NATIONAL ACADEMIES Sciences Engineering Medicine

TRB TRANSPORTATION RESEARCH BOARD

# TRB Webinar: Supply Chain Based Resilience Planning in the U.S.

*April 24, 2025*

*12:00 – 1:30 PM*

# PDH Certification Information

1.5 Professional Development Hours (PDH) – see follow-up email

You must attend the entire webinar.

Questions? Contact Andie Pitchford at TRBwebinar@nas.edu

***The Transportation Research Board has met the standards and requirements of the Registered Continuing Education Program. Credit earned on completion of this program will be reported to RCEP at RCEP.net. A certificate of completion will be issued to each participant. As such, it does not include content that may be deemed or construed to be an approval or endorsement by the RCEP.***

ENGINEERING
RCEP
REGISTERED CONTINUING EDUCATION PROGRAM

# Purpose Statement

This webinar will explore how incorporating the 4Rs into state freight programs can help mitigate these risks. Presenters will highlight innovative approaches to freight resilience planning and strategies to improve supply chain stability.

# Learning Objectives

At the end of this webinar, you will be able to:

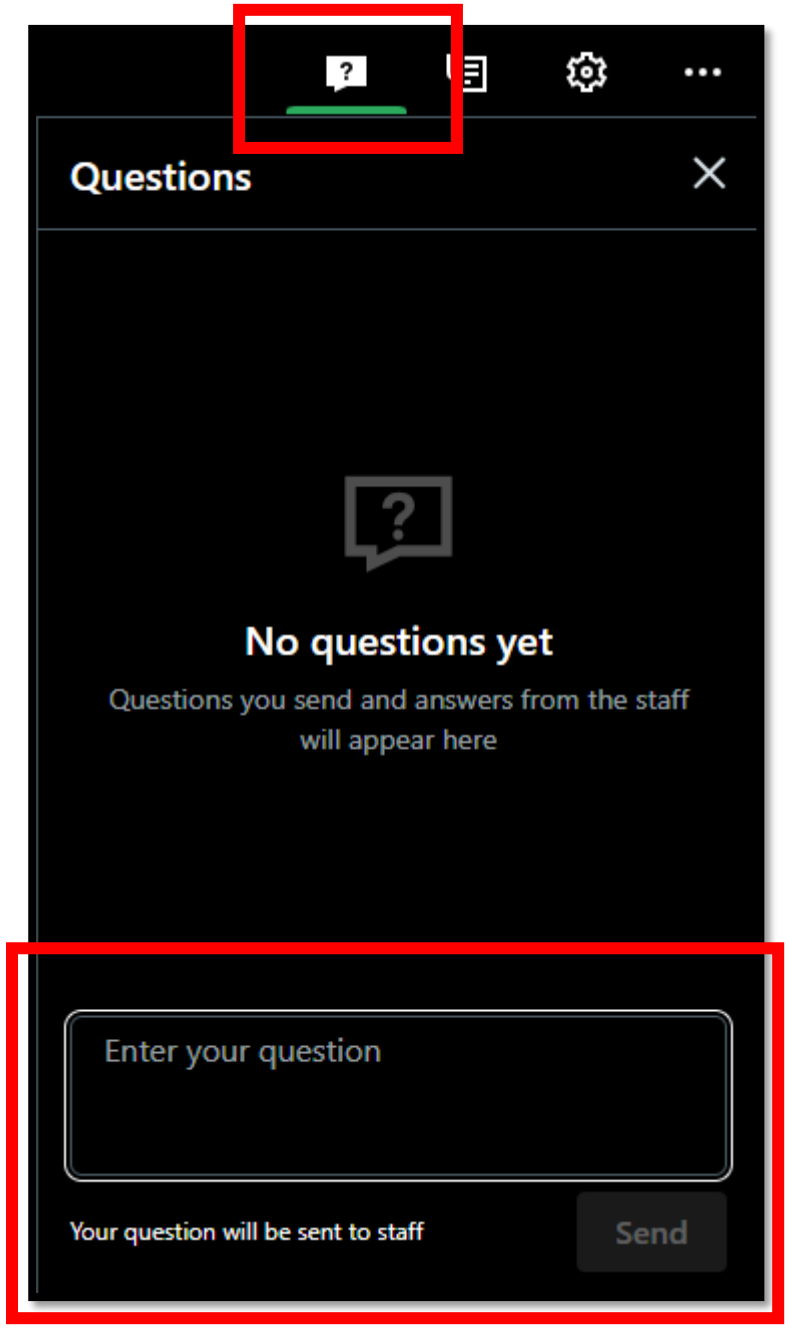
(1) Apply 4Rs to freight resilience planning framework

(2) Improve the freight system using resilience-based strategies

(3) Use best practices in freight resilience planning

# Questions and Answers

- Please type your questions into your webinar control panel
- We will read your questions out loud, and answer as many as time allows



# Today's presenters

**Michael Williamson**
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CAMBRIDGE SYSTEMATICS

**Tyler Graham**
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Texas Department of Transportation™

**Chip White**
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CAMBRIDGE SYSTEMATICS

NATIONAL ACADEMIES *Sciences Engineering Medicine*

# DHS Supply Chain Resilience Issues, Problems & Solutions

**SCRIPS: Supply Chain Resilience (SCR) Issues, Problems and Solutions for the Homeland Security Enterprise**

*A Workshop for Defining Research Needs and Opportunities*

October 1-2, 2024, Washington, D.C.

**24 April 2025 TRB Webinar**

**Chelsea White III,** *Schneider Nat'l Chair & Professor, Georgia Tech*

Georgia Institute of Technology

# *Outline*

- About the Workshop
- Common themes
- Commonly identified research opportunities

# *A report on a workshop for defining research needs & opportunities*

**SCRIPS: Supply Chain Resilience (SCR) Issues, Problems and Solutions for the Homeland Security Enterprise** October 1-2, 2024, Washington, D.C.

Workshop hosts and report authors

- Ronald G. Askin, Center for Accelerating Operational Efficiency (CAOE)
- Gregory Pompelli, Cross-Border Threat Screening and Supply Chain Defense (CBTS)
- Fred Roberts, Command, Control and Interoperability Center for Advance Data Analysis (CCICADA)

Workshop Organizing Committee

- Ronald Askin, CAOE, Organizing Committee Chair
- Greg Pompelli, CBTS
- Fred Roberts, CCICADA
- Hilary Shackelford, DHS OUP (Office of University Programs)
- John Caton, DHS SCRC (Supply Chain Resilience Center)
- Tracie Hanson, DHS SCRC

# *A report on a workshop for defining research needs & opportunities*

## Objectives

- To identify and bring together leaders from academia, government and industry to create a diverse community of researchers, policy analysts and problem domain owners united by common interest in the supply chain resiliency of critical industries
- To define a research agenda for the next 3-5 years that could advance relevant science and lead to measurable advances in the resiliency of critical industry supply chains.

## Scope

Focus on three key industries: Semiconductor Manufacturing; Food/Agriculture Industry, Port/Maritime Operations.

## Technical Focus

Information, data analytic and quantitative modeling needs to enhance SCR.

## Report citation:

Askin, Ronald G., G. Pompelli, F. Roberts, *SCRIPS: Supply Chain Resilience Issues, Problems and Solutions for the Homeland Security Enterprise*, Center for Accelerating Operational Efficiency, Arizona State University, Tempe, AZ, 2024

# *A report on a workshop for defining research needs & opportunities*

## Breakout Group Agenda

Day 1

- Breakout #1: “SWOT (Status/Weaknesses/research Opportunities/Threats): Supply Chain Weaknesses/Threats/Needs”
- Breakout #2: Research Needs: Science and Solution Gaps
- Breakout #3: What Science can be Advanced and Applied

Day 2

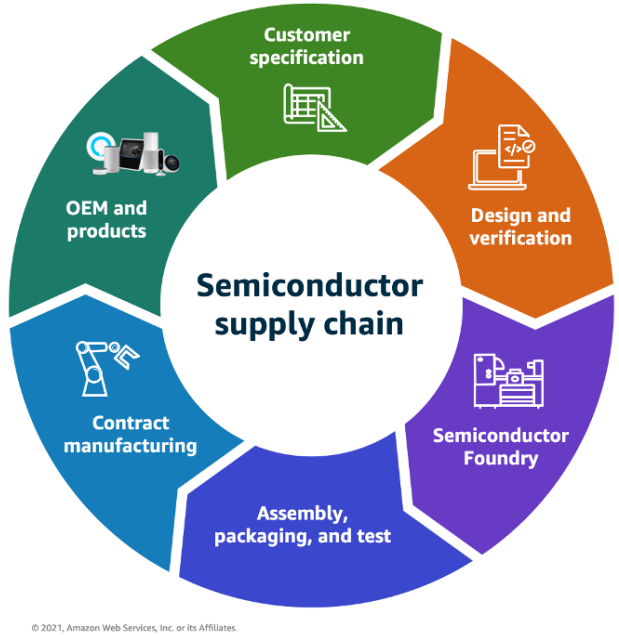
- Breakout #4: Revisiting Day 1 and Affinity/Synthesis Analysis
- Breakout #5: Prioritizing Short- Long-Term Research Needs: Importance/Feasibility

## Breakout Group Organization

- Food/Ag (Agriculture) industry (Greg Pompelli, CBTS)
- Port/Maritime operations (Fred Roberts, CCICADA)
- Semiconductor manufacturing (Chip White, GT)
- General SCR issues that cut across those and other vital industries (Ronald Askin, CAOE)

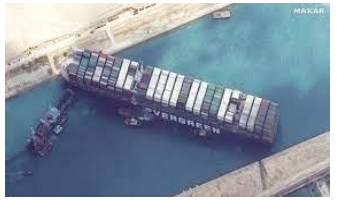
# Common Themes/Supply Chain Characteristics (1/3)

- Manufacturing supply chains are more complex than, and lack the visibility of, a factory.
- A supply chain is a collection of independent, geographically distributed firms (material providers, sub-component/sub-assembly suppliers, carriers, warehouse suppliers, OEMs, distributors, customers in different time zones, long lead times, different countries), each with its own:
  - Decision-making agent (multi-agent decision-making)
  - Limits on access to all supply chain data (decentralized decision-making)
  - Decision rules (mapping available data to actions)
- Interoperability is a major hurdle, e.g., LA and Long Beach ports use different software platforms



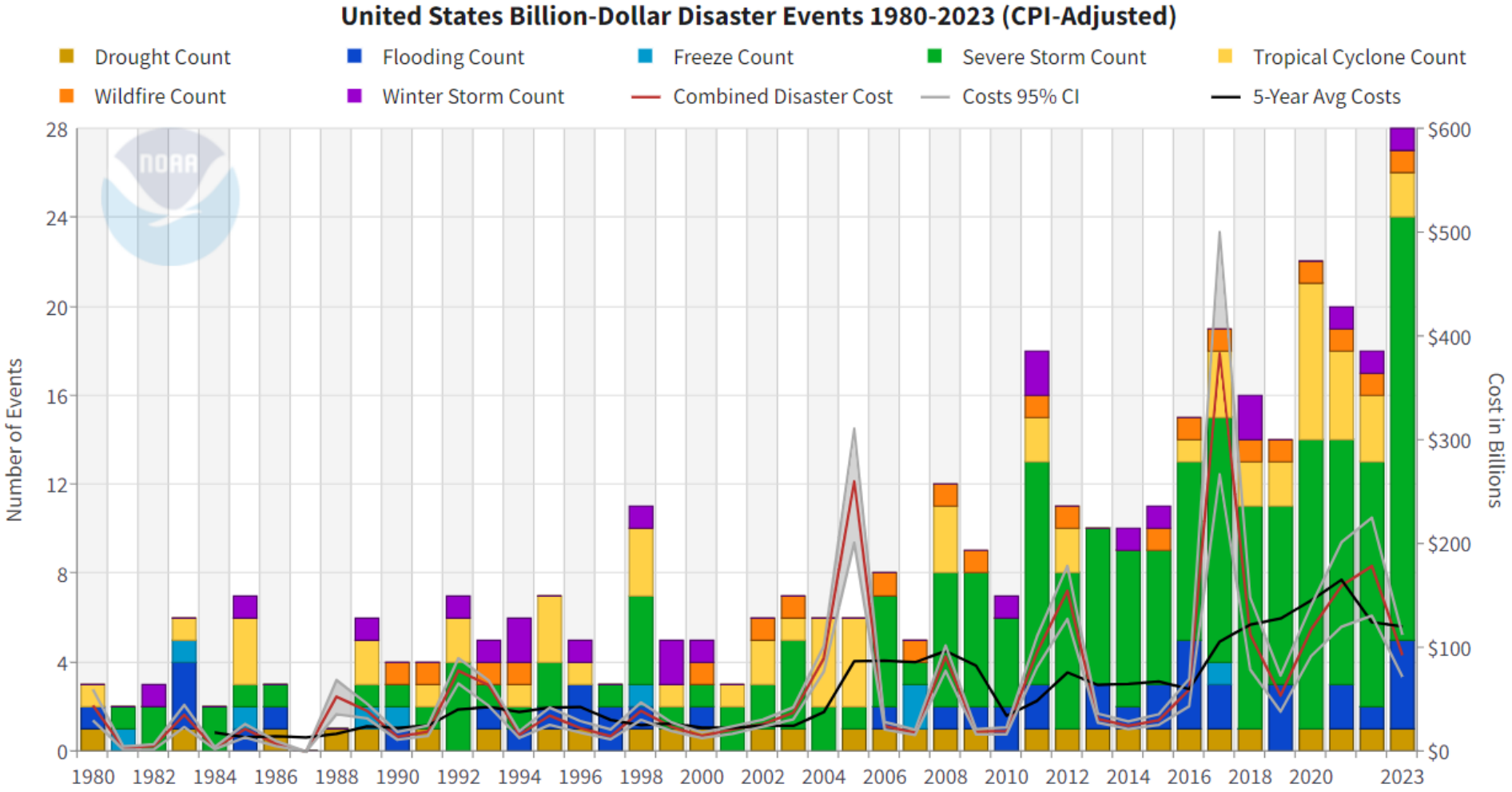
# Common Themes/Supply Chain Characteristics (2/3)

- Firms may not want to share data or even share the names of their suppliers to protect confidentiality, current or future competitive advantage, &/or legal compliance.
- Data may be noise corrupted, delayed, &/or intermittently unavailable => disruption detection becomes a challenge
- Risks include extreme weather, labor disputes, trade wars, accidents, traffic congestion, poor/no planning, poor execution, mistakes, civil unrest, sabotage, pandemics, extreme shifts in product demand, geopolitical risks with rapid geopolitical alignments, possibly magnified by geographic concentration of current material sources and manufacturing steps



# *Billion-Dollar Disaster Events (CPI-Adjusted)*



# *Common Themes/Supply Chain Characteristics (3/3)*

- Quantity and quality of workforce uncertain, inadequately trained, increased absenteeism during demand surge for medical products =>
- Increasing interest in automation, the need for design for automation expertise for SMMs, the cost of automation and limited access to cash/debt by many SMMs, cybersecurity concerns.
- Roles of public policy/investment and private sector responsibility for an up-to-date, resilient, efficient industrial base - TBD

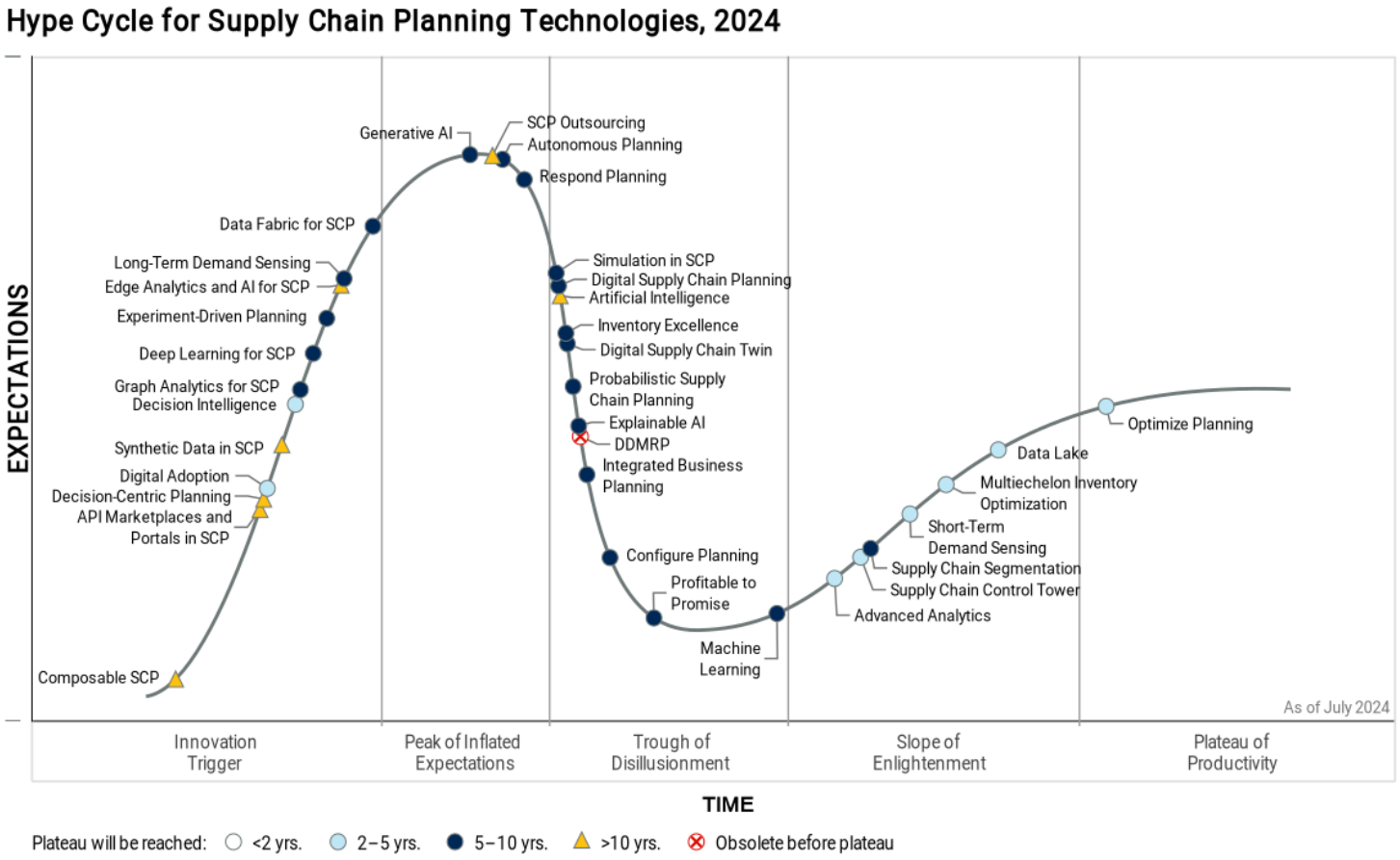
# *Research Opportunities/Solution Approaches*

**Needs:**

- A foundational platform (e.g., extensions of RL, ML) that can model a dynamic system with multiple agents, each with a different access to data, where the data may be noise corrupted, delayed, &/or intermittently unavailable.
- Next Gen analytic and computational tools and techniques for this platform (blends of AI and mathematical optimization) that can efficiently and rapidly address important operational and design issues, including system stress testing for disruptions of concern.
- Tools and techniques to extend supply chain stress testing to both reactive resilience (detect, respond, recover) and proactive resilience (forecast, avoid, deter).
- Next Gen tools and techniques to rapidly & accurately apply/specialize the platform to specific examples.

*Comment:* digital twins have great potential for improving performance and resilience but can be time consuming and tedious to construct. Generative AI? LLM?

# Gartner Hype Cycle




Gartner

# *Research Opportunities/Solution Approaches*

**Another potential use of the platform:** As a multi-objective decision support system (DSS) that relies of a human or group of humans to provide preferential tradeoff information. Extending the platform to incorporate human behavioral principles would be key. Applications could include:

- Public sector policy development to, e.g., build resilience enhancing options such as buffer inventory investment & infrastructure expansion into critical supply chains.
- To aid SMEs with limited IT and modeling expertise to improve overall system resilience since such SMEs may often be the weakest link and least understood vulnerability in a supply chain. Especially important for upper level (Tier 3 and higher) suppliers.

**Other needs:**

- Better data collection and data sharing
- Better sensors and sensing systems can assist with data issues, support modeling and automation and facilitate early detection of supply chain disruptions.

***Thank you!***

Texas Department of Transportation

April 24, 2025

# TEXAS FREIGHT & SUPPLY CHAIN RESILIENCE PLAN

# The World Depends on Texas Supply Chains

## Agriculture

**Agricultural products and cattle with a focus on wheat.**

## Construction

Non-metallic minerals, clay/concrete/glass/stone, lumber, and wood, with a focus on fabricated metal products.

## Electronics

**Electronics and electrical equipment industries with a focus on semiconductors and computer components.**

## Military

**Personnel and equipment deployed to meet national defense needs, with a focus on base supplies and petroleum resources.**

## Petroleum

Oil and gas, petrochemicals, rubber, and plastics with a focus on oil and gas production.

## Transportation Equipment

**Transportation equipment industries with a focus on motor vehicle parts and accessories.**

## Warehousing & Distribution

**Warehousing and distribution of a wide variety of consumer goods, with a focus on pharmaceuticals.**

# Disruptions, Regardless of Cause, Result in Significant Cost

## Economic Loss by Supply Chain of Winter Storm Uri

**TOTAL ECONOMIC IMPACT ON KEY INDUSTRY SUPPLY CHAINS DUE TO 2021 WINTER STORM URI**

| KEY INDUSTRY SUPPLY CHAINS | Wage Income Losses* | GSP Losses* | Business Output Losses* |
|---|---|---|---|
| AGRICULTURE | $102.2 | $200.8 | $714.8 |
| CONSTRUCTION | $127.4 | $198.7 | $453.9 |
| ELECTRONICS | $77.4 | $152.5 | $368.7 |
| MILITARY | $0.2 | $0.3 | $1.2 |
| PETROLEUM | $169.0 | $383.0 | $1,232.5 |
| TRANSPORTATION EQUIPMENT | $3.5 | $10.2 | $29.5 |
| WAREHOUSING AND DISTRIBUTION | $217.1 | $438.1 | $747.9 |
| **TOTAL KEY INDUSTRY SUPPLY CHAINS** | **$696.8** | **$1,383.5** | **$3,548.5** |

## Winter Storm Uri - Chain Reaction

**TEXAS**

Wellhead freeze-offs and power losses leading to a 25% reduction in Permian Basin gas production.

**CALIFORNIA**

- Heavy reliance on Texas for over 90% of natural gas.
- Gas supply disruptions highlighting the vulnerability of the state's energy infrastructure.

**OKLAHOMA**

- Power outages, frozen equipment, and infrastructure failures.
- Natural gas price surge of 40,000%, leading to significant financial strain.

**KANSAS**

- Natural gas prices surged 100-300 times higher than normal due to reduced Texas production.
- Gas usage doubled, leading to extreme costs for utilities and consumers.

**ARKANSAS**

- Gas supply shortfalls due to force majeure declarations by key suppliers.
- Abnormal energy expenses for public utilities.

**LOUISIANA**

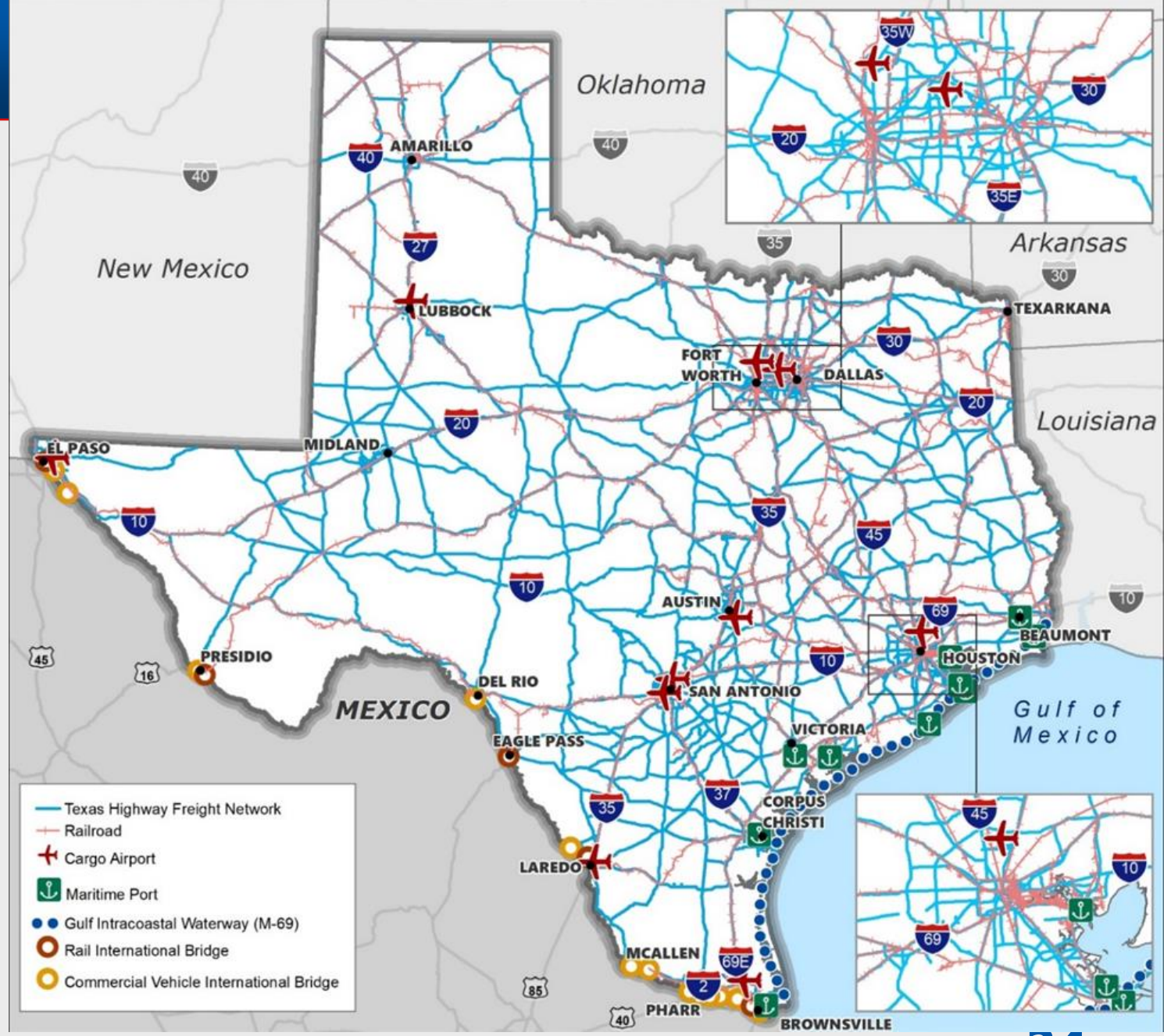
- Heavy reliance on Texas for over 90% of natural gas.
- Gas supply disruptions highlighting the vulnerability of the state's energy infrastructure.

A **Freight & Supply Chain Resilience Plan (FRP)** can help TxDOT prepare for disruptions by:

- Understanding the linkages between disruptors and the movement of freight for critical supply chains.
- Identifying freight resilience projects and mitigation strategies to prioritize investments.
- Estimating the economic impacts and the value of freight resilience.

# Modal Networks Provide Resilience Building Blocks

- **Texas Multimodal Freight Network (TMFN)**
  - Over 23,000 miles of highways
  - Class I and III (short line) railroads
  - 10 maritime ports
  - Gulf Coast Intercoastal Waterway (GIWW)
  - 10 air cargo airports
  - 15 commercial vehicle international border crossings
  - 5 rail international border crossings



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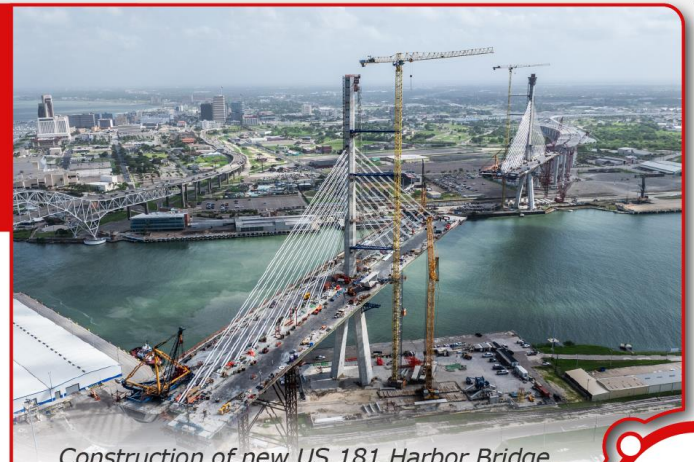
# The 4Rs of Resilience Framework Adds Dimensionality

## Robustness

*The* **ability to withstand** *impacts of disruptions*

***Infrastructure Hardening***

The US181 Harbor Bridge Replacement increases robustness by hardening an evacuation route.



*Construction of new US 181 Harbor Bridge.*

## Redundancy

*The extent to which* **system elements are substitutable**

***Substitutable Infrastructure***

Backup infrastructure increases redundancy by continuing operations after a disruption, such as substitutable border crossings.

*Eagle Pass Border Crossing, with rail bridge on the foreground and vehicle bridge in the background.*

**4Rs of Resilience**

## Resourcefulness

*The ability to* **mobilize resources**

***Staging and Equipment Availability***

Strategically located staging areas and equipment increase resourcefulness by having resources available to diagnose and address disruptions.

*Staging area in preparation for Hurricane Ike.*

## Rapidity

*The capacity to* **restore functionality in a timely manner**

***Real-Time Intelligence and Rapid Response***

Intelligent transportation systems and contract mechanisms in place increase rapidity by quickly deploying resources and reducing downtime.

*Traffic management center in Houston with real-time monitoring and response capabilities.*

# How the 4Rs Inform Investments in the TMFN

A decision framework based on the 4Rs, and measures of criticality, can help prioritize freight resilience improvements

**Robustness** | **Redundancy** | **Resourcefulness** | **Rapidity**

***Identifies freight resilience improvement needs***

**4Rs Composite Score**
*Is your asset resilient or not?*

***Highlights areas of concern where freight resilience is low***

**Criticality**
*What is the relative importance of assets on the TMFN to critical supply chains?*

***Prioritizes freight resilience improvements***

**Strategies and Investments**
*What can you do to improve resilience on the TMFN?*

***Targets investments based on the needs of each 4R***

- Freight Infrastructure Hardening
- Alternative Routes and Backup Systems
- Operational Improvements and Resource Allocation
- Rapid Response and Recovery Strategies

# 4Rs of Resilience

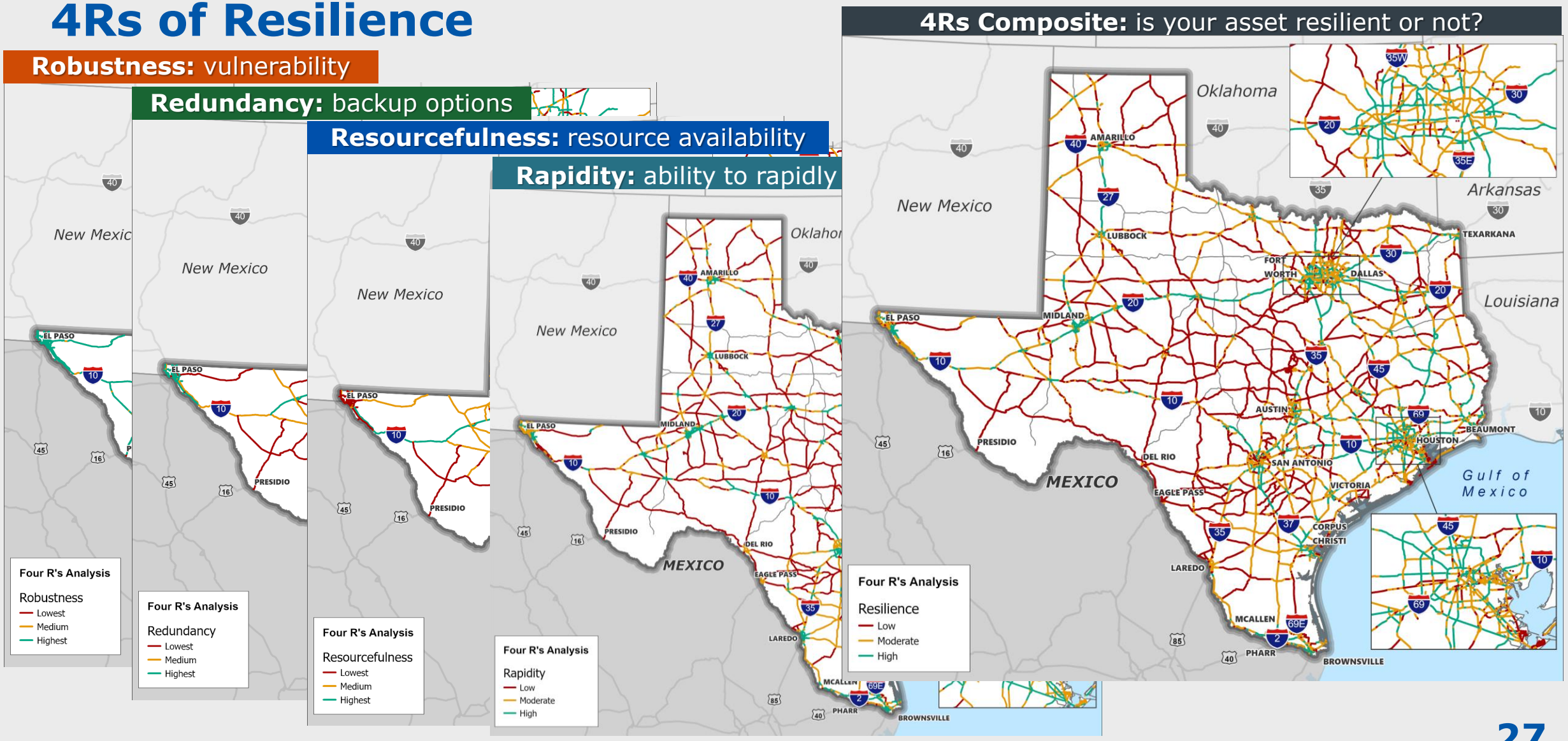
**Robustness:** vulnerability

**Redundancy:** backup options

**Resourcefulness:** resource availability

**Rapidity:** ability to rapidly

**4Rs Composite:** is your asset resilient or not?



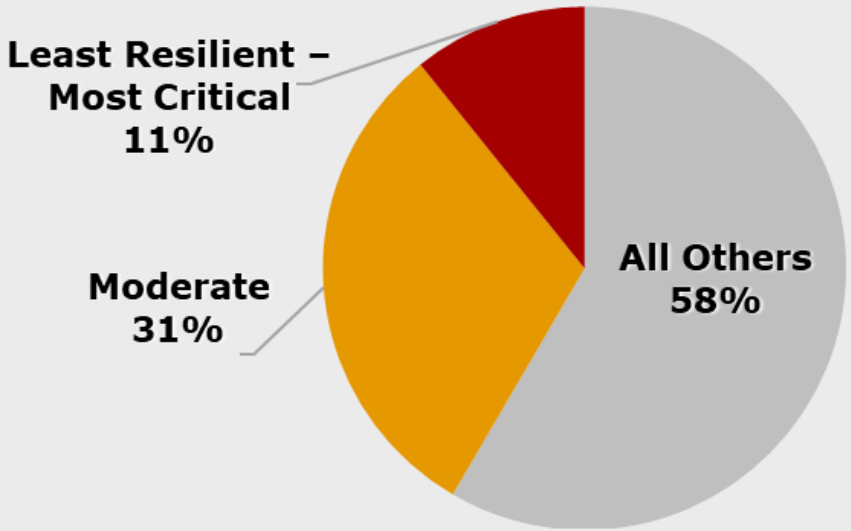
# Criticality and Exclusivity Considerations can Dramatically Affect the Impact of Resilience Deficiencies

**Criticality:**
Importance of transportation assets within the TMFN for supply chain efficiency and integrity, particularly during disruptions.

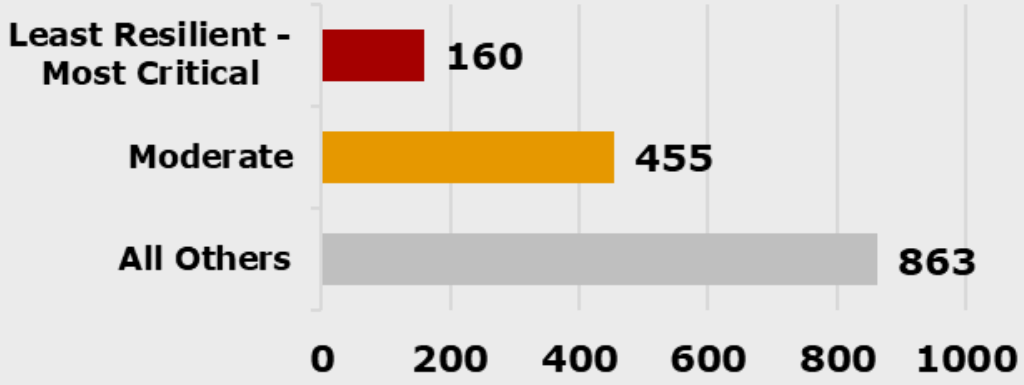
**Exclusivity:**
Parts of the multimodal network located in areas of importance as the primary producer or distributor of a good or commodity.

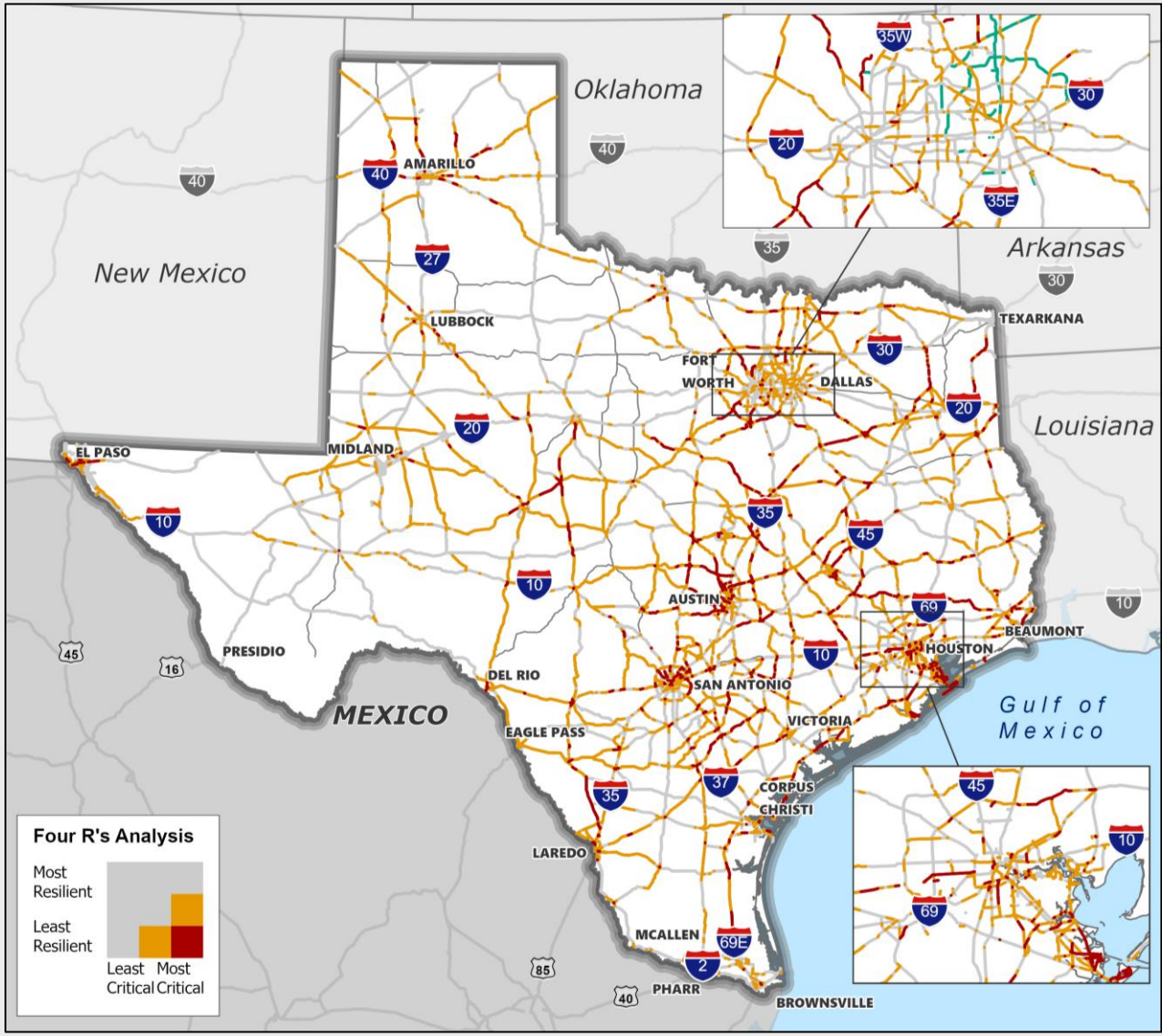
# Least Resilient/Most Critical Infrastructure can Define Areas of Greatest Need

## Segments by Resilience-Criticality Rating (miles)

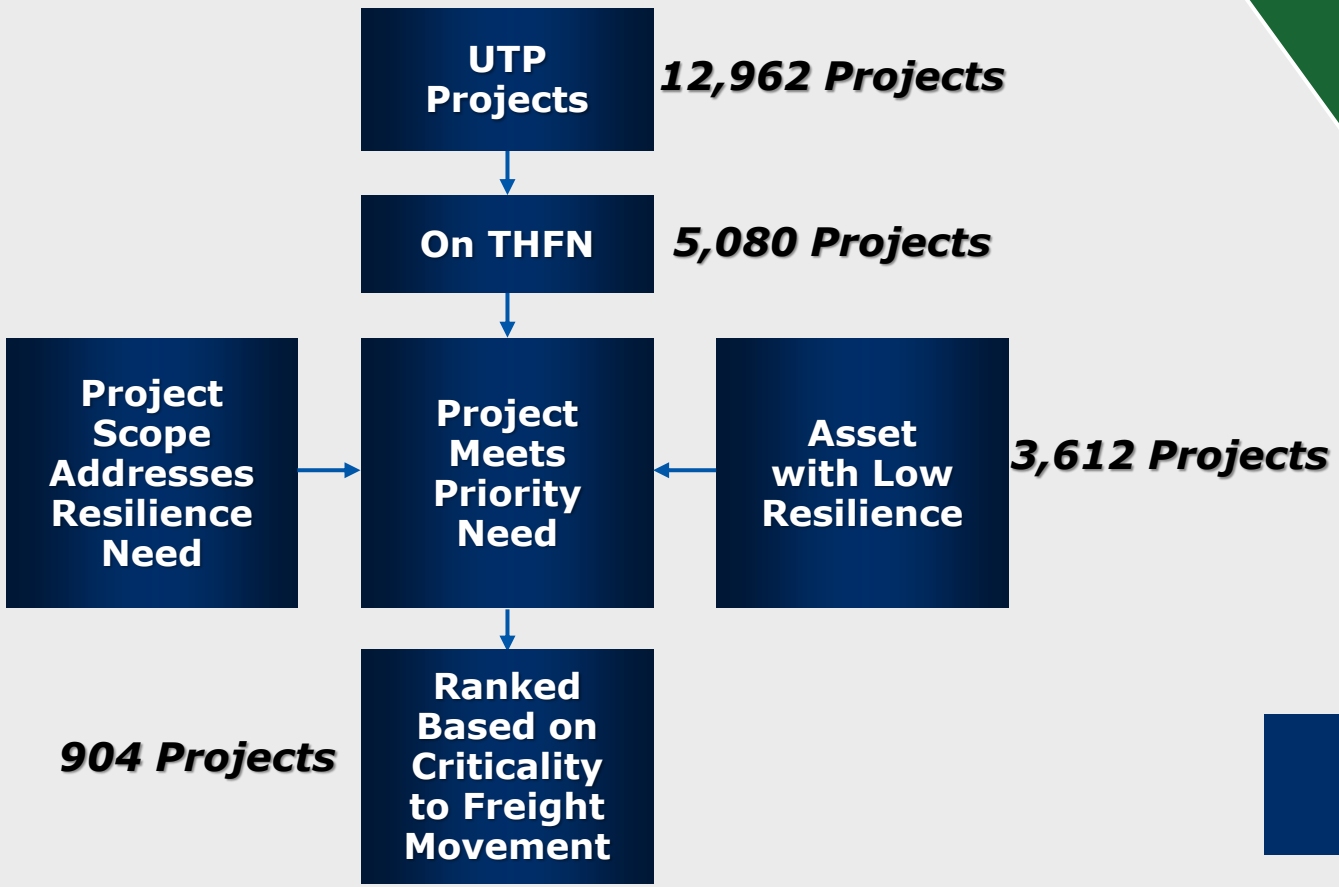


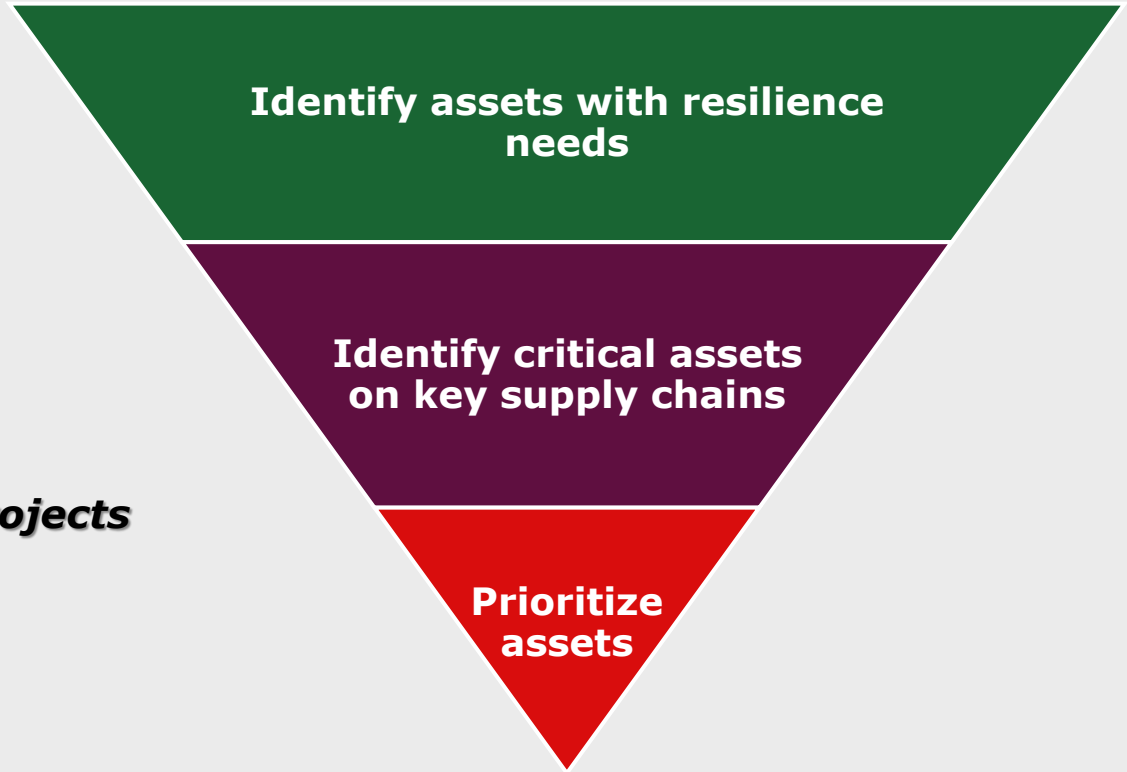

## Segments by Resilience-Criticality Rating (miles)



# Highway Project Identification & Gap Identification

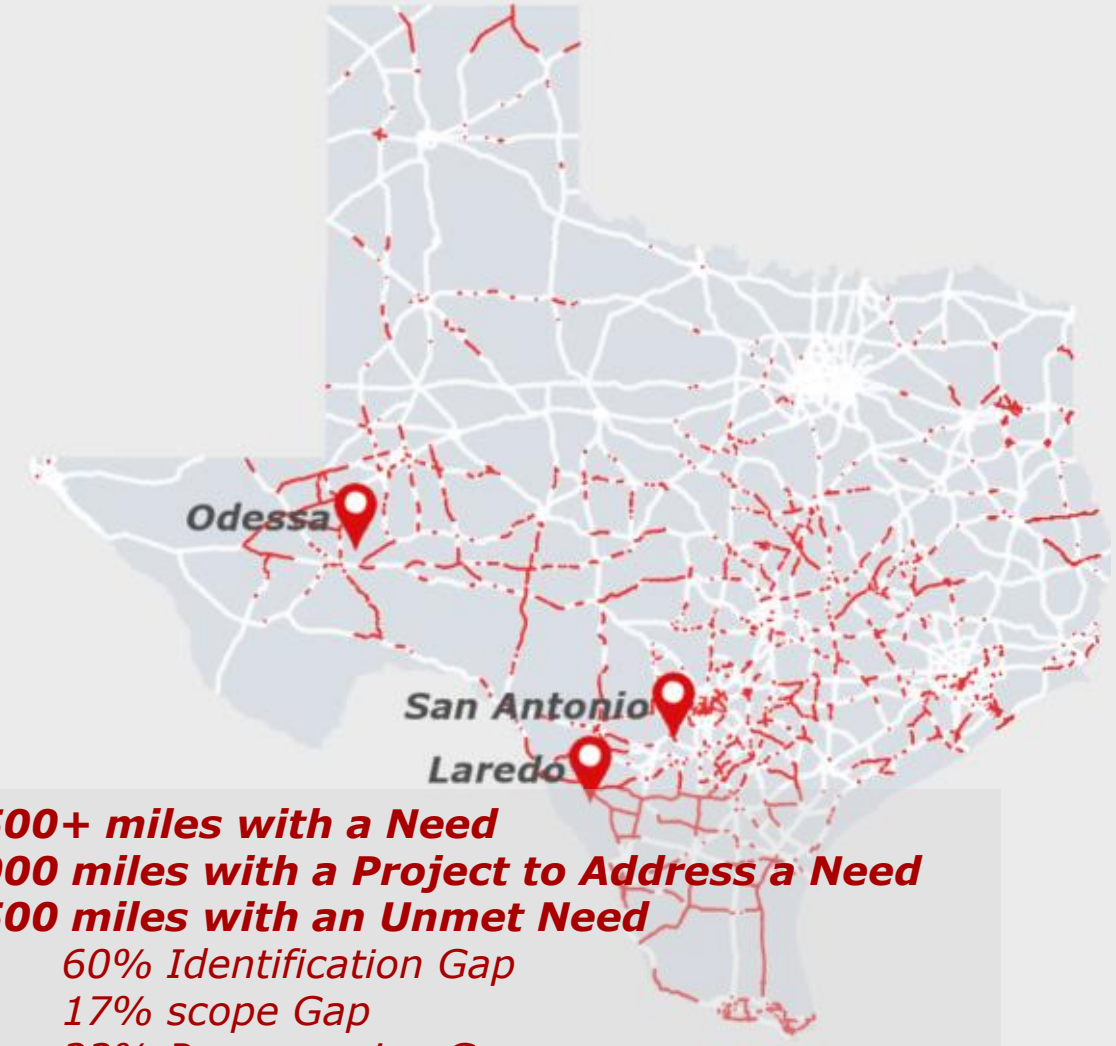



**Freight Resilience Priority Investments & Gaps**

# Unmet Resilience Needs on THFN vary by Resilience Need

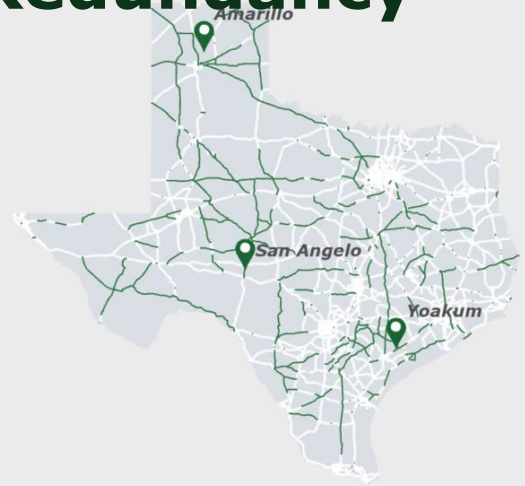
## Robustness



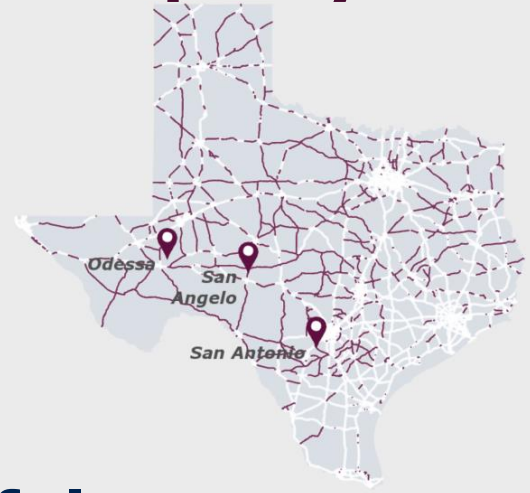

***6,500+ miles with a Need***
***2,000 miles with a Project to Address a Need***
***4,500 miles with an Unmet Need***

*60% Identification Gap*
*17% scope Gap*
*23% Programming Gap*

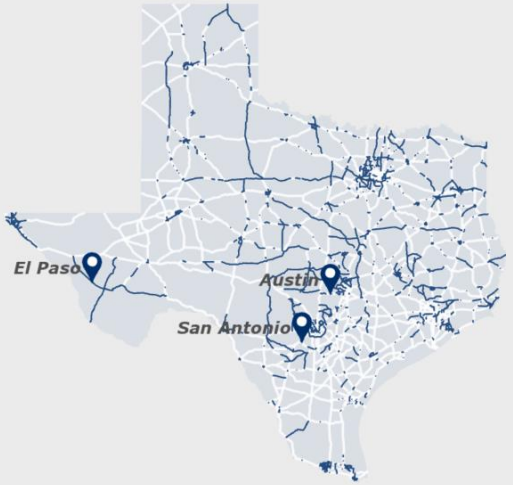
## Redundancy




## Rapidity




## Resourcefulness



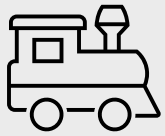
# Investment Examples based on the 4Rs - Highway

The type of investment is determined by each resilience need.

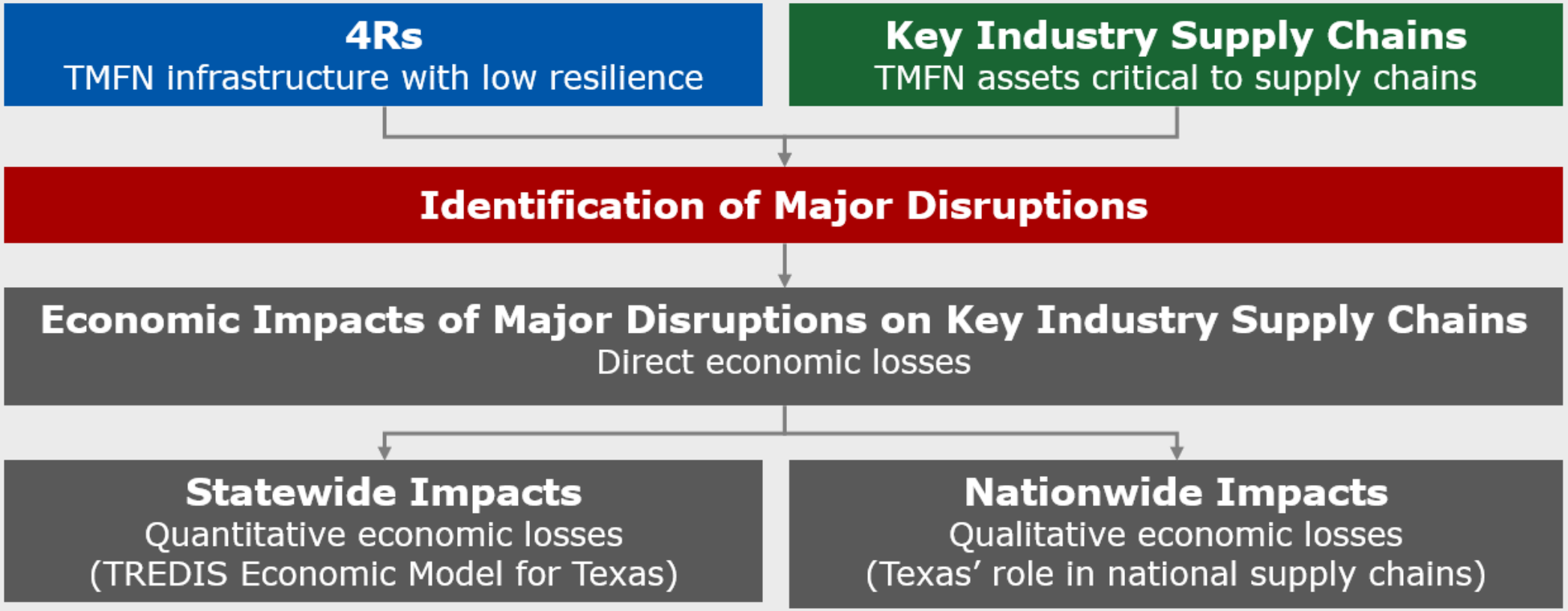
| Robustness<br>Vulnerability to climate disruptors | Redundancy<br>Risk of operational failures due to no backup options | Resourcefulness<br>Limited capacity to bring assets to a functional state | Rapidity<br>Limited ability to reduce freight downtime |
|---|---|---|---|
| • Flood mitigation projects<br>• Drainage improvement<br>• Elevating roadway; Slope stabilization | • Construct alternative or secondary routes<br>• Improve and expand evacuation route networks<br>• Increase connectivity and access to key supply chain assets | • Risk-based procurement for maintenance equipment and response resources<br>• Emergency preparedness plans based on site-specific risk profiles<br>• Right-of-way improvements (ROW) | • ITS systems deployment<br>• IT systems and enterprise improvement |
| **Example: Flood Mitigation Projects:** Incorporating bioswales into roadway designs near large freight hubs to manage stormwater runoff and reduce flood-related disruptions. | **Example: SH 99 Grand Parkway** project adds a third loop as a critical alternative freight corridor to I-10, I-610 and Beltway 8. | **Example: Dual-Use Truck Parking and Emergency Staging Areas:** Designated spaces that convert to support emergency response and resource staging efforts during disruptions. | **Example: Beaumont District TSMO Program Plan:** to install more climatized dynamic message signs, CCTV, and road weather information system sensors. |

# Investment Examples based on the 4Rs – Non-Highway

The type of investment is determined by each resilience need.

| | **Robustness**<br>Vulnerability to climate disruptors | **Redundancy**<br>Risk of operational failures due to no backup options | **Resourcefulness**<br>Limited capacity to bring assets to a functional state | **Rapidity**<br>Limited ability to reduce freight downtime |
|---|---|---|---|---|
|  | Raise and harden rail segments, access routes to intermodal facilities, or other infrastructure | Build additional tracks, sidings, and switches to enhance movements between rail lines | Increase asset capacity of existing yards or implement additional sites for rolling stock and equipment storage for operational flexibility | Enhance real-time monitoring and rapid response capabilities through integrated signaling systems and active rail crossings |
|  | Harden airport access routes, runways, and other infrastructure to minimize inland and coastal flooding impacts | Improve and/or extend runways to increase the number and variety of aircrafts and cargo handled | Increase cargo capabilities through apron expansion or warehousing facilities | Increase resources allocated to state of good repair and enhance maintenance facilities to reduce scheduled or unscheduled downtime |
|  | Raise and harden access routes, docks or other infrastructure to minimize inland and coastal flooding impacts | Improve on-site facilities to increase variety of cargo handled or deepening of channel | Enhance capabilities for cargo handling through port and capacity expansion | ITS coverage of seaports and other modes that integrate ports in monitoring and rapid response across modes |

# Measuring the Impacts of Not Planning Infrastructure Resilient to Disruptions



# Conclusions

- **4R** framework **helps** TxDOT's Freight Program **look beyond system vulnerability**
- A **supply chain lens helps translate the importance** of freight system resilience to the business community and consuming public
- The **FRP establishes freight resilience investment priorities** for state highway projects, and documents unmet needs by resilience need
- **Estimated economic losses** associated with disruptive events and closures **help tell the story** of why freight resilience matters
- **Final Freight and Supply Chain Resilience Plan Coming this Summer**

# Thank you!

## Contact info for the Freight & Supply Chain Resilience Plan

**Tyler Graham**
**Freight Systems Branch Manager**
**Texas Department of Transportation**
**tyler.graham1@txdot.gov**
**(512) 354-9278**

CAMBRIDGE SYSTEMATICS

Think Forward

# Freight Resilience Planning – Leveraging Opportunities and Applying Innovative Techniques

***TRB Webinar: Supply Chain Based Resilience Planning in the U.S.***

*presented to*

**TRB Webinar Attendees**


*presented by*

*Cambridge Systematics, Inc.*

*Suseel Indrakanti, AICP*


April 24th, 2025

# Discussion Outline

The Case For Freight Resilience Planning

Leveraging Opportunities

Applying Innovative Techniques And Data

Q&A

# The Case for Multimodal Freight Resilience

## *Freight by Numbers*

Freight Handled in 2023:

**20.1 billion tons**

Valued at **$18.7 trillion**
*(in 2017 dollars)*

Capital assets valued at **$8 trillion** in 2022

*Source: U.S. Department of Transportation, Bureau of Transportation Statistics. Transportation Statistics Annual Report 2024.*

## *Disruptions by Numbers*

Estimated weather-related delay costs to the trucking industry **$8 to $9 billion annually**

**32 billion lost vehicle hours per year**
(Weather-related disruptions on Trucking)

Port of Baltimore FSK Temporary Closure of Shipping Channel - Weekly supply chain cost of **$1.7 billion**

*Source: FHWA, Bureau of Transportation Statistics*

# Impacts of Disruptions on Freight and Supply Chains

## Infrastructure and Service Disruptions

- Delay and cancellations due to facility closures and disruptions
- Infrastructure loss and damage

## Impacts on Allied Sectors

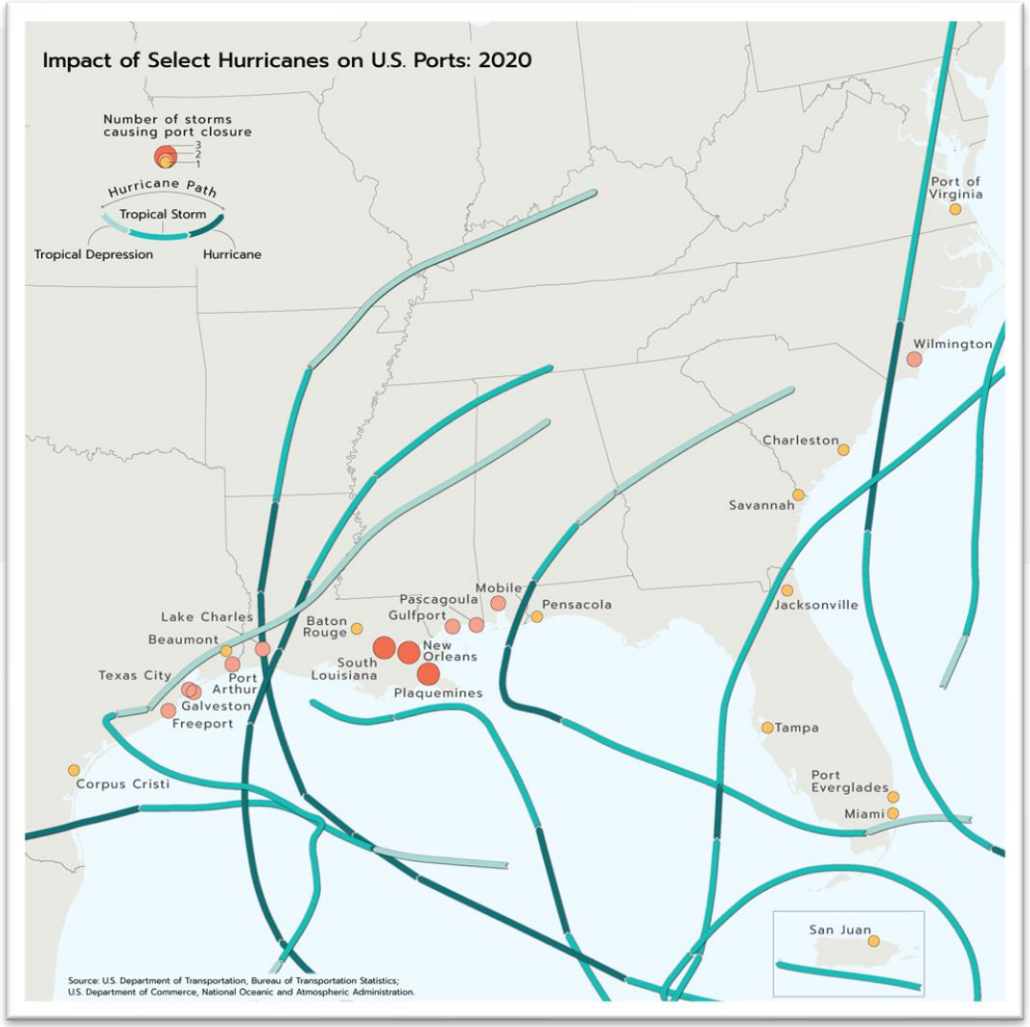
- Sourcing risk due to materials disruptions
- Manufacturing disruptions and delays

## Other Impacts

- Cascading impacts
- Contributing to market volatility

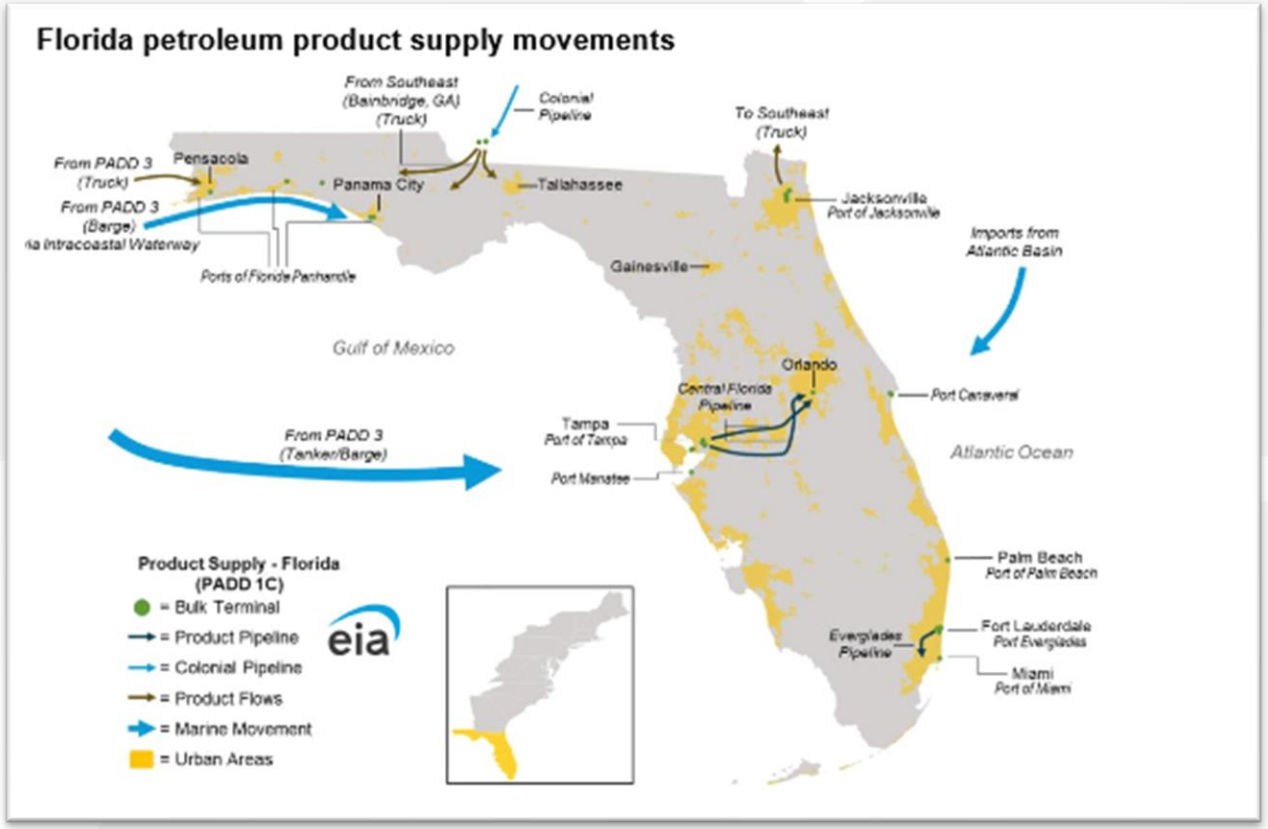
# Example Disruptions and Impacts – Ports

## Port Disruptions and Closures




*Source: U.S. Department of Transportation, Bureau of Transportation Statistics.*

## Disruptions to Energy Distribution




*Source: U.S. Energy Information Administration*



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# Freight Resilience Planning - Opportunities

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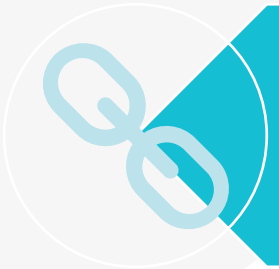
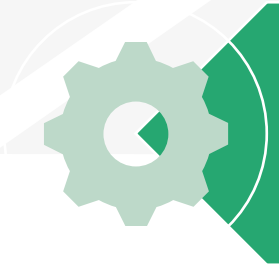
# Planning Opportunities



Integration into Freight Plans



Standalone Supply Chain Resilience Plans

Resilience Improvement Plans



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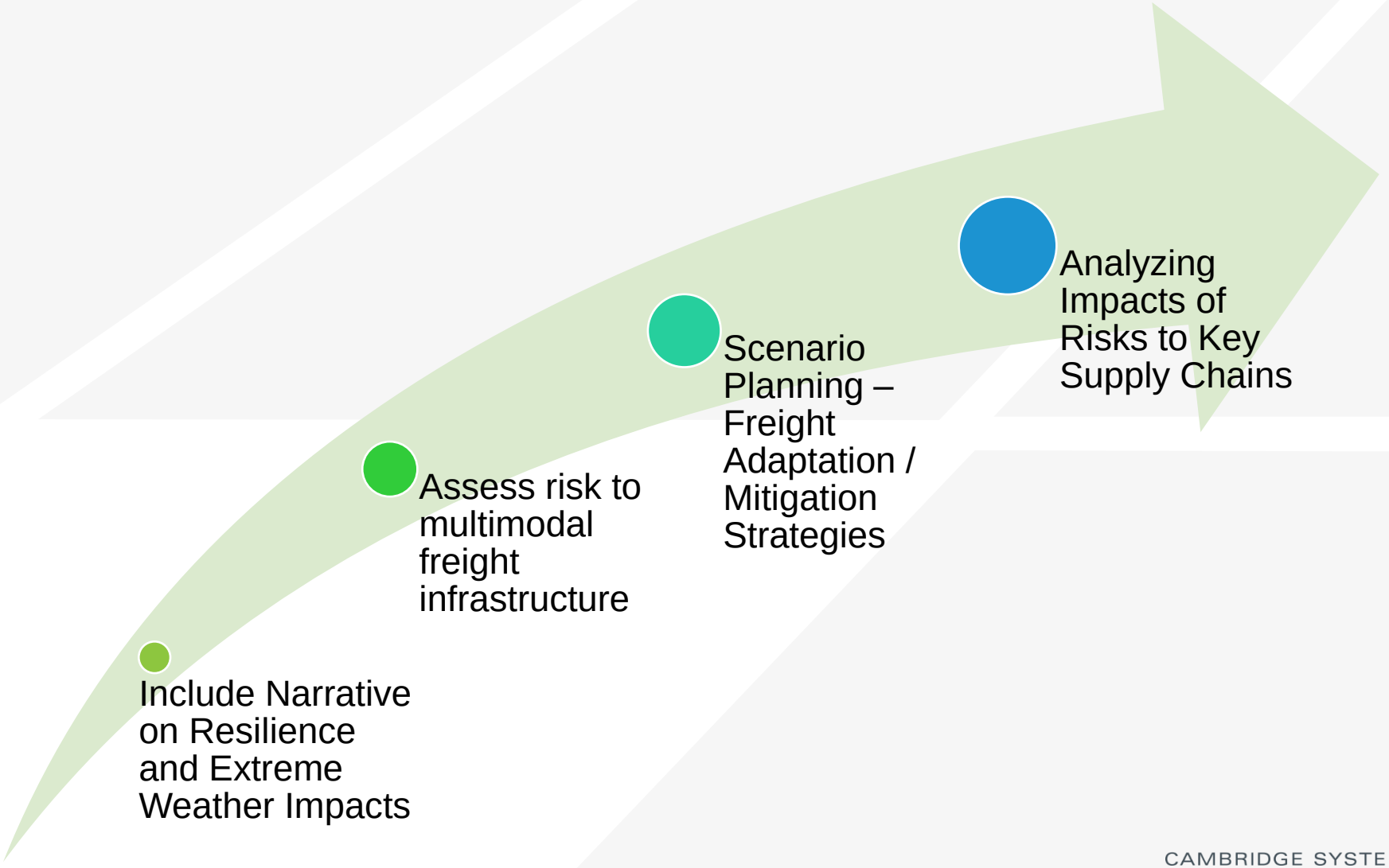
# Guidance on State Freight Plans and State Freight Advisory Committees (2023)

| | |
|---|---|
| Recommendations for State Consideration | *"…how the State is addressing climate change, which is increasingly affecting the safety, reliability, and resiliency of the freight transportation system through severe weather events and other impacts"* |
| | *"States are encouraged to leverage existing statewide resilience plans and strategies, as well as long-range statewide and metropolitan transportation plans, and apply those to a freight-specific context."* |
| | *"States are encouraged to consider nature-based improvements for resilience strategies in addition to strategies that harden existing infrastructure."* |
| | *"DOT strongly recommends that States consider including elements of that Resilience Improvement Plan, or by reference, if applicable, in their State Freight Plans."* |

# Potential Levels of Integration



# Guidance on State Freight Plans - Supply Chain Resilience

| | |
|---|---|
| Specifically, Regarding Supply Chain Resilience | *"DOT strongly encourages States to include a discussion of supply chain resiliency"* |
| | *"States should also consider freight policies and strategies that increase supply chain resilience in the State, particularly for the movement of critical products related to health, safety, energy, and food"* |
| | *"States may consider strategies to preemptively address these vulnerabilities to increase overall supply chain resilience."* |

# Leveraging Opportunities

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# Actions to Leverage Opportunities

**Identifying Objective And Purpose** in Defining Freight Resilience And Laying Out Intended Outcomes

**Assess The Vulnerability And Risk** Of Freight Transportation Infrastructure And Systems To Extreme Weather And Climate Effects

**Integrate Resilience And Adaptation** Considerations Into Transportation / Multimodal Freight Decision-making

**Maintain Robust Two-way Communication** to Seek Input And Inform Stakeholders On Planning And Investment Decisions

# Objective and Purpose

**Representation in Resilience Planning**

Freight Staff and Modal Partners

**A Resilient Multimodal Freight System**

Goals, Objectives, Measures

**Vision for Integration into Business Processes**

Outcomes for Funding and Prioritization

# Vulnerability and Risk Assessment

Exposure - Stranded freight - perishable goods

Understanding mode-specific vulnerabilities (Port vs Access Roads)

Adaptive Capacity and Detour Potential (weight limits and mode switching)

Including reliability costs (lost revenue, wages, mode operation costs) in consequence analysis

# Integration and Management Decisions

Identifying freight-specific adaptation strategies

Determine risk tolerance for multimodal facility disruptions

Include freight reliability costs into investment decisions

Scenario planning for developing strategies

Prioritizing freight corridors for project prioritization

# Innovative Techniques and Data

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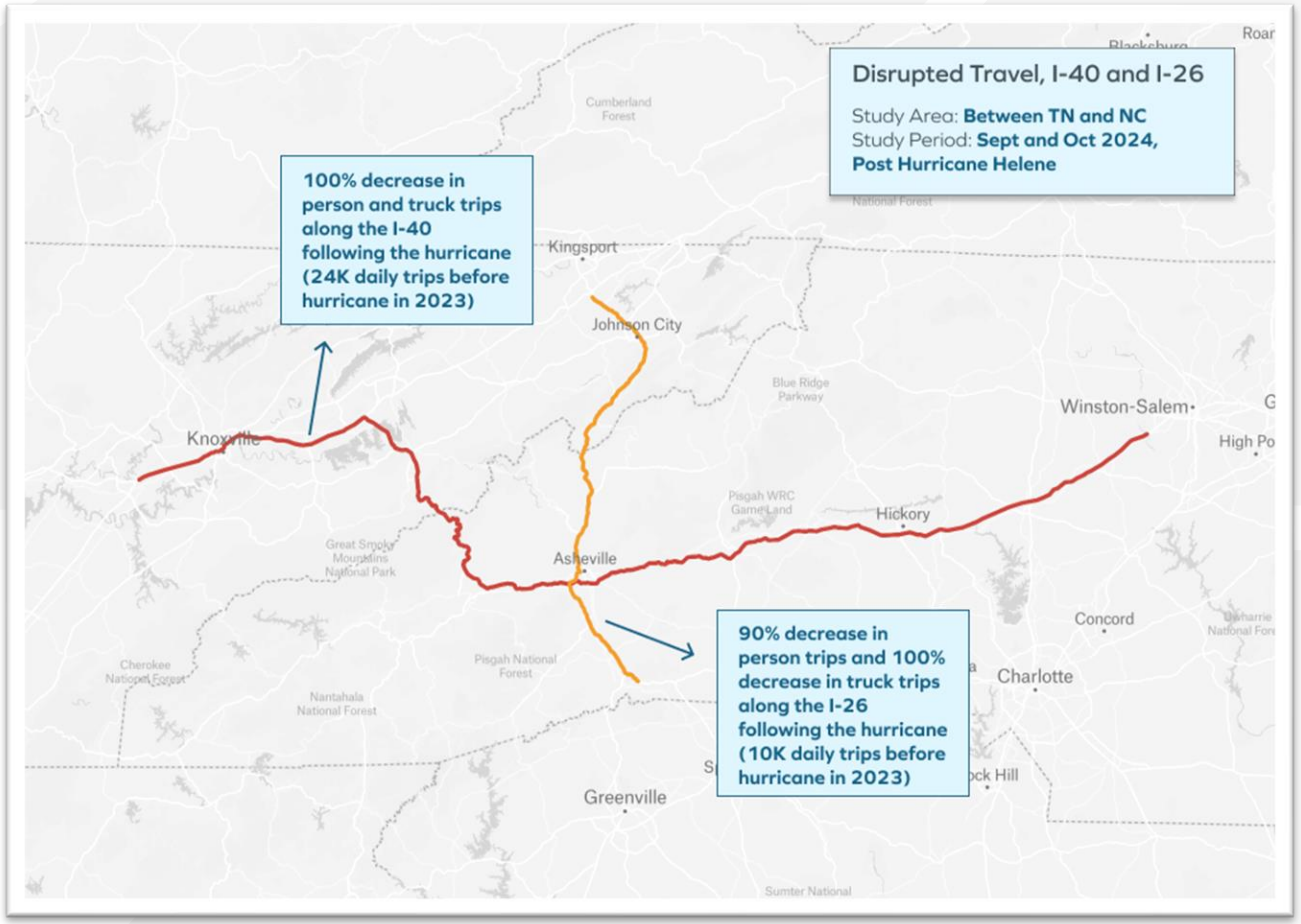
# Techniques and Data

Data and Insights

Assessment Methods, Metrics

# Use of Telematics and Location-Based Services Data

- Local and inter-regional disruptions from the hurricane
- Planning for an examining the impacts of detours
- Community recovery metrics
- Travel patterns and facility usage




*Source: LOCUS, Inc.*



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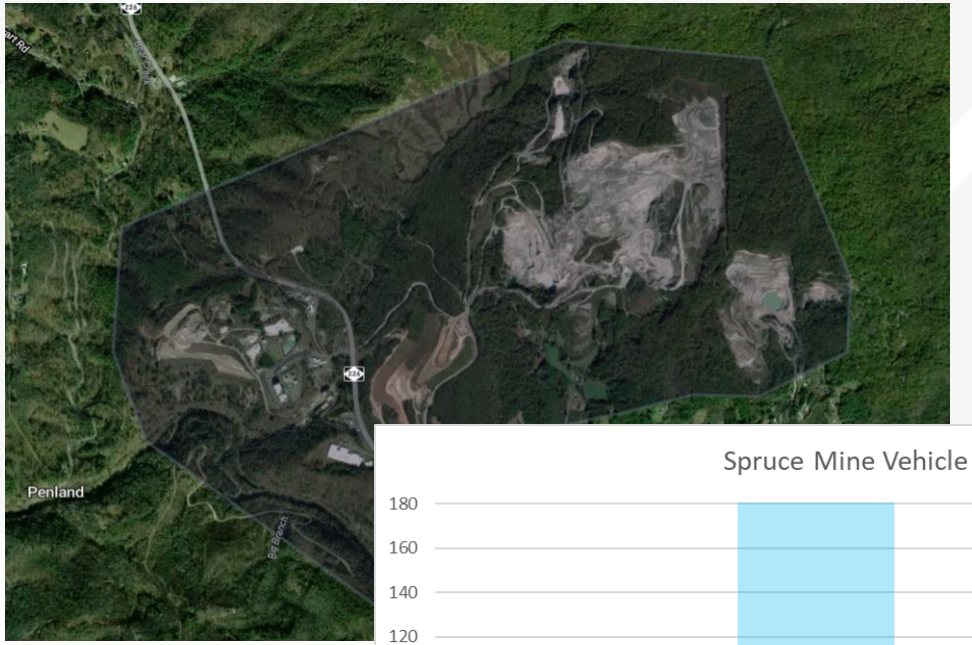
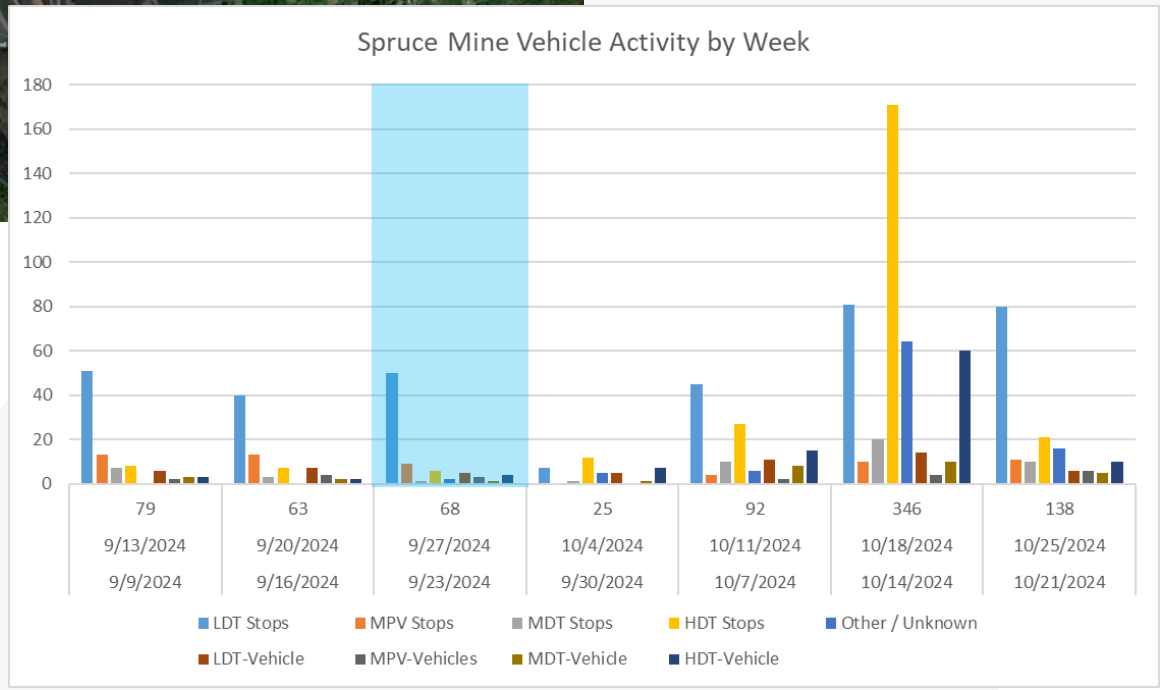
# Geofencing Critical Supply Chain Facilities

- Spruce Pine mine, NC – Global Significance in Semi Conductor Supply Chain.
- Ultra Pure Quartz – Silicon Wafers - Microchips and Solar Panels
- Analysis of Commercial Truck Movement Before/After Hurricane Helene

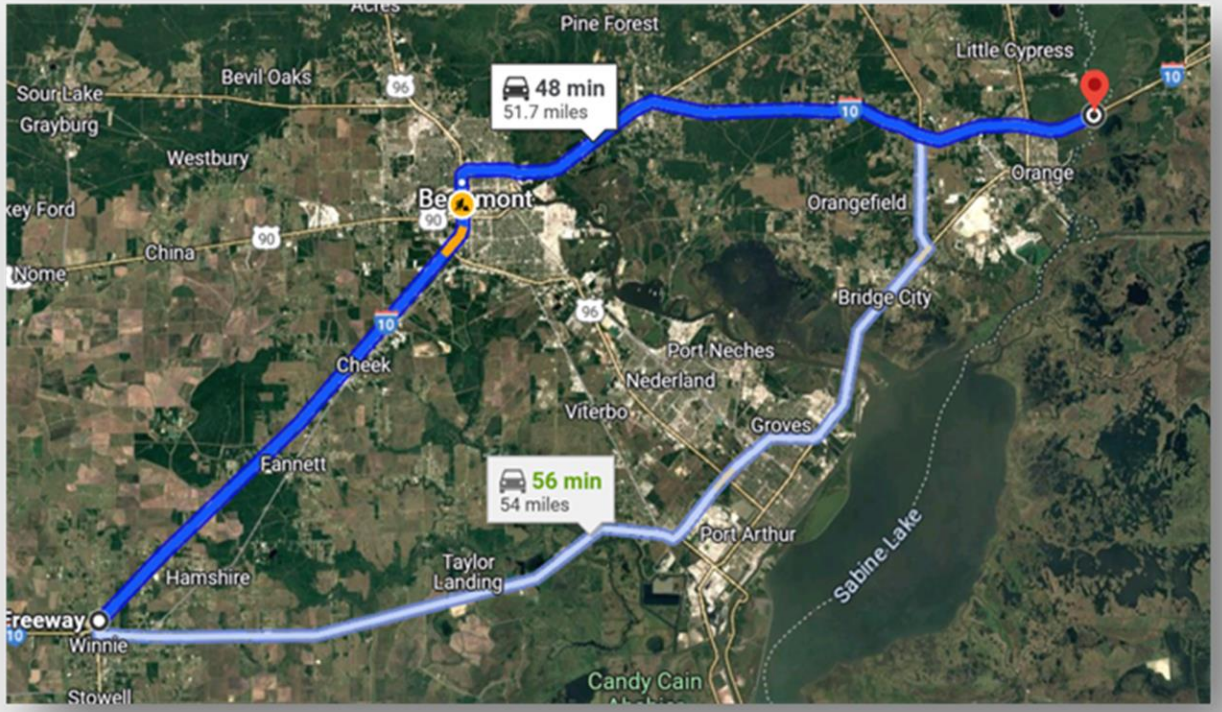



*Source: LOCUS, Inc.*



# Corridor Disruption Example

- Texas – Louisiana Border (I-10 corridor)
- Hurricane Beryl
  - » 1 week during “normal operations” (June 17 – July 1) before Hurricane Beryl
  - » 1 week from landfall day for Hurricane Beryl (July 8 – July 15, 2024)




| O/D | LA - Calcasieu | LA - Jefferson Davis | LA - Allen | LA - Cameron | LA - Beauregard | TX - Jefferson | TX - Harris | TX - Chambers | TX - Orange | TX - Hardin | TX - Liberty | TX - Jasper | TX - Galveston | TX - Newton | TX - Montgomery | TX - Brazoria | TX - Polk | TX - Tyler | TX - San Jacinto |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| LA - Calcasieu | | | | | | 7% | -4% | 18% | 44% | -19% | 19% | -13% | 200% | 0% | 92% | 50% | | | |
| LA - Jefferson Davis | | | | | | 44% | 7% | 7% | | | -100% | | | | -11% | | | | |
| LA - Allen | | | | | | | -62% | | | | | | | | | | | | |
| LA - Cameron | | | | | | | | | | | | | | | | | | | |
| LA - Beauregard | | | | | | | -100% | | | | | | | | | | | | |
| TX - Jefferson | 4% | -9% | | | | -12% | -18% | -3% | -27% | -3% | 81% | 11% | -22% | -62% | 58% | -11% | -33% | -53% | |
| TX - Harris | -14% | -26% | -100% | | -33% | -25% | -100% | -33% | -44% | -19% | | -14% | -100% | | | | | | |
| TX - Chambers | -14% | -5% | | | | -11% | | 222% | 83% | 83% | | 91% | | | | | | | |
| TX - Orange | 11% | | | | | -17% | -27% | -9% | 1% | -64% | 0% | -10% | | -100% | -100% | -100% | | | |
| TX - Hardin | 138% | | | | | -37% | -17% | 175% | -44% | | | | | | | | | | |
| TX - Liberty | -15% | | | | | -2% | | | -25% | | | | | -100% | | | | | |
| TX - Jasper | -56% | | | | | -10% | -68% | 200% | -35% | | | | | | | | | | |
| TX - Galveston | 60% | | | | | 9% | -62% | 267% | | | | | | | | | | | |
| TX - Newton | 13% | | | | | -53% | | | 0% | | | | | | | | | | |
| TX - Montgomery | 8% | | | | | -47% | | | | | | | | | | | | | |
| TX - Brazoria | -25% | | | | | 50% | | | | | | | | | | | | | |
| TX - Polk | | | | | | | | | | | | | | | | | | | |
| TX - Tyler | -100% | | | | | -57% | | | | | | | | | | | | | |

*Source: LOCUS, Inc.*



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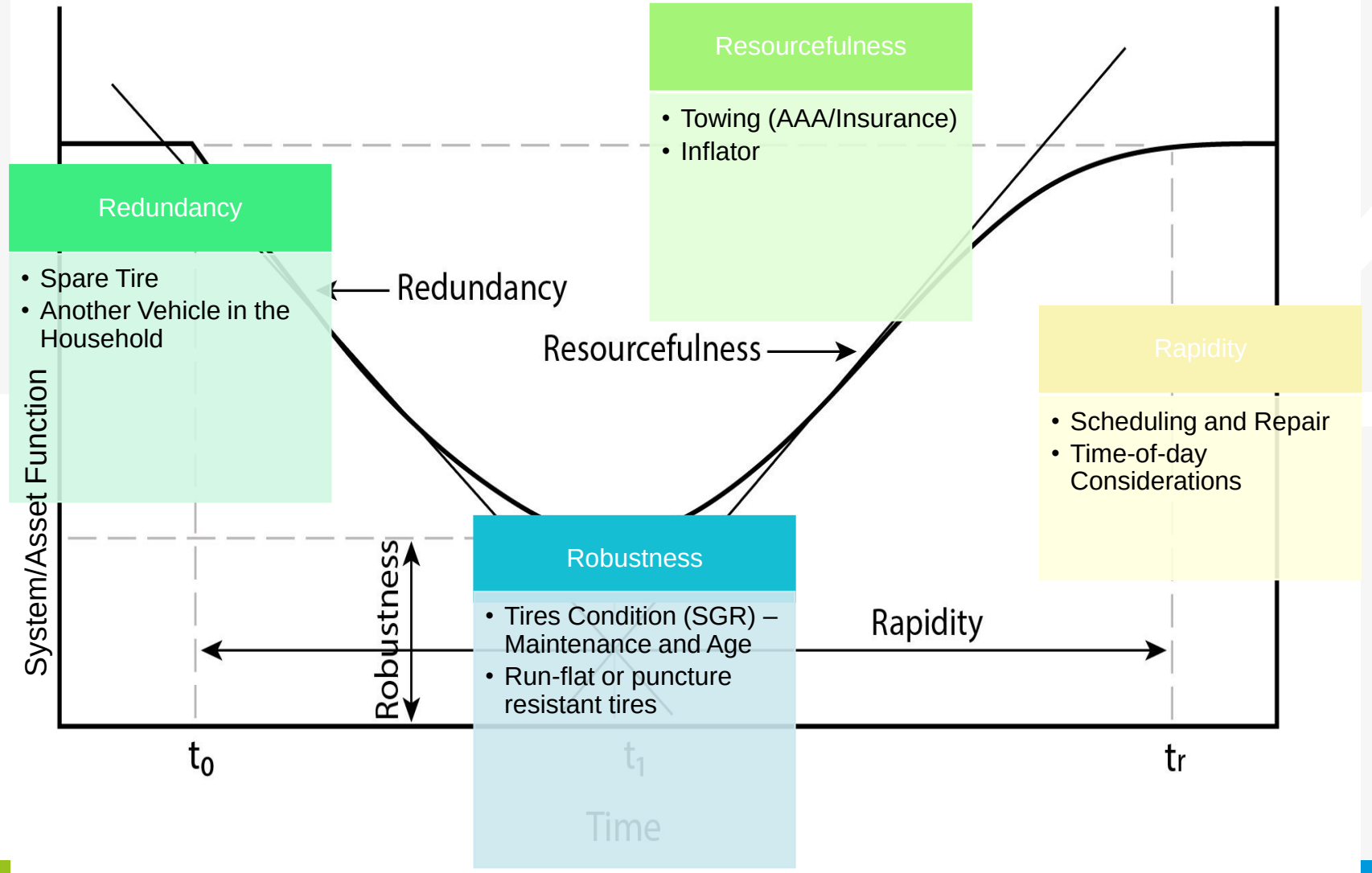
# Measuring Freight Resilience




The Flat Tire Analogy



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# Thank You!


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**April 28, 2025**

TRB Webinar: Urban and Rural Freight Movement—Statewide Corridor Considerations

**April 30, 2025**

TRB Webinar: Implementation of UAS into Transportation Infrastructure Inspection

https://www.nationalacademies.org/trb/events

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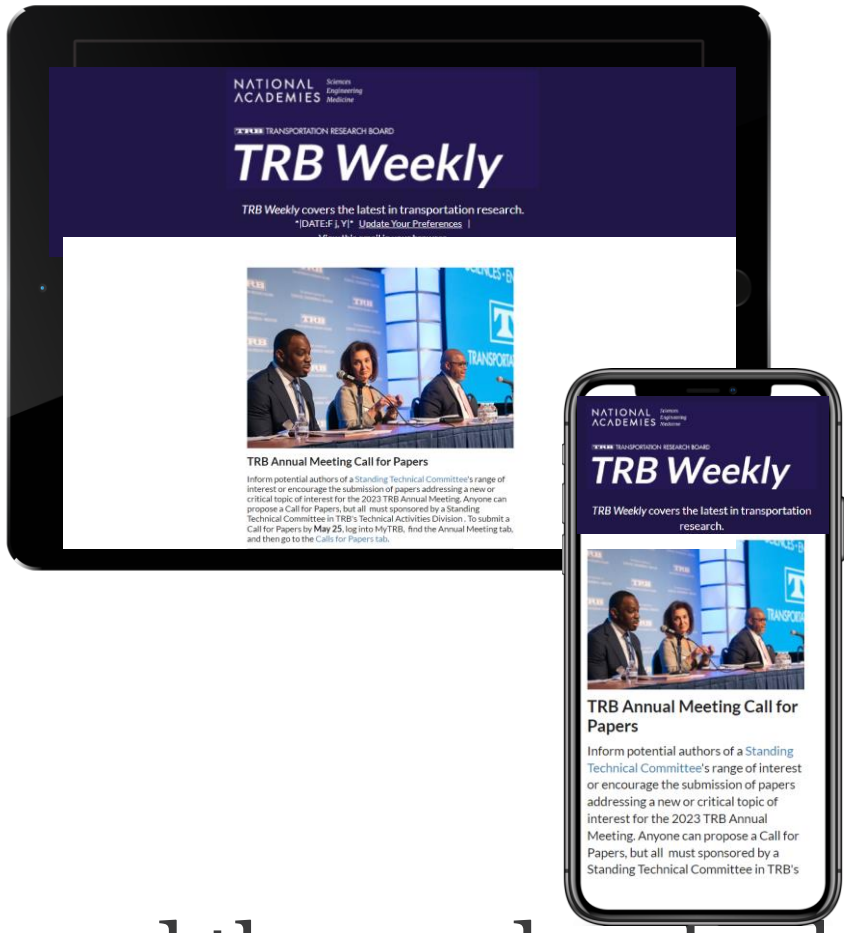


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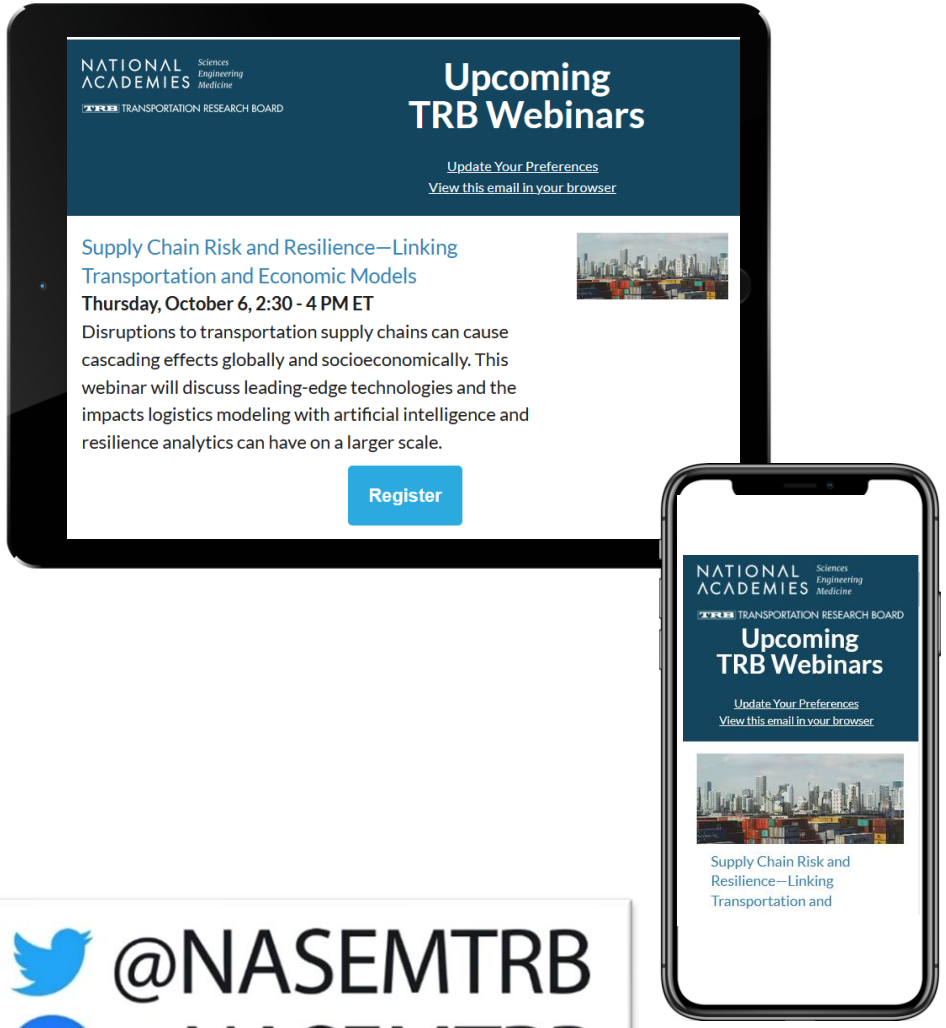


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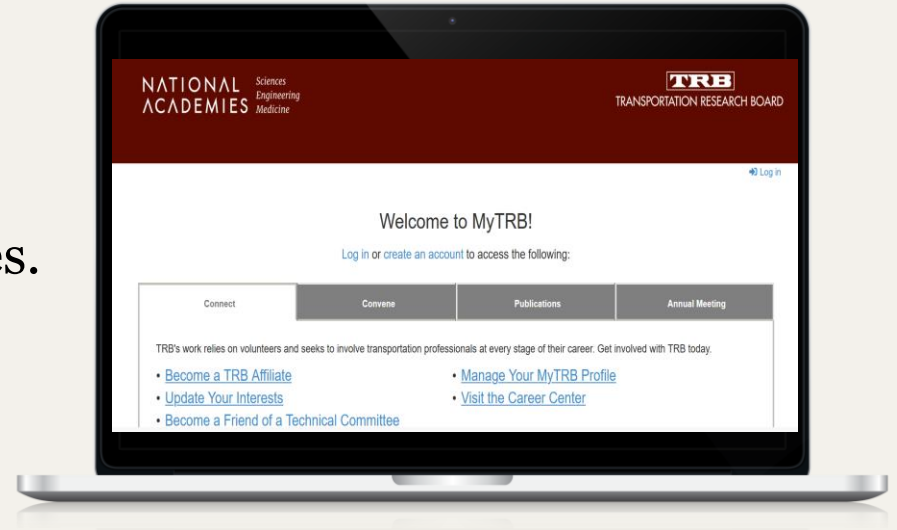


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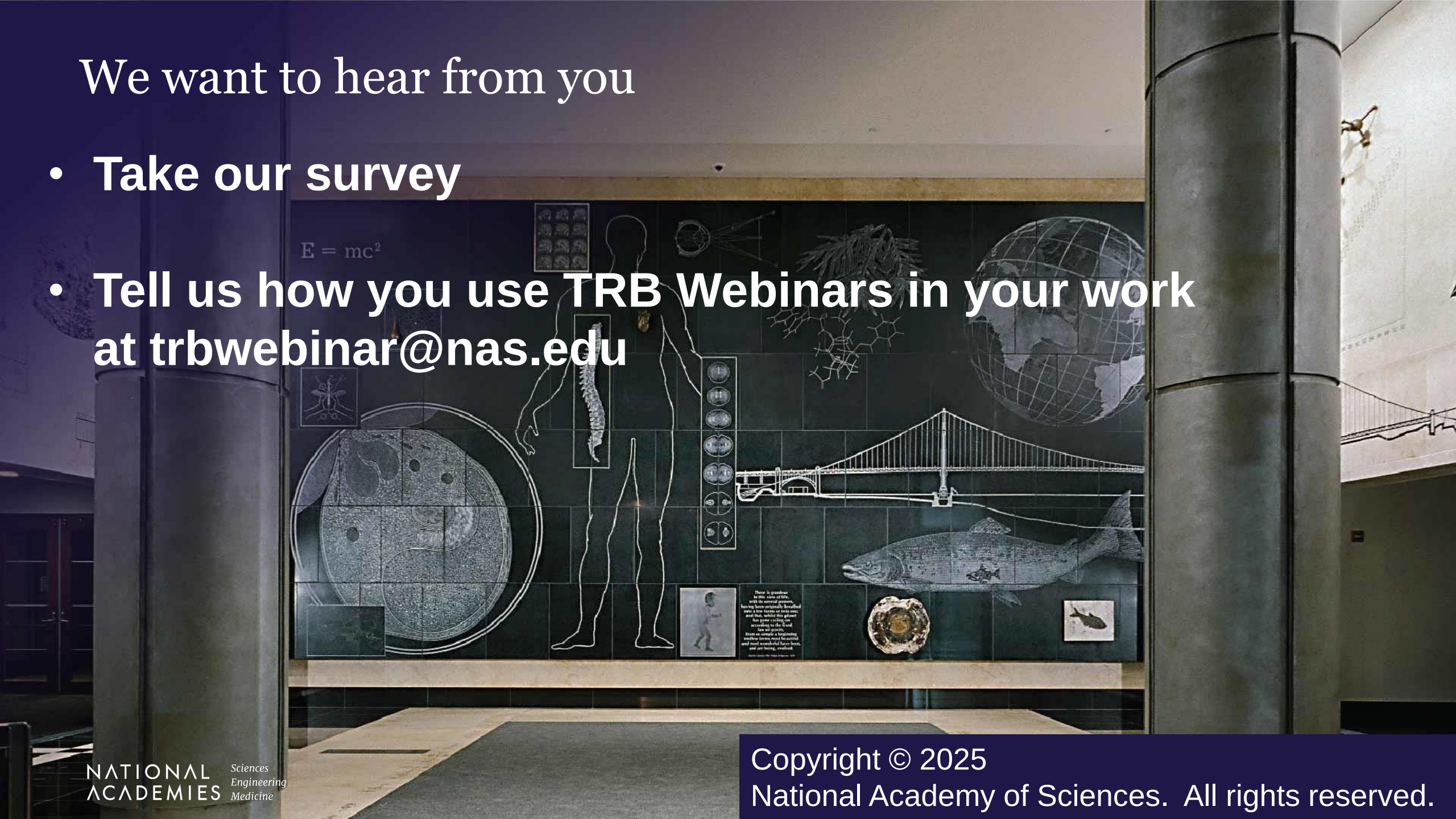


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