 2015, the North Central Texas Council of Governments (NCTCOG) conducted a [vulnerability assessment](#) as one of the FHWA pilot

projects. The study found that the Dallas-Fort Worth region is already experiencing more extreme weather events, and this trend is expected to continue. Under a “business as usual” emissions scenario, by 2100, mean temperatures are expected to increase by 8 degrees Fahrenheit compared to the current average, and the region is expected to experience lower annual rainfall punctuated by storms of greater intensity. The effects of these climate impacts are likely to be magnified due to high plasticity soils. The vulnerability assessment also found that for the transportation sector, these future temperature increases will accelerate pavement degradation, rutting, joint failures, and utility breaches. In addition, many critical roadway segments are in flood-prone or poorly drained areas (see Figure 3).

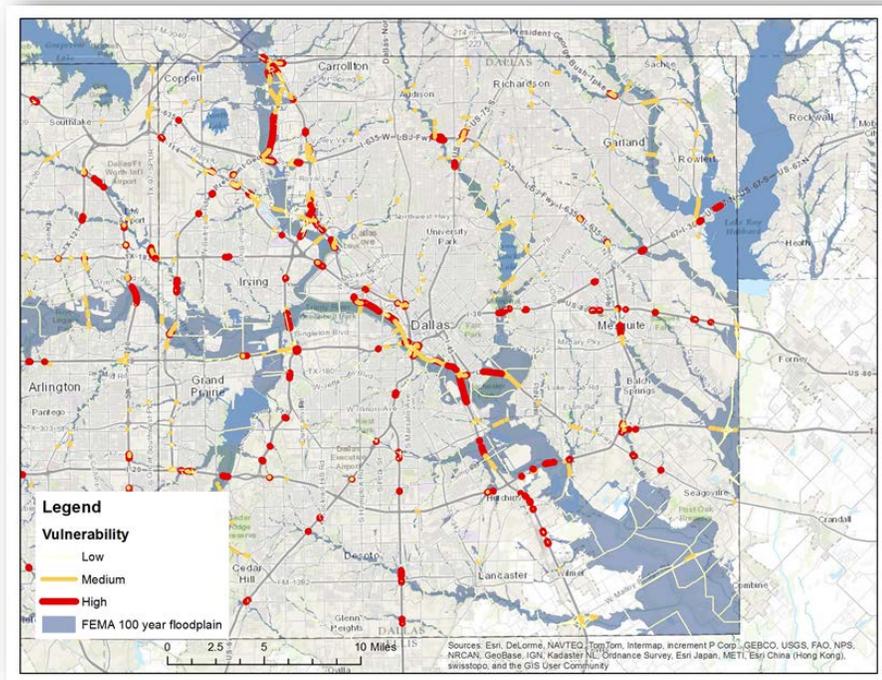


Figure 3: NCTCOG identified flood risks for critical roadway segments in the region. The map above shows the results for Dallas County (Source: NCTCOG).

NCTCOG is starting to address these vulnerabilities through its Transportation Asset Management Program. This includes a \$2.5 billion program called Capital/Operations Asset Management (Cap-Main) that applies asset management principles and performance-based data analysis tools to develop more holistic transportation planning and investment strategies. The program involved a comprehensive review of all facilities to identify where rebuilding is necessary and where lower cost techniques will suffice. Through Cap/Main, NCTCOG is also maximizing incident detection, enhancing potential alternate routes, and identifying at-risk locations to apply technology to notify them when extreme events occur, such as flooding at low-water crossings. Finally, NCTCOG used FHWA's [Infrastructure Voluntary Evaluation Sustainability Tool \(INVEST\)](#) to evaluate its MTPs, Mobility 2035 and Mobility 2040, and identify areas for improvement. One area for improvement identified in Mobility 2035 was infrastructure resilience, which NCTCOG was able to improve upon in Mobility 2040.

### ***Examples of Resilience in the Transportation Planning Process – Jim Thorne, FHWA Resource Center***

Jim Thorne of the FHWA Resource Center provided examples of transportation agencies from around the country that have incorporated resilience into some aspect of their planning process. He noted that one place to start considering resilience in transportation planning is by using INVEST, a self-evaluation tool developed by FHWA that aids agencies in evaluating the sustainability performance of their projects and programs based on sets of criteria. INVEST has a [criterion related to infrastructure resilience](#) within the system planning module, and agencies score points for the following elements related to resilience:

- Develop and adopt goals and objectives;
- Coordinate with partner agencies;
- Integrate vulnerability and risk assessment information into planning documents;
- Develop and implement adaptation and resilience strategies;
- Develop performance measures; and
- Demonstrate sustainable outcomes.

Mr. Thorne discussed the following ways in which agencies have considered resilience in their planning process:

- *Scenario planning.* MPOs in Albuquerque and Cape Cod used a scenario planning approach to examine mitigation and adaptation strategies in transportation and land use planning. They assessed climate impacts and effects on transportation, land use, and natural resources, and integrated the analysis into their MTPs.
- *MTP project evaluation.* As part of its 2040 MTP development, the Chattanooga-Hamilton County MPO convened a workshop to evaluate the vulnerability of the region's infrastructure to climate change and identify critical assets. The MPO evaluated projects included in the MTP on how they would impact these critical assets.
- *MTP objectives.* The MPO in Hillsborough County, Florida has an objective in its 2040 MTP to increase the security and resilience of the multimodal transportation system. It ties this to performance measures related to the recovery time and economic impact of a major storm. The MTP also includes an investment plan to reduce vulnerabilities.
- *TIP resilience criteria.* The Boston Region MPO has resilience-related criteria for its TIP project submittals. These criteria include whether the project improves emergency response and improves the system's ability to respond to extreme conditions, and whether the project lies within a natural hazard zone.

- *Multi-sector resilience plan.* The Nashville MPO worked with other regional agencies to develop the Building Resilience Plan, which aims to implement pre-emptive adaptation measures that respond to extreme events.
- *Hazard mitigation planning.* The Genesee Finger Lakes Regional Planning Council in Rochester, New York identified vulnerabilities at the regional level and developed a Hazard Mitigation Strategy Toolbox to address these vulnerabilities. The Toolbox included adaptation and mitigation model ordinances for local governments.

### ***Hazard Mitigation Planning in Central Texas – Chris Schrek, CAPCOG***

Capital Area Council of Governments (CAPCOG) is the regional planning agency for the area around Austin, Texas. CAPCOG is involved in efforts to build resilience through the Central Texas Disaster Resiliency Project, which stemmed from severe floods on Memorial Day 2015 and is funded by the U.S. Economic Development Administration. The project involved creating a central repository for Federal Emergency Management Agency (FEMA) data related to this disaster, modeling flood scenarios to identify vulnerabilities and estimate impacts of similar events, and sharing data and modeling to help inform resilience planning in jurisdictions within the region.

The project used FEMA’s [Hazus](#) tool, which includes a standardized methodology that contains models for estimating potential losses from various natural hazard scenarios. Key takeaways from the project were that businesses are often unprepared for natural disasters, and that data about the impact of extreme events is often incomplete. CAPCOG found that moving forward, there is a need for real-time, actionable information about natural disasters to be paired with pre-planned responses. The University of Texas is currently working on modeling flood events in real time, which would help direct first responders and prioritize evacuations.

### ***Vulnerable Freight Infrastructure in Texas – Jolanda Prozzi, TTI***

Jolanda Prozzi of TTI discussed the results of a study that evaluated how extreme weather events will impact freight infrastructure and operations in Texas. Texas has an extensive freight system, including highways, freight rail, ports, airports, pipelines, and border crossings. Extreme weather events have a significant economic impact on freight operators. Through the study, TTI documented basic issues concerning extreme weather and freight infrastructure by conducting interviews with freight operators and infrastructure operators about three specific events: the Memorial Day 2015 flooding, Hurricane Ike, and ice events in the Dallas-Fort Worth region.

The study found that the extreme weather events of greatest concern to freight operators were hurricanes, followed by intense rainfall events/flooding and ice storms. The study identified the impacts of these extreme weather events on the companies, evaluated the companies’ information needs, and found that in most cases formal coordination and communication strategies are in place. Overall, most freight companies are already considering extreme weather in their planning, investment, and maintenance strategies. The companies are most concerned about infrastructure that is out of their control, including roadways and energy supply.

## SUMMARY OF DISCUSSIONS

Three discussion sessions throughout the day gave workshop participants an opportunity to synthesize what they learned in the presentations, share their own experiences and ideas, and brainstorm resilience strategies. Participants were divided into small group breakouts (6-7 people), and the breakout groups reported the highlights of their discussions with all participants. This section summarizes the major discussion topics.

### ***Vulnerability Assessments***

Participants discussed what would motivate or has motivated their agency to conduct a vulnerability assessment. This includes regulation or policy guidance, available funding, “peer pressure” (keeping up with other agencies), and being able to show that conducting a vulnerability assessment would save money in the long run. Experiencing an extreme weather event, reoccurring natural disasters, or major economic changes are also motivating agencies to take action. For example, one participant mentioned that during a recent hurricane, people were stuck on an interstate for hours, so they have already experienced the impact of extreme events and know that they will in the future. Another MPO noted that an oil boom in their area increased the usage of the roadway and motivated them to assess their vulnerabilities to both economic forces and extreme weather.

### ***Resilience Strategies***

After assessing vulnerabilities, agencies can develop strategies to address these vulnerabilities and build resilience. Workshop participants brainstormed resilience strategies that MPOs in Texas could implement through the transportation planning process. There strategies include:

- Evaluate materials used in construction and whether they are sustainable in the event of a natural disaster;
- Consider the soil type and ecology in the area and incorporate this into project design;
- Invest in workforce development to educate employees about resilience, and workforce planning to evaluate how workforce needs may change as the climate changes (e.g., more frequent maintenance needed in certain areas);
- Conduct multi-criteria analysis to evaluate and compare resilience options;
- Use corridor studies to identify vulnerable infrastructure and develop adaptation strategies in those areas;
- Conduct evacuation route planning and develop alternative routes in vulnerable areas;
- Use the results of a vulnerability assessment to inform infrastructure design, such as bridge or roadbed elevation;
- Identify undeveloped areas that are vulnerable to extreme weather and changes in climate, and limit or prohibit development in those areas; and
- Develop partnerships with mapping providers or smart vehicle operators to provide real-time updates to route information in extreme weather situations.

Participants noted that it is important for agencies to be flexible in their adaptation strategies so that they can address new trends and problems as they arise. They also discussed the importance of interagency collaboration and getting buy-in for resilience strategies through public participation, and of training and educating MPO boards about extreme weather and resilience.

Strategies to build resilience can show up in various stages in the transportation planning process. Ideally, resilience could be incorporated throughout the process, from visioning to project implementation. Participants noted that resilience could be incorporated into MTP goals, used as a performance measure, and used in project selection criteria. Resilience can also be incorporated into other planning studies, such as corridor studies or scenario planning.

Participants also discussed options for funding these resilience strategies. They felt that it is important to identify funding streams ahead of time so that funding is available when they experience an extreme weather event. One option would be to develop a rainy day fund to be used for responding to extreme events and rebuilding in a more resilient way. One participant also mentioned the possibility of looking for insurance for vulnerable infrastructure, or developing a loan program that would help agencies finance the rebuilding of transportation infrastructure damaged or destroyed through extreme weather or climate impacts.

### ***Coordination with Officials Responsible for Disaster Risk Reduction***

Some Texas MPOs already coordinate with officials responsible for disaster risk reduction in their transportation planning process. For example, some MPOs have local emergency response officials on their boards or involve them in workshops to develop the MTP. A variety of agencies may be involved in disaster risk reduction in a particular region. These include Federal agencies such as FEMA, State agencies such as the Texas Division of Emergency Management, regional councils of government, and municipal emergency management and response agencies. Participants recommended that MPOs determine which agency or agencies in their region are doing hazard mitigation planning, and how they can collaborate or use information from that effort.

Participants discussed additional resources for coordinating with agencies conducting hazard mitigation planning. For example, FEMA's Hazus tool is a free mapping program that estimates potential loss from various natural hazard scenarios. This tool can give MPOs and agencies involved in hazard mitigation planning a shared set of data and information for resiliency planning.

### ***Strategies for Agencies with Limited Staff or Resources***

Participants discussed strategies that agencies with limited resources could pursue to assess vulnerabilities and integrate resilience into the transportation planning process. A focus of this discussion was the importance of partnerships. Partners can help MPOs identify and access funding sources and climate data, provide expertise on vulnerabilities in the area, and strategize around resilience options. These potential partners include municipalities, local planning agencies, consultants, universities, other sectors, and Federal and State agencies. MPOs can also benefit from working with local stakeholders who have on-the-ground insight into vulnerabilities, and from coordinating with other planning efforts such as hazard mitigation planning or other sectors such as water management.

With limited resources, agencies may not be able to address all vulnerabilities, so they will need to prioritize. MPOs with limited resources could narrow the scope of their vulnerability assessments to focus on the climate variables or impacts that are a known issue in the area. They could also prioritize the most critical assets first, both in terms of assessing the vulnerabilities of these assets and developing strategies to build their resilience. Agencies could narrow the scope to align with other MPO priorities, such as safety or asset management. They could also prioritize resilience strategies that are achievable in the short term, or conduct a cost-benefit analysis to identify the most cost-effective strategies.

When selecting data for a vulnerability assessment, agencies can use data that is readily available rather than collecting new data or conducting extensive modeling. For example, they can use local experience and knowledge or crowdsource data from 311 calls to identify locations that have repeated maintenance issues caused by extreme weather. Agencies can also use previous studies from other MPOs, other agencies in the region, or universities to get data or to better understand vulnerabilities in their area. Tools such as FHWA's Vulnerability Assessment Framework or INVEST can also help agencies develop resilience strategies.

Workshop participants identified several resilience strategies that may have a low or moderate cost and be more feasible for agencies with limited resources. These include:

- Update the existing project selection process to result in funding projects that contribute to resilience;
- Develop a template for standard operating procedures for emergency response that can be used by municipalities in the area;
- Develop a disaster mitigation plan; and
- Identify alternate routes based on existing infrastructure to improve redundancy of the network.

### ***Available Resources***

Participants discussed available resources for conducting vulnerability assessments and developing resilience strategies. These include organizations to partner with, available data, and tools and methodologies.

#### *Partners*

- TxDOT District Offices;
- Federal agencies, including FHWA, FEMA, NOAA, and the U.S. Geological Survey (USGS);
- Consultants and design firms that have experience with vulnerability assessments;
- Regional and statewide disaster preparedness and response agencies;
- Freight industry;
- Nonprofit environmental organizations;
- University research centers;
- Municipal agencies, including water agencies; and
- Other MPOs in the State or in neighboring States.

#### *Data sources*

- Vulnerability assessments conducted by other MPOs in Texas, including CAMPO and NCTCOG;
- [FTA vulnerability assessment pilots](#), including one along the Gulf Coast that included two transit agencies in Texas: Galveston Island Transit and Houston Metro;
- [Texas Water Development Board information on flooding](#);
- TxDOT data on pavement condition, soil condition, and rain and drought cycles;
- Data from neighboring States with similar climates;
- Corridor studies conducted by TxDOT Districts;
- [TTI Freight Study](#);
- University datasets;

- New regulations in 23 CFR 667 requiring State DOTs to conduct evaluations to determine if there are alternatives to infrastructure that has required repeated repair and reconstruction due to emergency events;
- [USDOT Gulf Coast Study](#); and
- Maps developed through Hazus, NOAA, and USGS.

*Tools and methodologies*

- FHWA Vulnerability Assessment Framework and pilot studies;
- Other FHWA Peer Exchanges; and
- INVEST resilience criteria.

## CONCLUSION

The workshop's speakers and participants identified many resources related to resilience. Participants noted that the following additional resources, which could be provided by FHWA or others, would help them assess vulnerabilities and develop resilience strategies:

- A national list of climate data sources;
- More case studies, including best practices, lessons learned, success stories, and a description of the analysis conducted;
- More workshops;
- Information on benefit-cost analysis and other economic tools;
- Consolidated data at the State level, possibly through an online platform that is MPO-facing.

The workshop presentations and discussions highlighted that resilience can be incorporated throughout the transportation planning process. Participants stated that, moving forward, they would consider including resilience in the vision and goals of the MTP, in project selection criteria, and as part of scopes of work. Participants brainstormed resilience strategies that could be applied in Texas, and identified strategies that MPOs with limited resources could pursue to assess vulnerabilities and build resilience. Participants noted that they had a clearer understanding of resilience coming out of the workshop. They also stated that the concept felt less nebulous and less daunting than it seemed at the beginning of the day.

Many Texas MPOs are well on their way to addressing the resilience elements of the new planning rule. From assessing vulnerabilities, to developing resilience strategies for inclusion in their transportation plans, to coordinating with officials responsible for disaster risk reduction, agencies are taking steps to build their resilience to climate change and extreme weather. The information and resources discussed at this workshop will help agencies of all sizes and resources go even further and integrate resilience throughout the transportation planning process.

## APPENDIX A: AGENDA

Time	Topic
8:30-9:00 am	Workshop registration
9:00-10:00 am  <i>Overview presentations</i>	<p>Welcome and introductions (Kirk Fauver, FHWA Texas Division)</p> <p>Overview of TxDOT resilience work (Peter Smith, TxDOT)</p> <p>Overview of resilience requirements in the transportation planning rule (Jill Stark, FHWA Office of Planning)</p> <p>Group Discussion #1: Resilience elements of the transportation planning rule</p>
10:00-11:45 am  <i>Vulnerability assessments</i>	<p>Overview of vulnerability assessments (Becky Lupes, FHWA Office of Natural Environment)</p> <p>Examples in Practice – Texas MPO and State DOT Vulnerability Assessments</p> <ul style="list-style-type: none"> <li>• <i>Capital Area Metropolitan Planning Organization (CAMPO) – Kelly Porter</i></li> <li>• <i>North Central Texas Council of Governments (NCTCOG) – Chris Klaus</i></li> </ul> <p>Group Discussion #2: Actions Texas MPOs can take to identify and assess vulnerabilities</p>
11:45 am-1:00 pm	Lunch
1:00-3:30 pm  <i>Resilience strategies</i>	<p>Examples in Practice</p> <ul style="list-style-type: none"> <li>• <i>Identifying and assessing resilience strategies (Jim Thorne, FHWA Resource Center)</i></li> <li>• <i>Hazard mitigation planning (Chris Schreck, Capital Area Council of Governments)</i></li> <li>• <i>Vulnerable freight infrastructure in Texas (Jolanda Prozzi, Texas A&amp;M Transportation Institute)</i></li> </ul> <p>Group Discussion #3: Actions Texas MPOs can take to identify potential resilience strategies and address resilience in the transportation planning process</p> <p>Takeaways and next steps</p>

## APPENDIX B: WORKSHOP PARTICIPANTS

<b>Name</b>	<b>Organization</b>
Clay Barnett	Sherman-Denison MPO
Allison Blazosky	Alamo Area MPO
Marty Boyd	TxDOT El Paso District
Liz Bullock	TxDOT Waco District
Megan Campbell	TxDOT Houston District
Casey Carlton	WSP
James Caughorn	Arcadis
Kendra Coufal	Killeen-Temple MPO (KTMPO)
Reza Farzaneh	Texas A&M Transportation Institute (TTI)
Kirk Fauver	FHWA Texas Division
Jared Fijalkowski	USDOT Volpe Center
Joel Garza	Harlingen-San Benito MPO
Sara Garza	TxDOT- TPP (Laredo District)
Robert Grimm	Southeast Texas Regional Planning Commission (Beaumont/Port Arthur MPO)
Michael Haithcock	TxDOT- Abilene District
Clifton Hall	North Central Texas Council of Governments (NCTCOG)
Cliff Hallford	TxDOT- Abilene District
Colin Hancock	CAMPO
Major Hofheins	San Angelo MPO
Stephanie Kirschner	Goodman Corp.
Chris Klaus	North Central Texas Council of Governments (NCTCOG)
Don Koski	Federal Transit Administration (Region VI)
Jimmie Lewis	Southeast Texas Regional Planning Commission (Beaumont/Port Arthur MPO)
Becky Lupes	FHWA
Mark McDaniel	TxDOT- Austin
Ed McRoy	Abilene MPO
Matt Miller	Texas A&M Transportation Institute (TTI)
Justin Morgan	FHWA Texas Division
Madhu Narayanasamy	CDM Smith
Jack Parker	RTI
Rocio Perez	TxDOT- Austin, Research and Technology Implementation
Sirisha Pillalamarri	Arcadis
Rebecca Pinto	TxDOT El Paso District

<b>Name</b>	<b>Organization</b>
Amy Plovnick	USDOT Volpe Center
Kelly Porter	CAMPO
Jolanda Prozzi	Texas A&M Transportation Institute (TTI)
Lena Reese	CAMPO
Raymond Sanchez	TxDOT- TPP (Pharr District)
Chris Schreck	Capital Area Council of Governments
Leanna Sheppard	TxDOT - Austin, Transportation Planning & Programming
Peter Smith	TxDOT
Jill Stark	FHWA
Charlie Sullivan	CDM Smith
Vivek Tandon	UT- El Paso
Jim Thorne	FHWA
Peggy Thurin	TxDOT- TPP
Marketa Vavrova	El Paso MPO
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