



# APA Transportation Planning Division Webinar

State

Large MPO

Medium MPO

Moderator

Background

## Perspectives on Resiliency Planning

#9202462

CM | 1.50

August 14, 2020

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100 years ago, the focus of transportation planning was construction – to “get the farmer out of the mud”.

50 years ago, the focus of planning was efficiency for cars – to complete the transportation system and increase speeds and throughput.

Today we recognize the need for a wider scope of transportation planning in many areas, including vulnerability & resilience.

**Vulnerability** is how we’re at risk.

**Resilience** is our ability to absorb shocks gracefully.

Background

# National Federal-Aid Highway Program Performance Goals

**Safety** – Directly compromised during event and recovery

**Infrastructure Condition** – Directly compromised during event and recovery

**Congestion Reduction** – Possible congestion during evacuations and during recovery if infrastructure is out of service

**System Reliability** – Directly compromised during event and recovery

**Freight Movement & Economic Vitality** – Directly compromised during event and recovery

**Environmental Sustainability** – Possibly compromised by loss of infrastructure and need for clean-up

**Reduced Project Delivery Delays** – Possibly compromised by project re-prioritization, changed budgets, and need for clean-up

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Austin, Texas

BS Arch

University of Texas at Austin

MSCRIP

University of Texas at Austin

Charlie Sullivan, AICP, is a senior planner at CDM Smith. He has 30 years of experience in transportation planning and travel demand modeling in the public sector and as a consultant.

His body of planning work includes Metropolitan Transportation Plans, Corridor Plans, Thoroughfare Plans, Transit Asset Management Plans, Public Participation Plans, and Vulnerability & Resilience Plans. On the travel demand modeling side, he has been involved in model data development, validation, and applications for models at all scales ranging from the first-ever models for smaller communities in Arizona to the first-ever statewide model for Texas.



Belton, Texas

BS Community Health  
Texas A&M University  
MBA – University of  
Mary Hardin-Baylor

Kendra Coufal is the Manager of Planning Services at the Killeen Temple Metropolitan Planning Organization (KTMPO), a mid-size MPO with a four-year TIP distribution of \$152 million for mobility and livability projects in an area that encompasses 1,200 square miles and includes 3 counties and 14 incorporated cities.

Kendra helps set the strategic direction of the department. Her responsibilities include overseeing planning staff, contract management, updating and maintaining the UPWP, short and long-range transportation planning and development, serving as a liaison between the MPO and other agencies/departments, planning of Technical and Policy Board meetings, special projects and grants management, and public engagement efforts of the KTMPO.



Houston, Texas

MS Watershed Management  
University of Delaware

Justin Bower is a principal planner at the Houston-Galveston Area Council.

He has over 20 years of work experience in natural resource management and planning-related roles. His work experience includes a variety of public, NGO, and private roles involving water quality, municipal water supply planning, watershed management, and natural areas conservation and education.

His current efforts with H-GAC focus on multijurisdictional watershed protection, flood management, and natural area conservation projects. He is actively involved in leadership roles with several water, forestry, conservation, and wildlife organizations in the Houston area.

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Austin, Texas

BS Ocean Engineering  
Texas A&M University  
MS Civil Engineering  
Texas A&M University

Bill Knowles, P.E., is the State Traffic Analysis Engineer for the TxDOT Transportation Planning & Programming Division, with 25 years of experience in public sector engineering, planning, environment, and research. He is a retired commander from the US Navy.

His work at TxDOT includes overseeing traffic forecasting, travel demand model development, travel surveys, and statewide data collection. He also serves as the lead for TxDOT's resiliency planning efforts.

Bill serves on two TRB Committees. He is the research sub-committee chair of the AHB40 Highway Capacity and Quality of Service Committee, and is a member of the AED10 Statewide and National Data and Information Management Committee.

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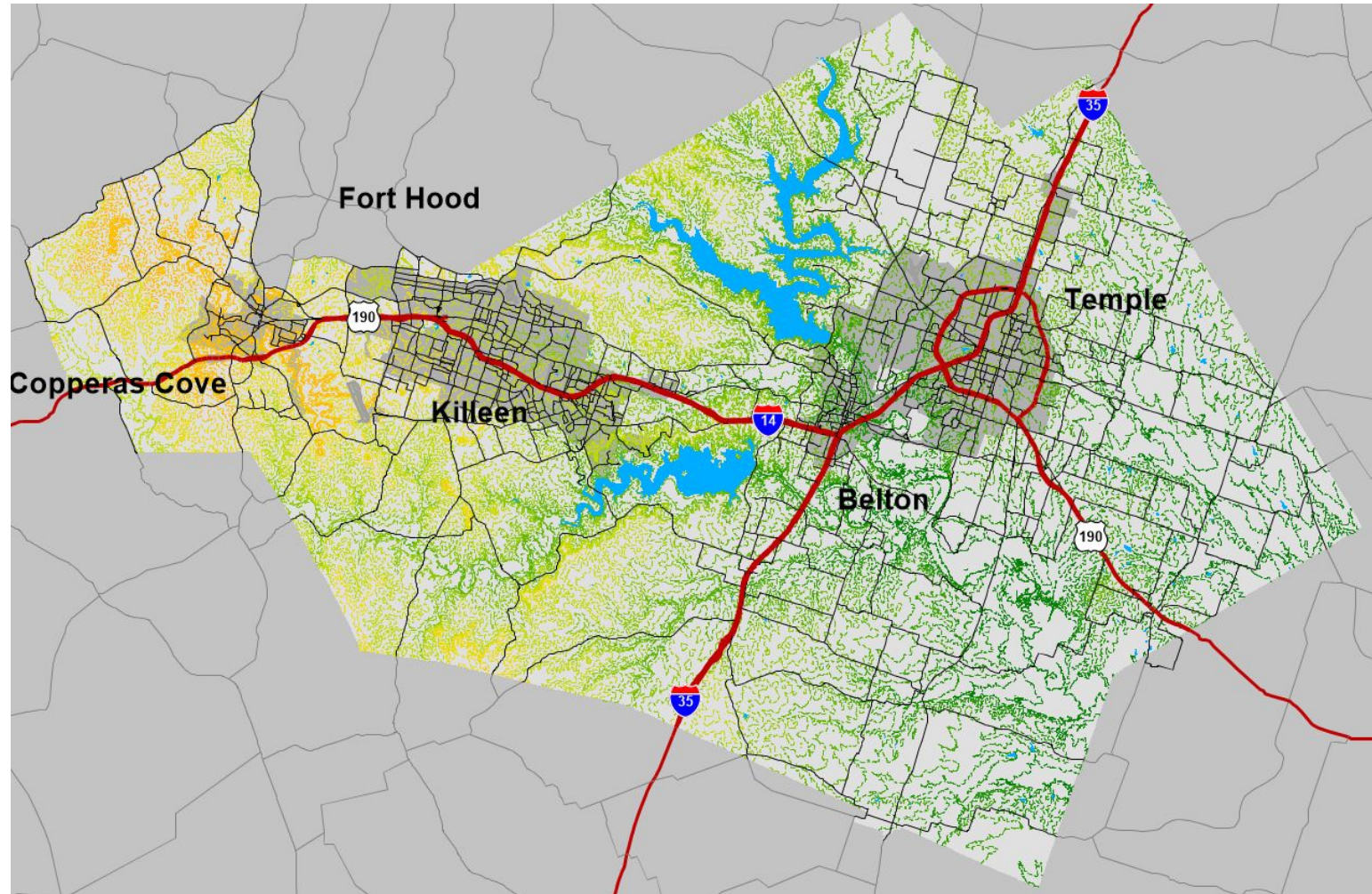
# The Regional Vulnerability & Resilience Framework

**Kendra Coufal**

**Manager of Planning Services**

**KTMPO**





- Central Texas north of Austin
- 3 counties
- 14 incorporated cities and part of Fort Hood



# Initial Development of Vulnerability & Resilience Planning at KTMPO

Environment was generally referenced in the project scoring process. This effort was to develop a more formal process to address vulnerability & resilience planning:

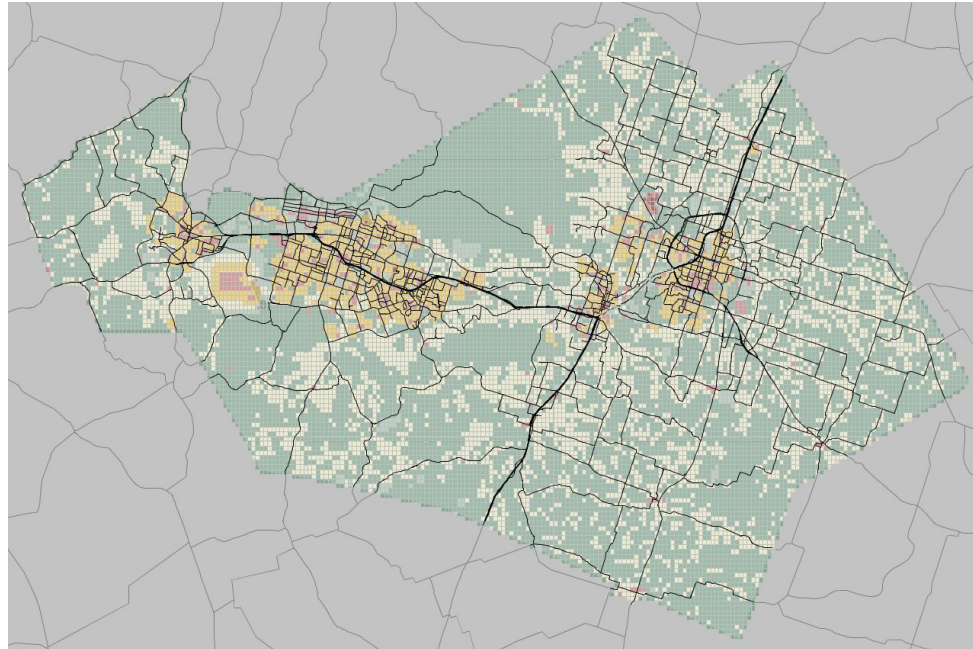
Road Track		
<b>1</b>	<b>Congestion</b>	<b>30 points</b>
	Existing LOS	Obj/Subj 0 to 10 points
	2040 No-Build LOS	0 to 10 points
	Change in LOS with the project	0 to 10 points
<b>2</b>	<b>Traffic</b>	<b>30 points</b>
	AADT	2 to 20 points
	Peak period traffic flow	0 to 5 points
	Network Connectivity	0 to 5 points
<b>3</b>	<b>Safety</b>	<b>10 points</b>
	Fatality rate	0 to 5 points
	Crash rate	0 to 5 points
<b>4</b>	<b>Linkage to MTP or Other Plan</b>	<b>15 points</b>
	Coordination with other plans	0 to 15 points
<b>5</b>	<b>Local Priority &amp; Support</b>	<b>10 points</b>
	Local priority	1 to 5 points
	Local support	0 to 5 points
<b>6</b>	<b>Project Scope</b>	<b>30 points</b>
	Scope of the benefit	1 to 5 points
	Planning & Environmental Linkages	0 to 5 points
	Economic development & freight movement	0 to 5 points
	Multimodal support	0 to 5 points
	Security & resilience	0 to 5 points
	Sustainability	0 to 5 points

Transportation Choices & Livability Track		
<b>1</b>	<b>Coordination &amp; Service Gaps</b>	<b>40 points</b>
	Peak period traffic flow	Obj/Subj 0 to 5 points
	Eliminates barriers	0 to 15 points
	Network connectivity	0 to 10 points
	Addresses a documented need	0 to 10 points
<b>2</b>	<b>Access to Jobs</b>	<b>15 points</b>
	Provides access to jobs in the EJCOG	0 to 10 points
	Provides access to jobs in the region	0 to 5 points
<b>3</b>	<b>Safety</b>	<b>20 points</b>
	Provides an exclusive path along an arterial or higher	0 to 5 points
	Provides a connection to a school	0 to 5 points
	Enhances areas with identified hazards	0 to 5 points
	Corrects ADA deficiencies	0 to 5 points
<b>4</b>	<b>Linkage to MTP or Other Plan</b>	<b>15 points</b>
	Coordination with other plans	0 to 15 points
<b>5</b>	<b>Local Priority &amp; Support</b>	<b>10 points</b>
	Local priority	1 to 5 points
	Local support	0 to 5 points
<b>6</b>	<b>Project Scope</b>	<b>30 points</b>
	Scope of the benefit	1 to 5 points
	Planning & Environmental Linkages	0 to 5 points
	Economic development	0 to 5 points
	Multimodal support	0 to 5 points
	Security & resilience	0 to 5 points
	Sustainability	0 to 5 points

- 1 Gather data in a formal system
- 2 Evaluate against defined stressors
- 3 Integrate results into project planning
- 4 Support vulnerability & resilience planning



# Regional Vulnerability & Resilience Framework

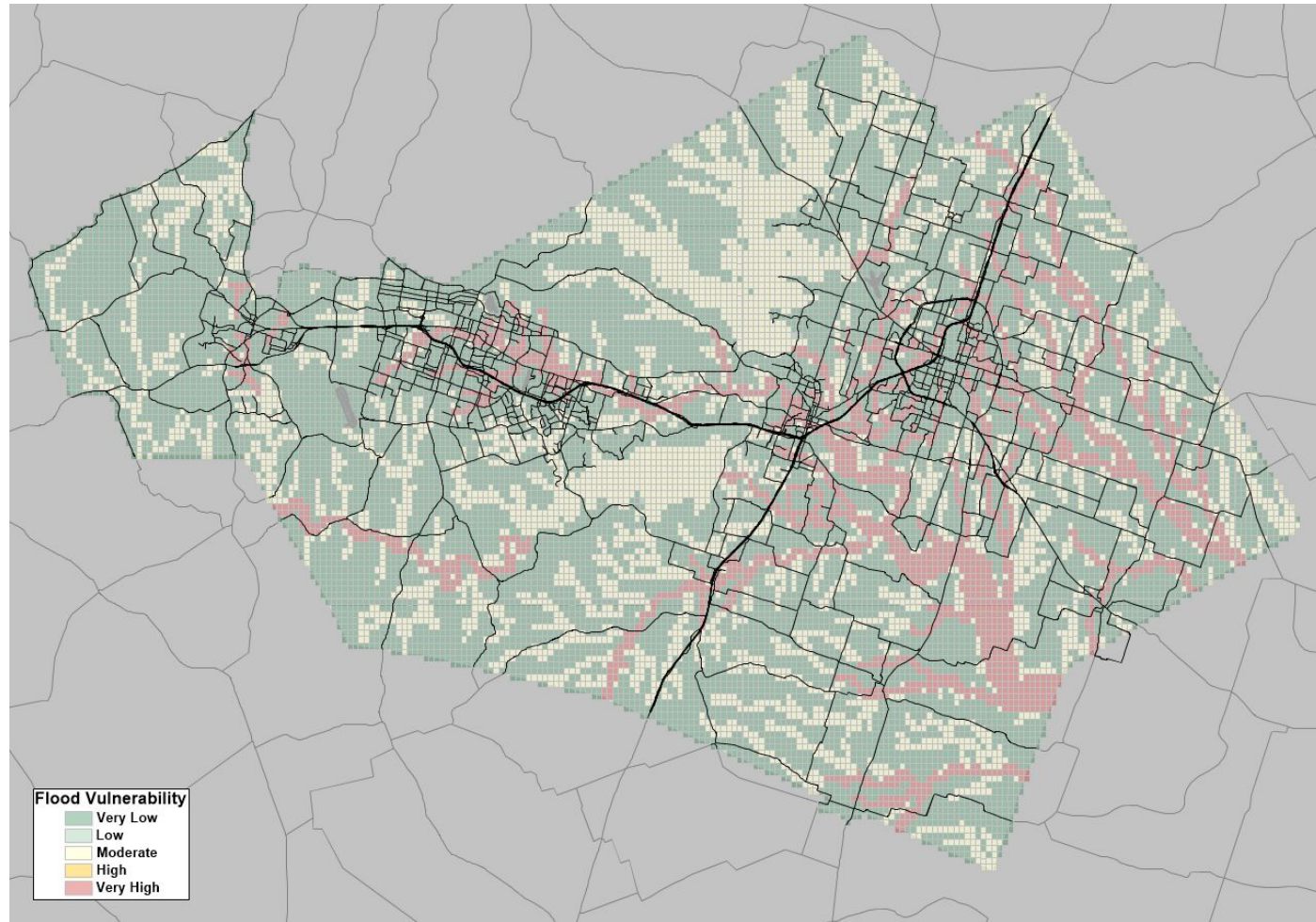


- RVRF defines a ¼ mile grid of the full study area
- Defined four stressors: rainfall, dam breach, wildfire, drought or high temperature
- Data from stressors comes from various sources and must be normalized to a common system and scale
- Developed stressor data, land use data, and critical land uses



# The RVRF Grid: Flooding from Rainfall

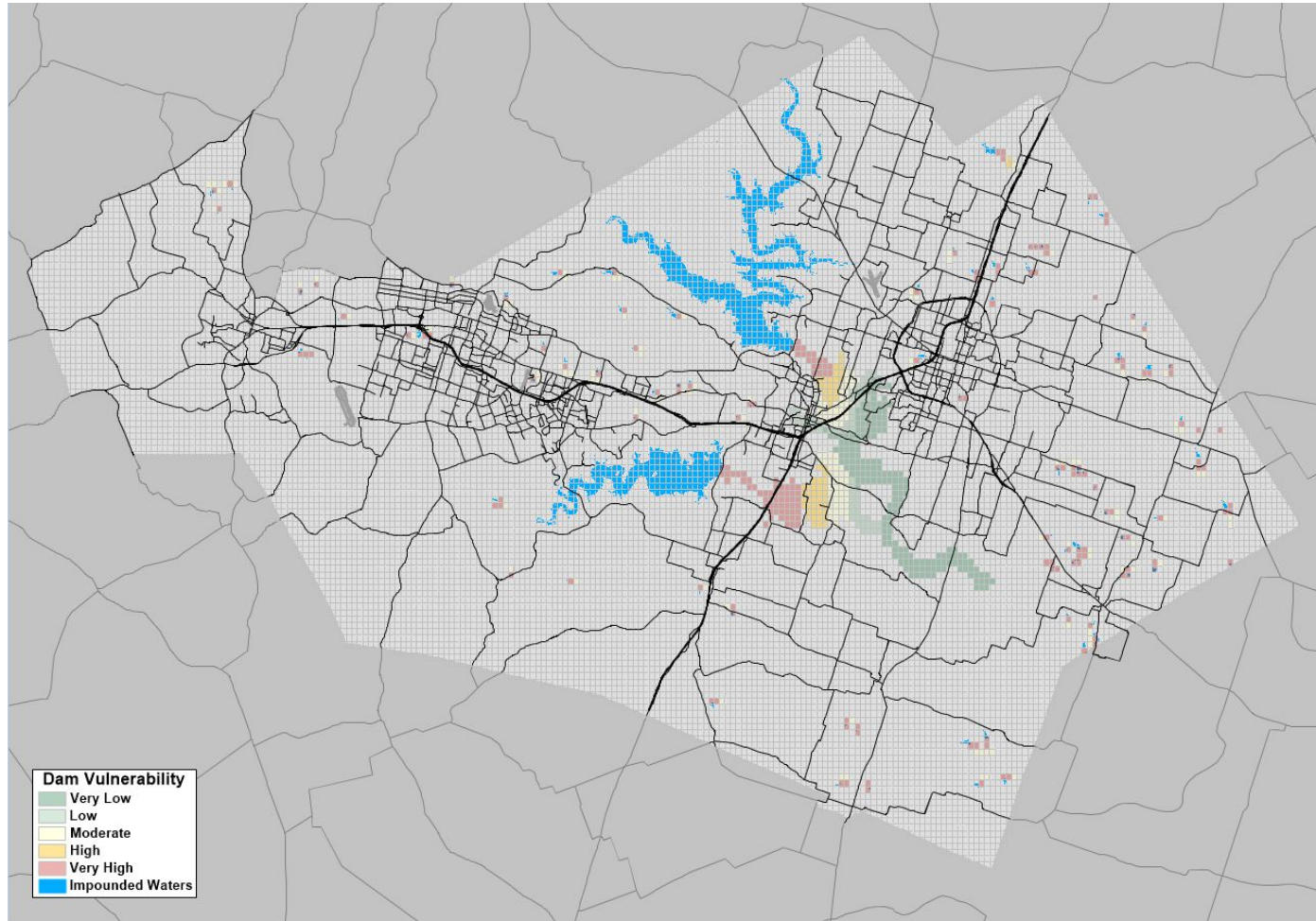
- Vulnerability scores sourced from the FEMA floodplain maps





# The RVERF Grid: Flooding from Dam Breach

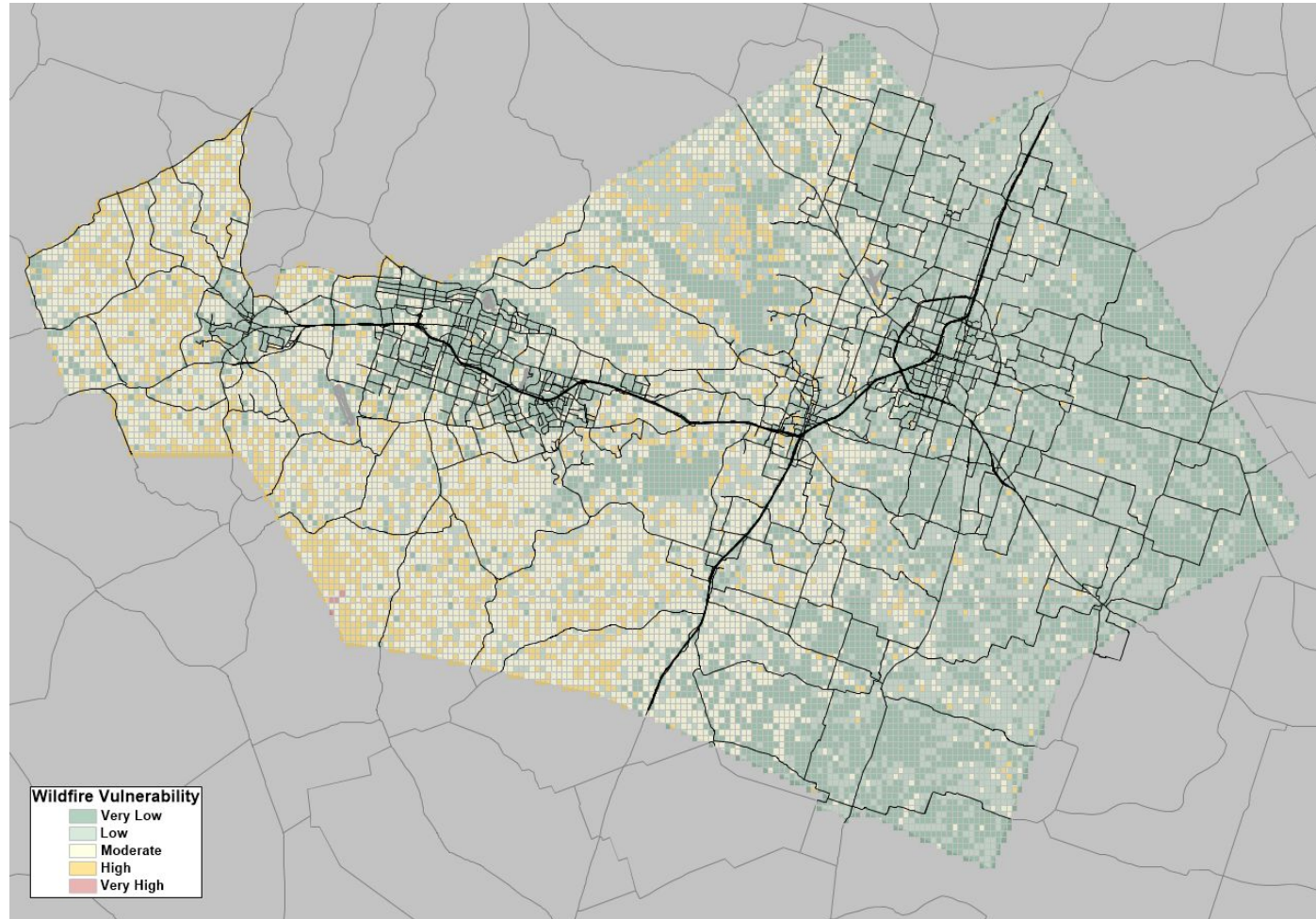
- Vulnerability scores sourced from a review of impounded waters and topology downstream of dams
- 99 dams; mostly earth banked





# The RVRF Grid: Wildfire

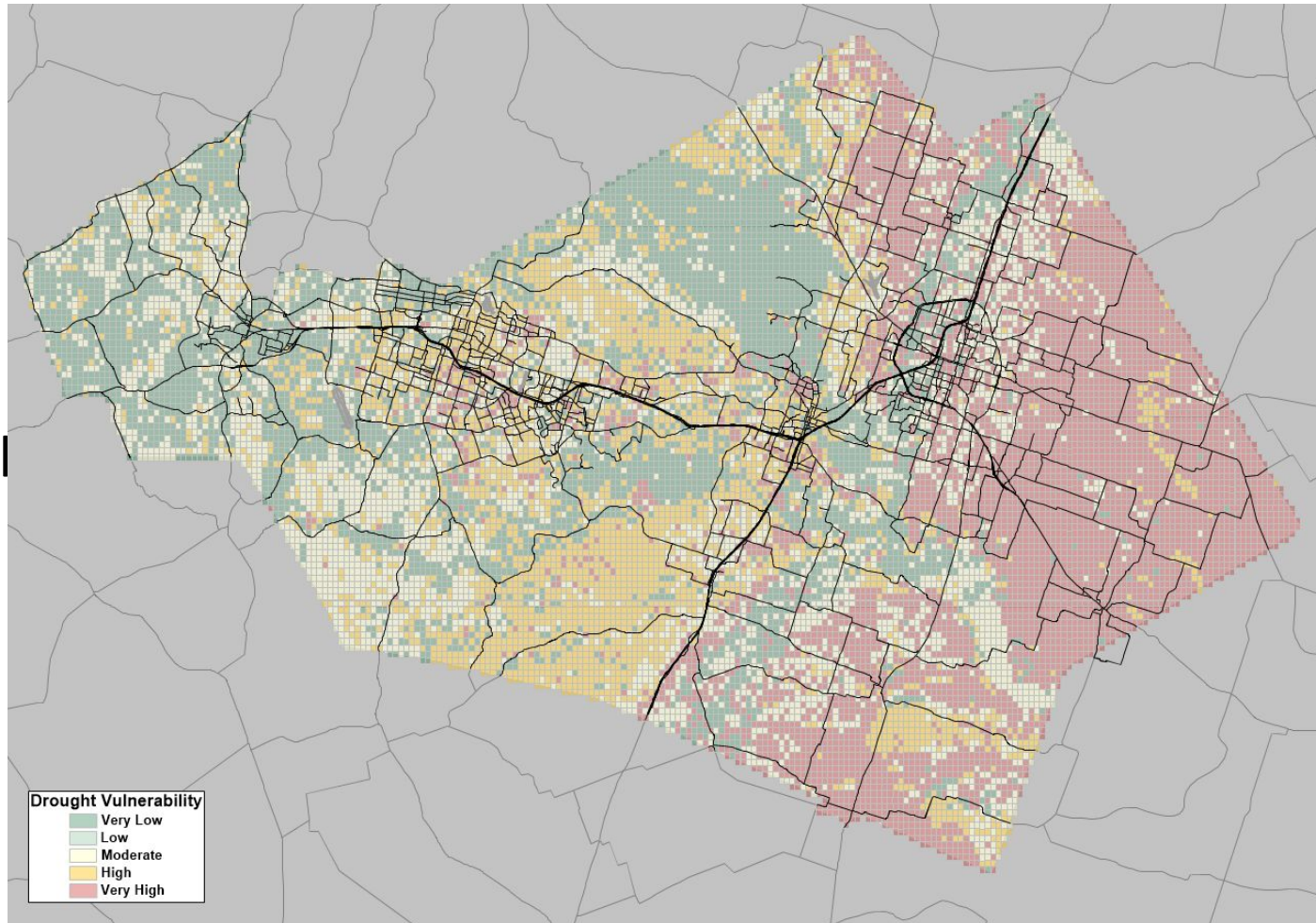
- Vulnerability scores sourced from the U S Forest Service LANDFIRE 2012 database
- Based on type of ground cover





# The RVRF Grid: Drought or High Temperature

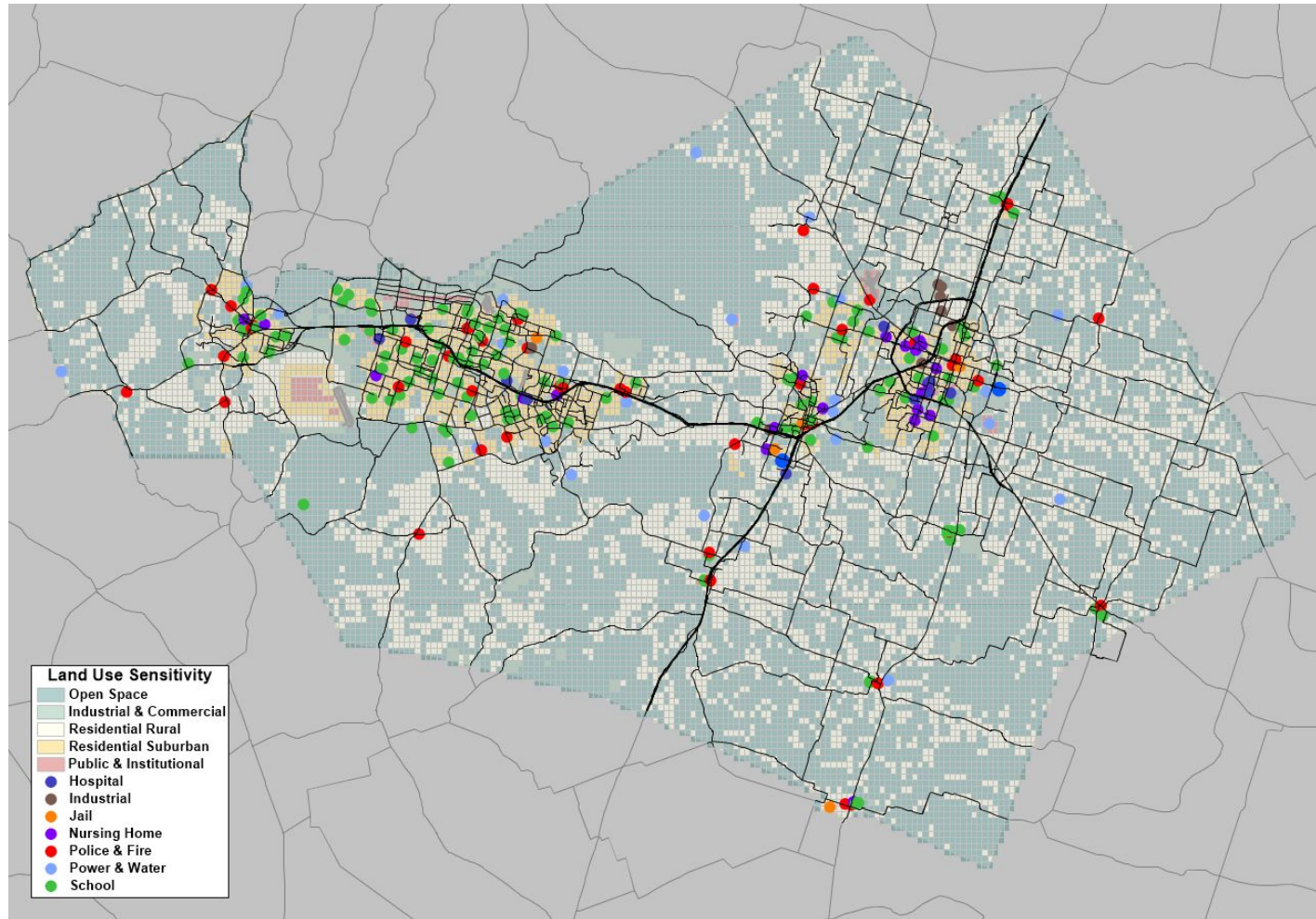
- Vulnerability scores sourced from the U S Geologic Survey Soil Survey
- Based on soil shrink & swell properties





## The RVRF Grid: Critical Land Uses

- Five types of land use and seven types of critical land uses defined mostly by a review of aerial imagery

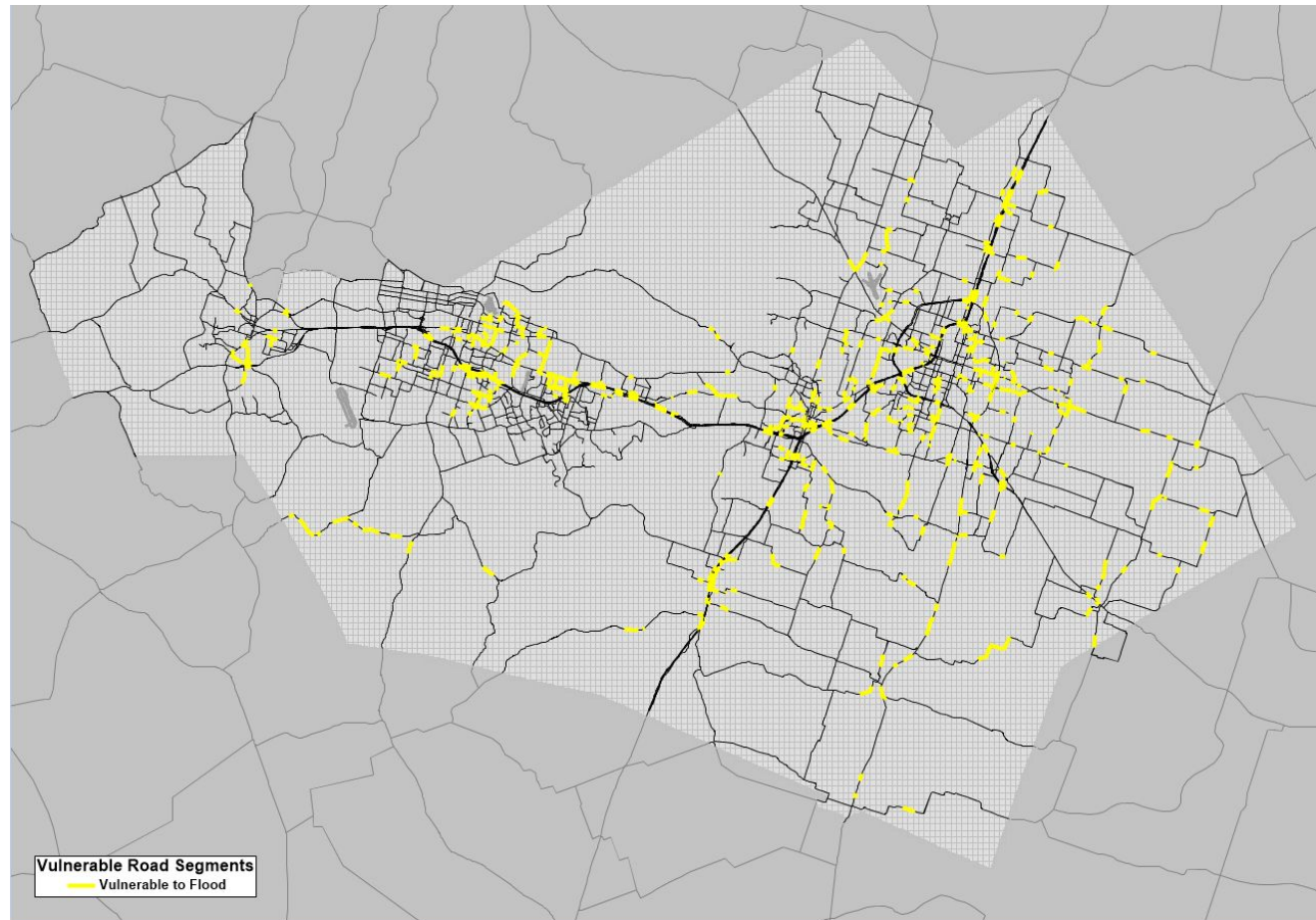






# The RVRF Grid: Vulnerable Road Segments

- The RVRF grid scores are applied to the network to define vulnerable road segments for each type of stressor





# The RVRF Scoring Spreadsheet

- The RVRF Scoring spreadsheet is formatted to match the Project Listing spreadsheet
- Has weighting values for each stressor and land use
- Final composite scores are normalized to a 1-5 scale for input to the project scoring spreadsheet
- Final filter identifies projects which contribute to resiliency

KILLEEN-TEMPLE METROPOLITAN PLANNING ORGANIZATION														
Asset Vulnerability and Resiliency Study														
Raw Scores					Weighting Factors					Final Score				
					30					60				
2045 Metropolitan Transportation Plan Project Vulnerability Scoring														
MPO PROPOSITION 1 / CATEGORY 2 PROJECTS (METROPOLITAN CORRIDORS)														
KTMO ID	Critical Land Use	Land Use Vulnerability	Flood Vulnerability	Dam Breach Vulnerability	Wildfire Vulnerability	Drought Vulnerability	Land Use Vulnerability	Flood Vulnerability	Dam Breach Vulnerability	Wildfire Vulnerability	Drought Vulnerability	Composite Score	Yes/No Resilience Filter	Final Project Score
#15-02b	N/A	3.429	1000	0.000	1.000	0.714	102.857	30.000	0.000	30.000	297.144	2.630	0	0.000
#40-02	Montessori School, Seron Medical Center, Indian Oaks Nursing	3.600	1533	0.000	1.267	3.800	108.000	45.399	0.000	38.001	304.000	2.901	0	0.000
#40-06	Indian Oaks Nursing Home, Nolanville Fire	2.643	2.814	0.070	2.047	3.349	79.286	84.419	0.070	61.395	267.907	2.883	0	0.000
#30-03b	None	3.667	1.667	0.000	1.000	1.333	110.000	5.000	0.000	30.000	106.667	1.735	1	1.735
#40-05	Chilholm Trail Elementary School, Friend The Company, Creekside Terrace Nursing Home	2.773	818	0.000	2.091	3.909	83.182	54.545	0.000	62.727	312.727	3.001	0	0.000
#40-04a	Bellon High School, Creekside Terrace Nursing Home	2.846	3.308	0.000	2.385	4.077	85.385	99.231	0.000	71.538	327.154	3.405	0	0.000
#35-07	Wilsonan International Lockwood Industries	2.444	1.600	0.000	1.900	2.200	73.333	48.000	0.000	57.000	16.000	2.077	0	0.000
#35-01	CR Clements Intermediate School	2.351	1.525	0.000	2.635	1.803	70.526	45.738	0.000	79.180	144.262	1.971	0	0.000

Raw scores

Weighting factors

Weighted scores

Composite score

Filter

Final score



# Next Steps: Integration into the Planning Process

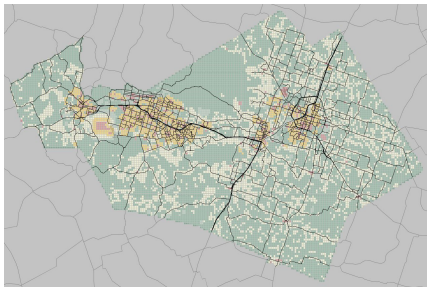
- Precedent from NCTCOG shows how vulnerability & resilience planning fits into overall regional planning





# Summary

KTMPO has completed our first steps in the development of a regional framework for vulnerability & resilience planning, and we are defining our next steps to mature our process.



Developed a GIS and grid to gather & define data for use

KILLEEN-TEMPLE METROPOLITAN PLANNING ORGANIZATION  
Asset Vulnerability and Resiliency Study

2045 Metropolitan Transportation Plan Project Vulnerability Scoring

Project ID	Project Name	2045 Metropolitan Transportation Plan Project Vulnerability Scoring									
		Level 1	Level 2	Level 3	Level 4	Level 5	Level 6	Level 7	Level 8	Level 9	Level 10
2045-001	Capital/Operations Asset Management System	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
2045-002	Capital/Operations Asset Management System	1000	1000	1000	1000	1000	1000	1000	1000	1000	
2045-003	Capital/Operations Asset Management System	1000	1000	1000	1000	1000	1000	1000	1000	1000	
2045-004	Capital/Operations Asset Management System	1000	1000	1000	1000	1000	1000	1000	1000	1000	
2045-005	Capital/Operations Asset Management System	1000	1000	1000	1000	1000	1000	1000	1000	1000	
2045-006	Capital/Operations Asset Management System	1000	1000	1000	1000	1000	1000	1000	1000	1000	
2045-007	Capital/Operations Asset Management System	1000	1000	1000	1000	1000	1000	1000	1000	1000	
2045-008	Capital/Operations Asset Management System	1000	1000	1000	1000	1000	1000	1000	1000	1000	
2045-009	Capital/Operations Asset Management System	1000	1000	1000	1000	1000	1000	1000	1000	1000	
2045-010	Capital/Operations Asset Management System	1000	1000	1000	1000	1000	1000	1000	1000	1000	

Integrated RVRF results into project evaluation



Exploring next steps of more fully integrating RVRF results into the full planning process

# Planning for Resiliency in the Houston-Galveston Region

Justin Bower  
Principal Planner  
Community and Environmental Planning

# MPO at a Glance

- MPA/TMA 8,800 square miles (Region is 12,000+ sq. miles )
- 6.7 million people; add another 4 million+ by 2045.
- 2021-2024 TIP identifies over \$9.7 billion in transportation investment; \$1.2 billion programmed by H-GAC / TPC and TIP

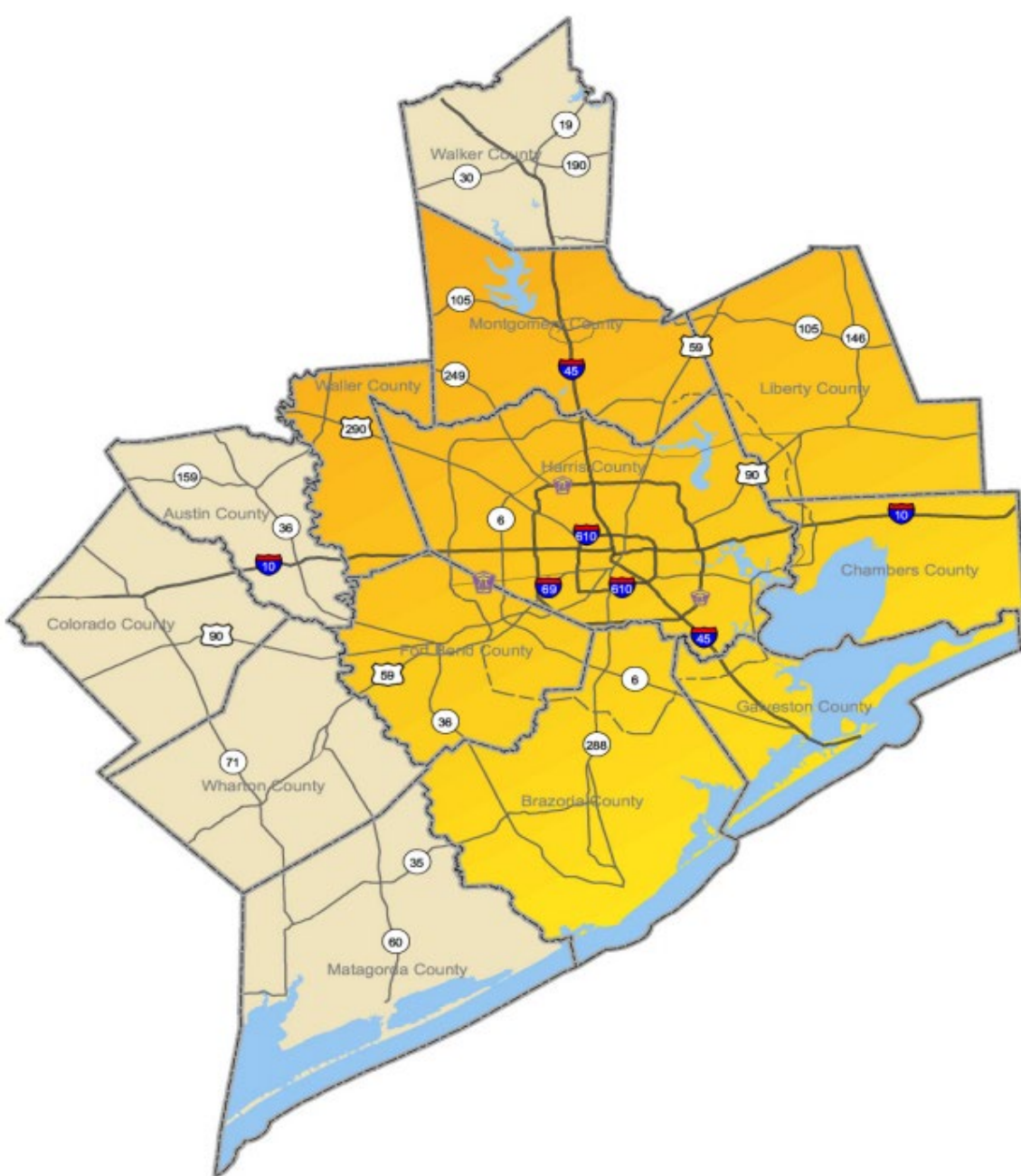




Photo: Brett Coomer,  
Houston Chronicle

# Regional Resiliency Challenges

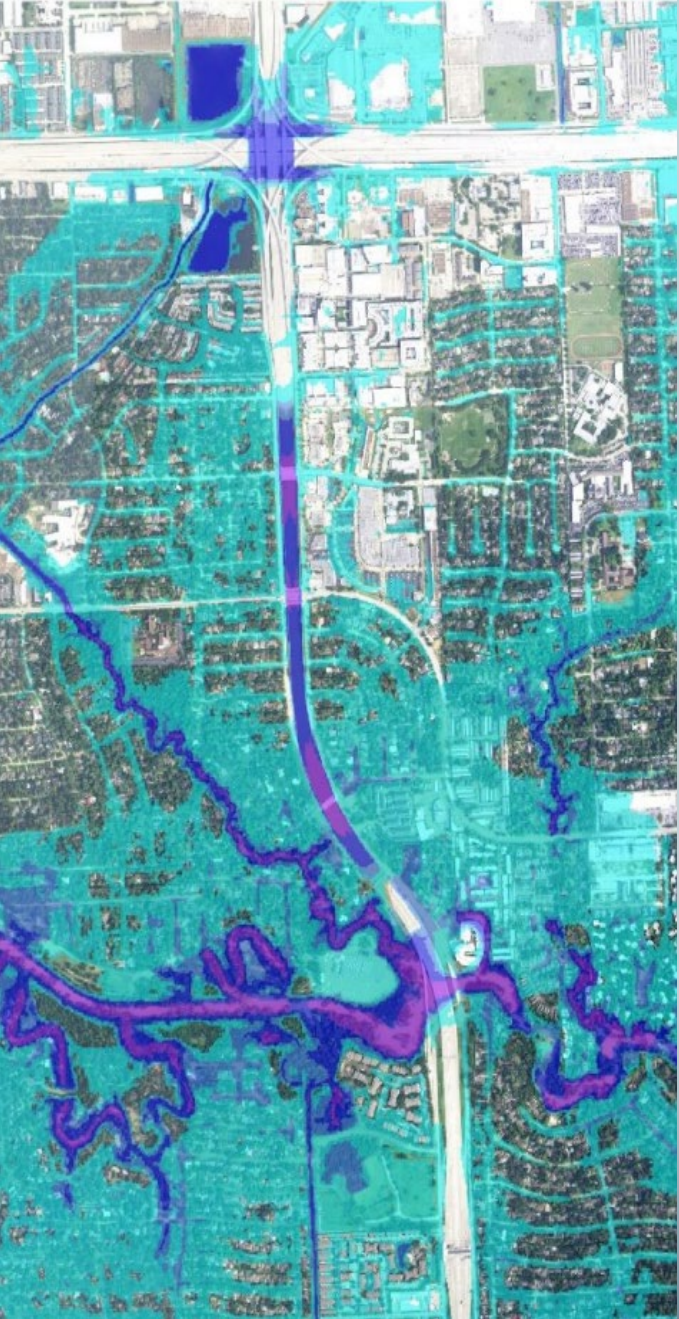
- Number, variety of jurisdictions; equity issues
- Unique vulnerability to storm events
  - Low-lying, coastal, high rainfall
  - High impervious cover and soils
  - Industry, transportation corridors, dense populations in highly affected areas
  - Aging infrastructure
- Growth impacts continue



# Coordinating Resilience Planning

- Existing coordination/roles serves as foundation (TPC, NRAC, RFMC, etc.)
- Formal Region Resilience Pilot Program for transportation
- Informal adjacent “spheres”
  - Economic/Growth planning
  - Environmental planning (quality, supply conservation)
  - Community/quality of life
  - Public safety/services
  - Disaster mitigation





# Region Resilience Pilot Program

- FHWA grant funded (2018) with TxDOT, draft submitted July 2020.
- Goals to:
  - Measure criticality/vulnerability of regional transportation assets
  - Develop recommendations for more resilient network to govts.
  - Use analyses to inform future decision/project selection criteria
- Focus on major roads/bridges and flooding/surge/sea level rise.

## STORMWATER MANAGEMENT

- 1.Increase Number of Swales & Ditches
- 2.Retention & Detention Ponds
- 3.Depressed & Raised Medians
- 4.Bioswales (Biofiltration Swales)
- 5.Green Infrastructure

## MAINTENANCE

- 6.Culvert Cleaning & Maintenance

## PLANNING/SOCIAL

- 7.Stormwater Management Plan
- 8.Land Use Planning/ Climate Justice
- 9.Relocate or Abandon Roads
- 10.Shelter-In-Place
- 11.Evacuation Route Identification & Planning
- 12.Prohibiting Overweight/ Oversize Vehicles
- 13.Sensor Technologies & Monitoring Programs

## INFRASTRUCTURE

- 14.Enhanced Road Surface
- 15.Enhanced Sub-Grade
- 16.Hardened Shoulders
- 17.Raised Road Profile
- 18.Geosynthetics/ Geo Textiles
- 19.Permearable Pavement

## OTHER

- 20.Maintain & Restore Wetlands
- 21.Beach Nourishment & Dune Restoration
- 22.Vegetation (as Erosion Control)
- 23.Seawalls & Revetments
- 24.Wave Attenuation Devices
- 25.Debris Deflectors for Bridge Protection

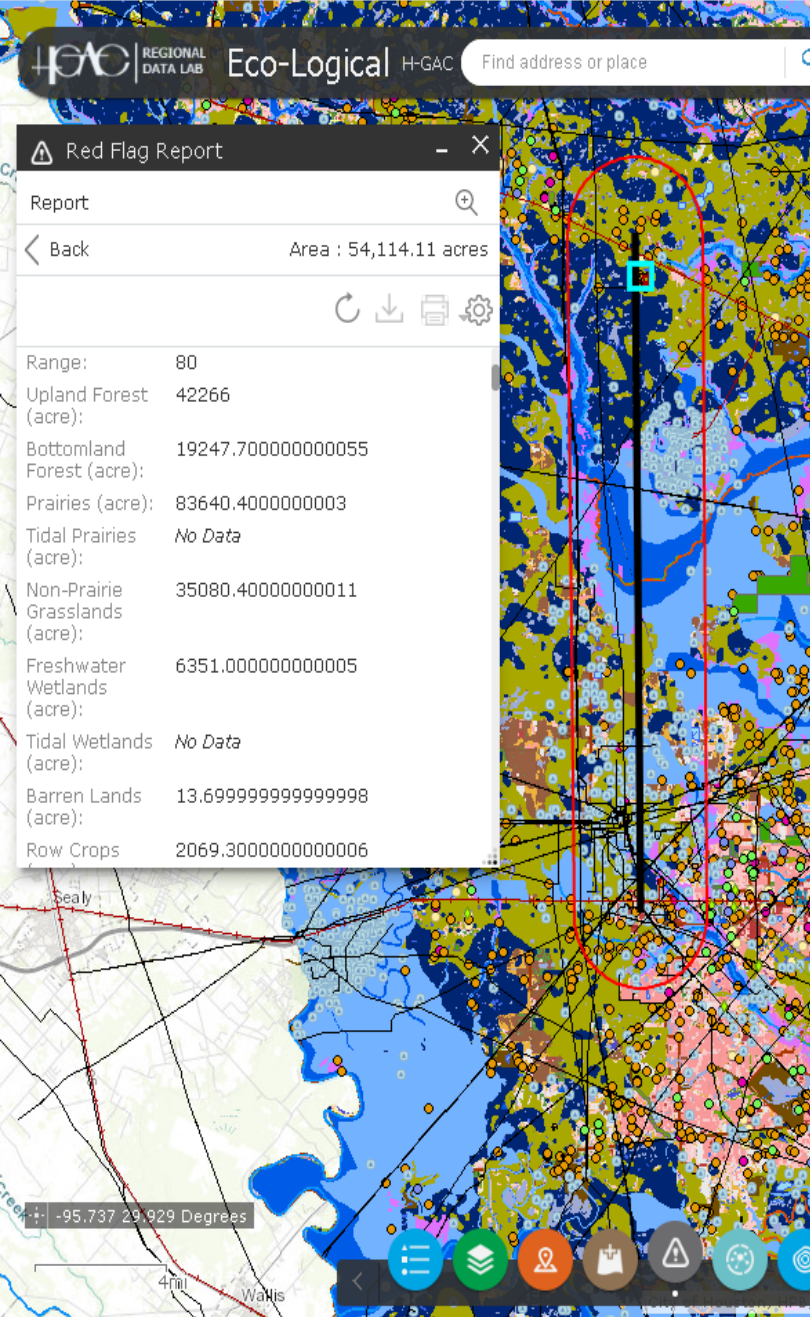
# Region Resilience Key Findings

- Out of 762 freeway miles, and 6,440 major road miles:
  - 12%/9% were highly Critical
  - 13%/12% highly Vulnerable
  - Where intersect, priority lies
  - Built into online Tool with modeled flood exposure depth.
- Strategies in categories, including stormwater management, maintenance, planning/social, infrastructure, and Other (natural function, etc.)
- Findings will influence TIP, other.

# Embracing the Adjacent

- Regional resilience needs, opportunities far greater than transportation.
- Our future requires a direct commitment on intersectionality of planning spheres.
- Case Studies
  - EcoLogical– Environmental impact assessment of potential transportation projects
  - Livable Centers– transit-responsive planning for enhancing community quality of life





# Case Study EcoLogical

- Multidisciplinary planning team
- Online GIS tool to assess environmental impact of user defined transportation projects (land cover impacted, red flags)
- Will be part of transportation project submission
- Usable by other planning efforts, partners <https://datalab.h-gac.com/EcologicalGIS/>

# Case Study– Livable Centers

- Ongoing community planning program to design areas that are walkable, have multimodal transportation, and enhance “Live/Work/Play” (*transportation funded*)
- Airline– Using LID and turning movement controls to enhance area
- Westchase– Roadway development to include green infrastructure elements
- Mont Belvieu– green infrastructure for traffic and flooding management.





Photo: Justin Bower

## Contact:

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# TxDOT Resiliency Planning

Bill Knowles, P.E., TxDOT



## OVERVIEW

- 2018 – Published “Developing a Resilient Texas Transportation System”
- 2019 – Held Statewide Resiliency Stakeholder Workshop
- 2020 – Initiated Resiliency Research





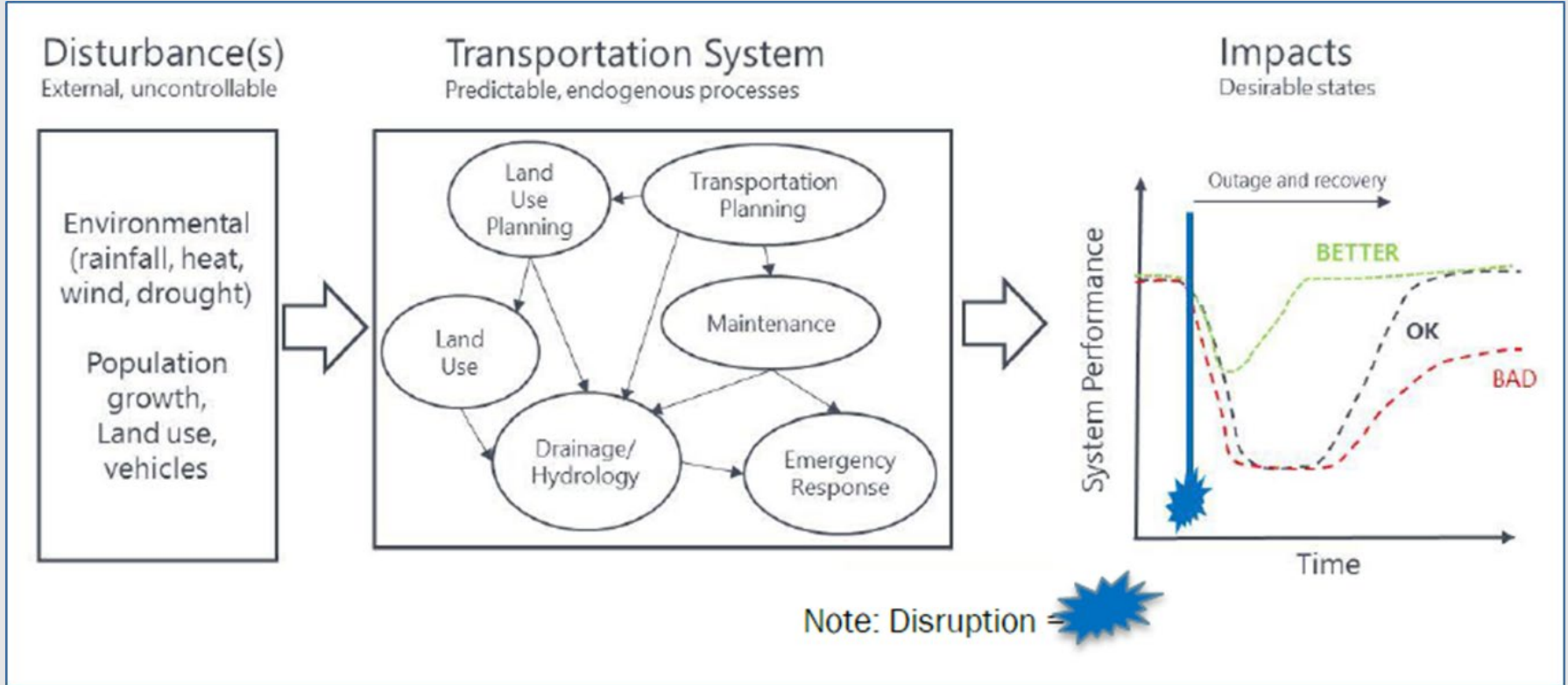


- 2015 Fixing America's Surface Transportation (FAST) Act requires:
  - State transportation agencies to address resiliency in their transportation planning processes
  - To develop a Transportation Asset Management Plan (TAMP) that integrates climate change and extreme weather event resilience approaches into transportation asset management
  
- How transportation agencies address these requirements is generally left up to the individual agencies



Steps to develop a framework for ensuring a resilient transportation system that meet FAST Act resiliency requirements:

1. Define resiliency for Texas' transportation system
2. Identify the resiliency goals and objective for Texas' transportation system
3. Identify resiliency performance measures
4. Assign roles and responsibilities
5. Assess the vulnerability of Texas' transportation system
6. Assess/quantify adaption, mitigation, and recovery options





This step requires the following tasks:

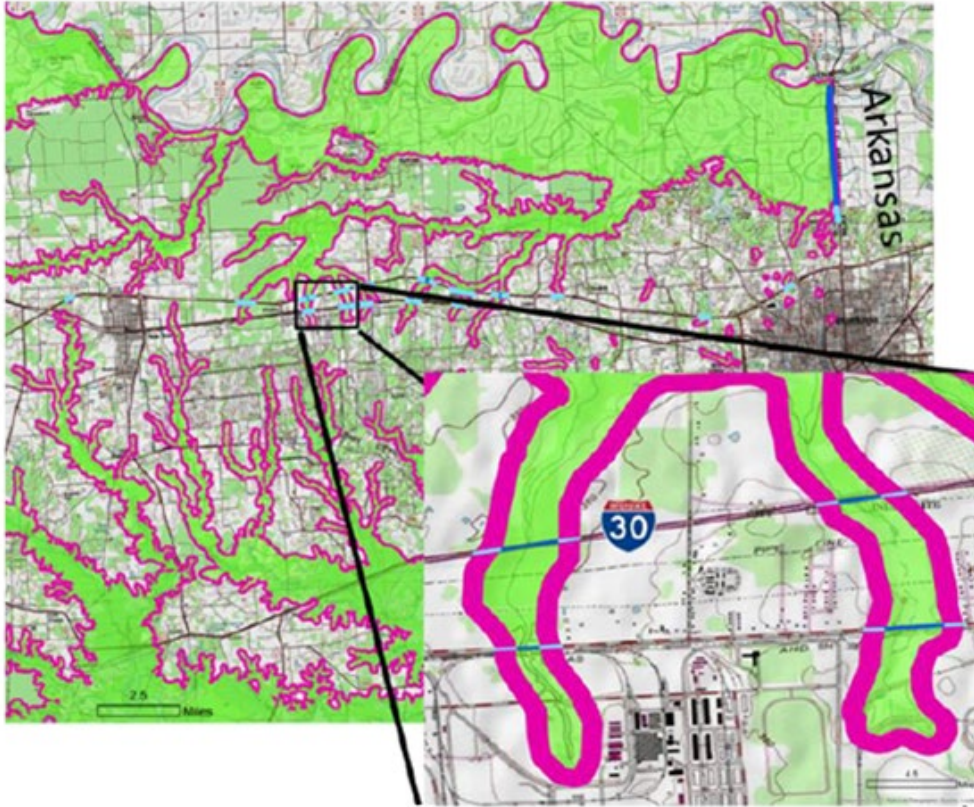
1. Identify and characterize extreme weather events of concern
2. Determine the risks/likelihood of the extreme weather events occurring
3. Identify vulnerable transportation systems elements
4. Determine the potential impact of the extreme weather event if occurring
5. Identify the critical transportation assets









- Overlay extreme weather risk data with transportation system assets to:
  - Assess the transportation system’s exposure to extreme weather events
  - Identify vulnerable system elements
  
- Objective to determine which assets have the potential of being severely impacted by the event (i.e. failure)
  - Asset age
  - Asset condition
  - Asset functional attributes (e.g. elevation in the case of flooding)
  - Severity of the event

# Example Federal Emergency Management Agency Floodplain Map



Legend

-  500 Year Flood Area
-  100 Year Flood Area
-  500 Year Vulnerable Miles
-  100 Year Vulnerable Miles

Source: TxDOT Maintenance Division

# Identify Critical Transportation Assets



Once the critical transportation assets have been identified, the vulnerable critical system elements can be identified, using criteria such as:

- Redundancy
- Level of use (current and future) or critical commerce or commuter corridors
- Functional classification
- Replacement cost
- Element of the Texas multimodal network
- Evacuation routes

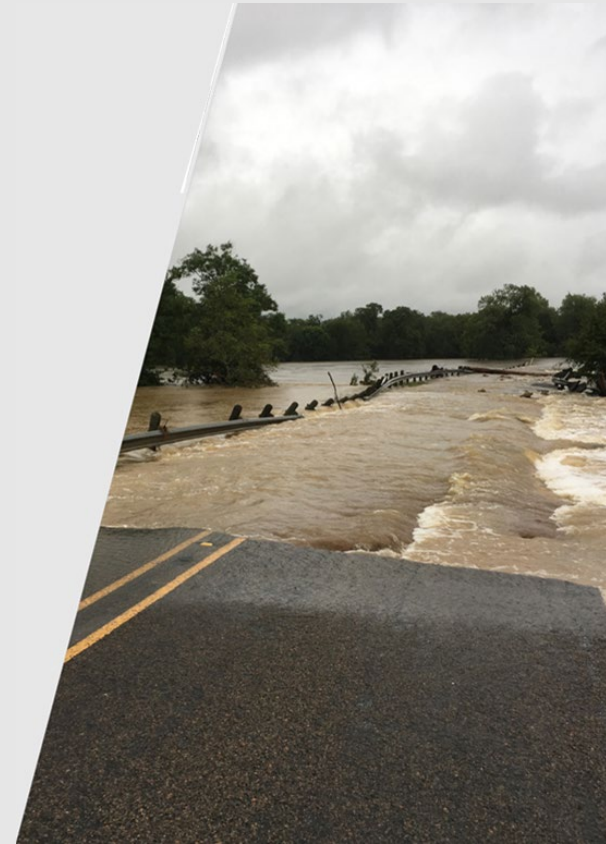




Title: “Establish TxDOT Transportation Resilience Planning Scorecard and Best Practices”

The impact of Hurricane Harvey in 2017 accelerated TxDOT’s resiliency efforts regarding the need to improve the resilience of the transportation infrastructure in Texas.

Future scenarios of extreme weather events in Texas will have significant impacts on highway infrastructure.





# Hurricane Harvey Impact Summary



- Over 60 inches rainfall in Houston/Beaumont area
- Estimated 13 million people were affected
- \$125 billion (2017 dollars) in estimated damage – Ranks as the second costliest hurricane to hit the U.S. mainland since 1900
- Floodwaters inundated major roads: IH-10, IH-45, and US-59
- Some roads and bridges were completely washed away, while in other areas, high water flows caused significant bridge scouring





## Technical Objectives:

1. Examine vulnerability in the state highway network
2. Establish a resilience scorecard for integrating hazard mitigation and resiliency into local and regional transportation plans, and evaluate the level of integration among transportation planning and other plans related to flood risk management and hazard mitigation
3. Establish resilience best practices and measures for integrating resiliency in TxDOT highway infrastructure planning



1. Conduct a statewide survey of all stakeholders for highway resilience needs and gaps
2. Conduct a statewide vulnerability analysis on highway infrastructure networks to identify critical and vulnerable assets
3. Develop and test a transportation resilience scorecard to evaluate the vulnerability, risk, and value of transportation assets to be used in the project development process

## Six Major Tasks (cont.)



4. Develop guidelines and performance measures for TxDOT highway resilience
5. Develop guidebook for TxDOT highway resilience planning using the scorecard
6. Implement resilience education through workshops





- Technical guide for implementation of highway resilience best practices and measures for transportation planning
- A transportation resilience scorecard tool for evaluation of local and regional transportation plans
- Technology transfer and education through workshops for state, municipal, and MPO transportation planners and engineers



- Build a more resilient transportation system
- To incorporate resiliency into TxDOT's Planning Process
- Addresses FAST Act requirements
- Aligns with TxDOT's Goals:
  - Deliver the Right Projects ✓
  - Focus on the Customer ✓
  - Foster Stewardship ✓
  - Optimize System Performance ✓
  - Preserve our Assets ✓
  - Promote Safety ✓
  - Value our Employees ✓



# THANK YOU

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