CHAPTER 11 – RESILIENCE AND SECURITY

This Technical Memo 3: Criticality Framework (TM3) builds on the previous two technical memos. Tech Memo 1: Network Definition (TM1) analyzed existing regional resiliency work to identify assets generally considered in resiliency analyses. Tech Memo 2: Hazard Definition (TM2) incorporated the relevant natural hazards which have been included in similar resiliency planning efforts. TM3 details the criticality criteria that will be employed to prioritize the transportation assets in the Corpus Christi MPO region. The TM3 outline is as follows: Literature Review, Data Assessment, Criticality Framework, and Implementation Recommendations. Appendix II: Additional Resources summarizes other topical but not directly relevant resources (which may be used in future stages of the analysis).

Project Context

The Corpus Christi Metropolitan Planning Organization (Corpus Christi MPO) and its region face a unique combination of natural hazards including a dry, non-freeze southern Texas climate and its location in 'hurricane alley' along the Gulf Coast. The ability to continue and or quickly restore transportation operations in the face of such hazards can save lives and protect critical and costly infrastructure investments and is therefore of central concern to the Corpus Christi MPO. As evidenced Hurricane Harvey in 2017 - which destroyed or severely damaged 80 percent of homes and buildings in Rockport, Fulton, Bayside, Aransas Pass, and Port Aransas [Texas A&M Corpus Christi, 2018] – there is a critical need for more resilient infrastructure in the region.

To proactively make the system more resilient and mitigate potential consequences of known environmental risks and hazards, the Corpus Christi MPO has contracted with the High Street Consulting Group (High Street) to make progress toward developing a regional Resiliency Improvement Plan by completing a Phase 1 analysis. Phase 1 will identify and prioritize an initial set of assets based on existing data related to their vulnerability to hazards and criticality. This in turn will help position Corpus Christi MPO and its partner agencies to tactically pursue federal PROTECT grants that can help fund identified improvements to its vulnerable assets. The PROTECT Formula and Discretionary Grant Programs (1) provides formula funding to states for resilience improvements, (2) distributes competitive planning grants to enable communities to assess vulnerabilities to current and future weather events, natural disasters and changing conditions, and plan transportation improvements and emergency response strategies to address those vulnerabilities, and (3) distributes competitive resilience improvement grants to protect surface transportation assets, coastal infrastructure, natural infrastructure, and communities.

Task Overview

This Technical Memo 3: Criticality Framework (TM3) builds on the previous two technical memos. Tech Memo 1: Network Definition (TM1) analyzed existing regional resiliency work to identify assets generally considered in resiliency analyses. Tech Memo 2: Hazard Definition (TM2) incorporated the relevant natural hazards which have been included in similar resiliency planning efforts. TM3 details the criticality criteria that will be employed to prioritize the transportation assets in the Corpus Christi MPO region. The TM3 outline is as follows: **Literature Review, Data Assessment, Criticality Framework,** and **Implementation Recommendations. Appendix II: Additional Resources** summarizes other topical but not directly relevant resources (which may be used in future stages of the analysis).

ASSET DEFINITIONS

The definitions of the assets identified in this resource review and therefore included in the technical memorandum are listed below[1].

Roadways: physical infrastructure designed and built to accommodate passenger and freight vehicular, bicycle, and pedestrian traffic. Roadway assets review covers roads on and off system as well as evacuation routes.

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1 Asset type nomenclature varies among plans and resources; the High Street Team grouped similar or analogous asset names together as illustrated in Appendix I: Asset Type Crosswalk.

Railways: networks of tracks and associated structures that enable the movement of trains, which can carry passengers, freight, or both.

Airports: aviation facilities designed to accommodate the arrival, departure, and maintenance of aircraft. The review encompasses various types of aviation facilities including public airports, private airports, and heliports.

Bridges: structures built to span physical obstacles, such as rivers, valleys, or roads, providing a passage for vehicles, pedestrians, and sometimes railways. Bridges included in this document research include bridges that are part of the National Bridge Inventory (NBI), which have spans over 20 ft, and non-NBI bridges.

Seaports: areas along coastlines or navigable waterways where ships can dock to load and unload cargo and passengers. Seaports review covers maritime facilities, waterways, and ports facilities including both shallow and deep draft ports.

Large and Small Culverts: tunnels or pipes that allow water to flow under roads, railways, or other structures. The literature review sections below do not consistently distinguish culverts based on their sizes, so they are referred to as merely culverts. However, the data assessment sections report data availability for the two culvert categories, large and small, which have span greater than and less than or equal to 20 feet, respectively.

Oil and Gas Pipelines: systems for transporting petroleum products, natural gas, and other fluids. Oil and gas pipelines review includes pipelines carrying various commodities such as crude oil, anhydrous ammonia, natural gas, and refined liquid products.

Transit Facilities: stations and routes of the public transportation system that are used to move people from one place to another. Transit facilities cover various modes such as buses, subways, trams, and light rail.

Low Water Crossings: low-elevation roadways traversing over a body of water that stays dry above the water when the flow is low and are designed to be submerged under high-flow conditions, such as floods.

Ferry Facilities: stations where ferries, which are vessels that transport passengers and vehicles across bodies of water, dock and embark/disembark passengers and vehicles. The ferry facilities review includes terminals and routes.

ITS/Ancillary Assets: Intelligent Transportation Systems (ITS) and ancillary assets refer to technologies and equipment used to improve transportation safety, efficiency, and coordination. This includes traffic signals, cameras, electronic signs, sensors, communication systems, and data management tools.

HAZARD DEFINITIONS

The following relevant hazards and definitions were identified through the literature review:

Coastal Erosion: the loss of land, marshes, wetlands, beaches, or other coastal features within the coastal zone because of the actions of wind, waves, tides, storm surges, subsidence, or other forces.

Dam and Levee Failure: A dam is a barrier that is constructed to hold back water. A dam failure is a systematic failure of a dam structure resulting in the uncontrolled release of water, often resulting in floods that could exceed the 100-year floodplain boundaries. A levee is an embankment built to prevent overflow from a body of water. A levee failure is when a levee embankment fails, or is intentionally breached, causing the previously contained water to flood the land behind the levee.

Drought: a natural reduction in the amount of precipitation expected over an extended period of time, usually a season or more in length.

Expansive Soil: soils and soft rock that tend to swell or shrink due to changes in moisture content.

Extreme Heat/Heat Wave: a combination of very high temperatures and, usually, exceptionally humid conditions. When persisting over a period of time (generally more than two days), it is called a heat wave.

Flooding: the accumulation of water within a water body and the overflow of excess water into adjacent floodplain lands. Types of floods include:

Coastal Flooding/Storm Surge: areas at risk of flooding when sea water surges inland from tropical storm events/an abnormal rise of water generated by a storm over and above the predicted astronomical tide.

Riverine Flooding: areas at risk of flooding when rivers and creeks come out of their banks.

Land subsidence/Landslides: the loss of surface elevation due to the removal of subsurface support. It can range from broad, regional lowering of the land surface to localized, full-blown collapses. Land subsidence occurs in different areas for different reasons. A sinkhole is a category of subsidence.

Lightning: a massive electrostatic discharge between electrically charged regions within clouds, or between a cloud and the Earth's surface.

Sea Level Rise: an increase in the level of the world's oceans.

Strong Wind: a storm with high winds or violent gusts with little or no rain. The windstorm hazard excludes extreme wind events that occur with other wind-related natural hazards such as hurricanes, tropical storms, and tornados.

Wildfire: a sweeping and destructive conflagration and can be further categorized as wildland, interface, or intermix fires. Wildland fires are fueled almost exclusively by natural vegetation wildland/urban interface (WUI) fires include both vegetation and the built environment. The wildfire disaster cycle begins when homes are built adjacent to wildland areas.

RESOURCE REVIEW

Resiliency is an emerging and important topic that has garnered increased attention and has new funding programs associated with it (such as PROTECT); as a result, agencies from federal to regional and local have developed resiliency plans, studies, and programs, as well as provide databases and GIS files ("resources"). Therefore, to understand which transportation assets and hazards the Corpus Christi MPO should consider including in its inaugural Resiliency Improvement Plan, the project team documented which asset types have been considered most frequently and has available data. The High Street team reviewed a total of 36 resources covering a range of geographies, as illustrated in Figure 1.

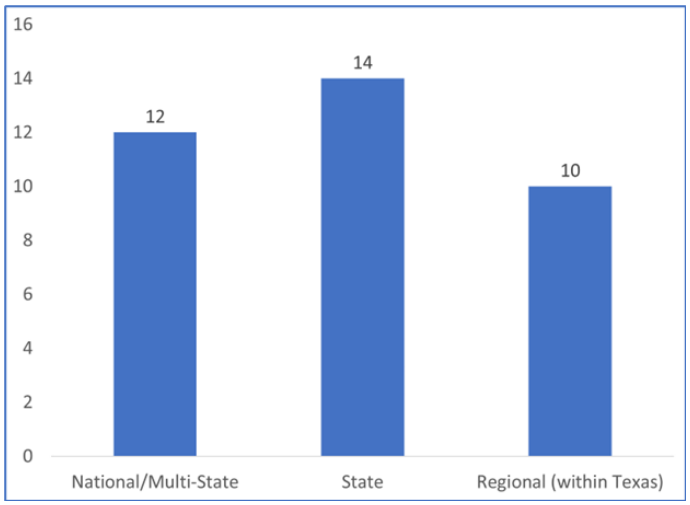


Figure 1: Resources by Geographical Coverage

LITERATURE REVIEW

The literature review identifies which assets and hazards are considered in relevant plans, programs, and studies. There is sometimes overlap and agreement among resources, and they can often differ in their scope, methodology, terminology, and focus. The literature review covers the following:

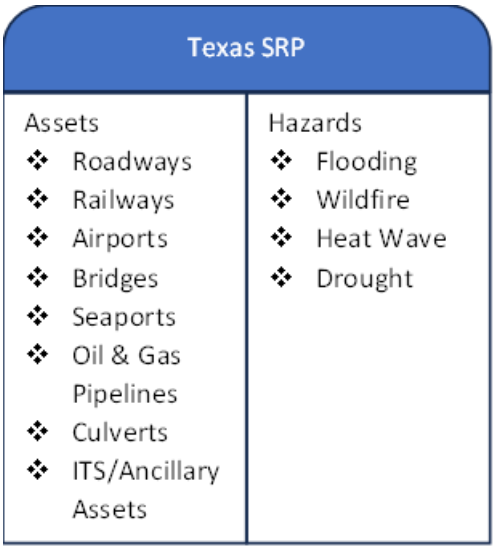
- resiliency plans and programs in Texas such as the Regional Resilience Partnership for Coastal Bend regional counties, Texas Department of Transportation (TxDOT) Statewide Resiliency Plan, vulnerability assessment reports for the Austin and Dallas metropolitan areas; and
- emergency plans from Corpus Christi, Nueces County, and other research entities and government agencies.

The following section details the resources considered and summarizes the assets referenced. It also provides a foundation for further work on identifying hazard types and criticality criteria.

RESILIENCY PLANS AND PROGRAMS IN TEXAS

TxDOT Statewide Resiliency Plan (SRP)

The Texas Statewide Resiliency Plan began in December 2022 and is slated to finish in the Summer of 2024. This ongoing effort aims to proactively manage and assess future transportation system disruptions due to extreme weather events. This includes identifying critical infrastructure and hazards, evaluating the vulnerability of these infrastructure assets to the hazards, and accordingly developing strategies to improve resilience. The SRP includes a balance of a science-based approach and stakeholder and public involvement. The SRP will satisfy Texas' Infrastructure Investment and Jobs Act PROTECT requirements and serve as a resource for state and local agencies to pursue further funding. The TxDOT SRP website lists the types of assets and hazards that will be analyzed in the plan.



TxDOT Statewide Freight Resiliency Plan, Stage 1: Prepare the Freight System

TxDOT developed the Statewide Freight Resiliency Plan to prepare, detect, respond to, and recover from events, which include natural disasters, terrorist incidents, or infrastructure failure. Specifically, the purpose of this study is to "assess the resilience of the strategic freight system in Texas when an event of extended duration limits freight mobility, resulting in prioritized infrastructure enhancements to keep freight moving." Stage 1 of the Plan, released in 2011, focuses on understanding the existing system's preparedness. The report identifies relevant freight infrastructure and hazards before analyzing resiliency. Stage 2, also released in 2011, primarily focuses on the freight communication network. The Statewide Freight Resiliency Plan analyzes the assets relevant to Texas' Freight System, which are included in the call-out box. Additionally, the Plan provides a matrix of hazards considered.

Statewide Freight Resiliency Plan

Assets	Hazards
❖ Roadways	❖ Flooding
❖ Railways	❖ Wildfire
❖ Airports	❖ Strong Wind
❖ Seaports	❖ Land Subsidence/ Landslides
❖ Oil and Gas Pipelines	

Central Texas Extreme Weather and Climate Change Vulnerability Assessment of Regional Transportation Infrastructure

This 2015 report was part of a series of Federal Highway Administration (FHWA) grant pilot studies meant to establish best practices for assessing transportation infrastructure vulnerability to climate change and extreme weather, as well as determine strategies for improving resiliency. Specifically, the Capital Area Metropolitan Planning Organization (CAMPO) and the City of Austin Office of Sustainability assess the potential vulnerability of a limited number of critical transportation assets in the CAMPO region to the effects of extreme weather and climate. The report discusses the transportation data considered before assessing criticality, sensitivity, and vulnerability to natural hazards.

Central Texas Extreme Weather and Climate Report

Assets	Hazards
❖ Roadways	❖ Flooding
❖ Railways	❖ Wildfire
❖ Airports	❖ Strong Wind
❖ Bridges	❖ Land Subsidence/ Landslides
❖ Transit Facilities	

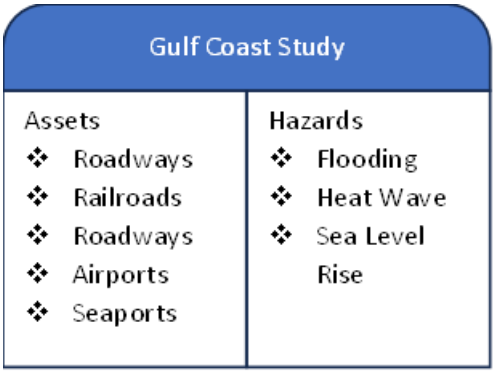
Climate Change/Extreme Weather Vulnerability and Risk Assessment for Transportation Infrastructure in Dallas and Tarrant Counties

The University of Texas Arlington created this report in 2015 for the North Central Texas Council of Government, a voluntary assortment of local governments and districts, and the MPO for the Dallas-Fort Worth metropolitan regions. The main objectives of this study are to assess how extreme weather events could affect the transportation infrastructure of North Central Texas, focusing on Dallas and Tarrant counties. It enables transportation planners to adapt and prepare future transportation infrastructure for extreme weather events. The assessment discusses the transportation infrastructure and hazards considered before assessing vulnerability. The assets and hazards considered are in the Climate Change/Extreme Weather Risk Assessment call-out box.

Climate Change/Extreme Weather Risk Assessment

Assets	Hazards
❖ Roadways	❖ Flooding
❖ Railways	❖ Wildfire
❖ Airports	❖ Heat Wave
❖ Bridges	

Impacts of Climate Change and Variability on Transportation Systems and Infrastructure: The Gulf Coast Study, Phases 1 and 2 (Gulf Coast Study)

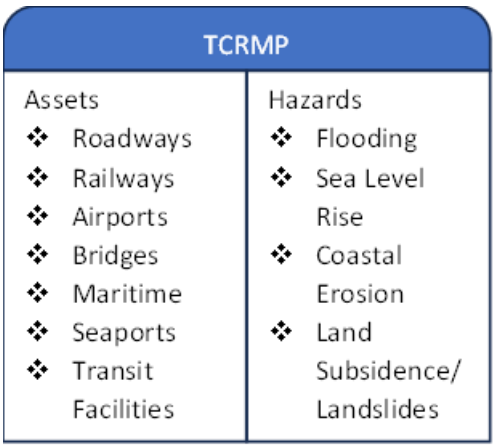


The Gulf Coast Study was produced by the U.S. Climate Change Science Program with funds from the U.S. Department of Transportation (DOT) in partnership with the U.S. Geological Survey. The Study Phases consider how changes in weather could affect the transportation infrastructure of the U.S. Gulf Coast between Galveston, Texas and Mobile, Alabama. The Phases aim to evaluate how changes in climate could impact design, construction, safety, operations, and maintenance of transportation infrastructure. Moreover, they focus on the decisions policy makers and managers can consider which increase safety and resiliency in the transportation system. Phase 1 (2008) takes a regional case study approach, while Phase 2 (2013) takes a more focused approach by analyzing specific infrastructure components and adaptation strategies. After elaborating on the importance of and risks to the Gulf Coast, the Phases analyze the potential climate impacts on different transportation modes, with Phase 1 analyzing the entire Gulf Coast and Phase 2 focusing on examples in Mobile, AL.

Texas Coastal Resiliency Study (TCRS)

This report was created in 2016 for the Texas General Land Office to identify the critical coastal infrastructure assets that are most vulnerable to storms similar to Hurricanes Dolly and Ike. The report identified and ranked priority existing and future projects that could protect vulnerable assets. Through three phases, the report recommends the projects that would have the greatest impact on recovery and resiliency. The TCRS identifies the critical infrastructure considered, specifies the transportation assets, and then performs the risk analysis for identified hazards.

Texas Coastal Resiliency Master Plan (TCRMP)



The Texas Coastal Resiliency Master Plan (TCRMP), created by the Texas General Land Office (GLO), is a multi-part statewide plan to analyze and protect the natural environment and infrastructure along the Texas coast. The TCRMP outlines projects across four Gulf regions compiled by coastal and environmental experts that will help enhance resiliency along the state's coast. The most recent installment, TCRMP 2023, is an update to the 2019 report. Analysts were asked to assess the impact of eight vulnerabilities in 48 coastal subregions identified in the 2023 TCRMP through a Qualtrics Survey. The projects are ranked by economic and ecological measures to help communities determine which to implement. The report is accompanied by data and mapping resources, which are discussed in depth in the Data Assessment section. The TCRMP 2023 covers five hazards, which are most relevant to the coastal regions of Texas, and it distinguishes between riverine and coastal flooding.

Coastal Texas Protection and Restoration Feasibility Study Final Report (Coastal Texas Study)

The Coastal Texas Study was a collaboration between the US Army Corps of Engineers and the Texas General Land Office completed in 2021. In recognition of the economic and ecological importance of Texas, the authors created the report to identify feasible projects that can address natural hazard risks to the economy and public health, as well as restore ecosystems and improve coastal resiliency. The report focuses on mechanisms for mitigating the impact of storm surges and protecting communities. It does not discuss specific transportation assets.

Coastal Texas Study

Hazards
- Flooding
- Sea Level Rise
- Coastal Erosion

Assessment of Historic and Future Trends of Extreme Weather in Texas, 1900-2036, 2021 Update (Extreme Weather Assessment)

The Extreme Weather Assessment was an update to a report created by the Texas A&M University, Office of the Texas State Climatologist. The report was sponsored by Texas 2036, a nonpartisan think tank. The report reviews historic trends in temperature, precipitation, and extreme weather in Texas to forecast trends out to 2036. The report acknowledges variation in the actual climate, but this provides scenarios that Texas can use to inform decision making. The report covers the entire state and hazards including coastal erosion, drought, flooding, wildfires, and a variety of storm types. The data employed in the report is not readily available but can provide methods for evaluating resiliency.

Extreme Weather Assessment

Hazards
- Flooding
- Heat Wave
- Wildfire
- Coastal erosion
- Strong Wind
- Drought
- Lightning

Resilient Houston

Resilient Houston is a review of Houston with a consideration for resilience. It takes a detailed look at the neighborhoods and people; water infrastructure, including bayous; and assesses relevant the lasting and acute hazards. It provides a framework that the city can follow to improve their city's resilience to extreme weather, of which the area is expected to experience in a greater degree over the coming decades. The report advocates for local, regional, and national partnerships to achieve the community centric goals. It also includes a component of individual ownership to facilitate citizen buy-in. The report clearly outlines the relevant regional hazards. Resilient Houston does not focus on transportation, but assets referenced in detail are listed here.

Resilient Houston

Assets	Hazards
❖ Roadways ❖ Transit Facilities	❖ Flooding ❖ Heat Wave ❖ Sea Level Rise ❖ Drought ❖ Land Subsidence/ Landslides ❖ Strong Wind ❖ Lightning

Broward MPO Resilience Analysis Methodology Technical Memo (Broward MPO Memo)

The Broward MPO Memo builds on two prior reports, the 2015 FHWA South Florida Climate Change Vulnerability Assessment and Adaptation Pilot Project and the 2016 Extreme Weather and Climate Change Risk to the Transportation System in Broward County Florida. This memo takes the findings of the prior two reports to develop a framework for evaluating network vulnerabilities and plan for preparedness. While the framework provides an inclusive list of potential assets and hazards, it only applies the hazards listed here to 8 corridors

Broward MPO Memo

Assets	Hazards
❖ Roadways ❖ Bridges	❖ Flooding ❖ Heat Wave ❖ Drought ❖ Sea Level Rise

Local Hazard Resources and Emergency Plans

The Corpus Christi MPO identified a few regionally specific resources which provide important information for a local understanding of assets, hazards, and critical infrastructure. This subsection provides a summary of these resources.

Nueces County Hazard Mitigation Action Plan (HMAP) Draft

HMAP	
Assets ❖ Roadways ❖ Railways	Hazards Flooding Wildfire Heat Wave Coastal Erosion Drought Land Subsidence/Landslides Strong Wind Expansive Soil Lightning Dam/Levee Failure

The 2023 HMAP Draft is a 5-year update of the 2017 HMAP sponsored by the Coastal Bend Council of Governments. The goal of the Nueces County HMAP is to eliminate losses due to natural disasters and improve community resilience. The plan employs data analysis, stakeholder meetings, and public engagement to understand the assets and risks for the county and individual cities and districts. It provides valuable insights into the region's hazards and the public's perception towards their seriousness. For each identified hazard, the plan mentions the assets that could be harmed in the included parts of the county.

City of Corpus Christi Emergency Operations Center

The City of Corpus Christi's website contains valuable information on emergency response, including resources for residents and information about the Emergency Operations Center (EOC). One such resource provided is an evacuation map with labeled routes (Figure 2). The city is separated into zones and the routes indicate which direction residents should evacuate. Operating as an evacuation route is an important criticality criterion for roadways. The EOC is assembled during an emergency to coordinate the efforts between local, regional, state, and national departments and agencies. Day-to-day EOC activities include receiving and communicating warnings and information, developing policies, and preparing for emergencies. During emergencies, the EOC leads the operations, analyzes information to recommend countermeasures, and communicates with residents, officials, and neighboring jurisdictions. The EOC operates in tandem with the City's Office of Emergency Management (OEM). Both the EOC and OEM contain experts on the City's assets, hazards, and critical infrastructure.

Corpus Christi Regional Transit Authority (CCRTA) Emergency Preparedness Policy

The CCRTA Emergency Preparedness Policy, updated 2023, outlines CCRTA employee responsibilities. During an emergency, CCRTA provides evacuation services for multiple cities and unincorporated areas in Nueces County. CCRTA receives instructions on evacuation procedures from the Nueces County Emergency Management Offices (EMO) when an emergency arises. CCRTA performs evacuation services while safety permits.

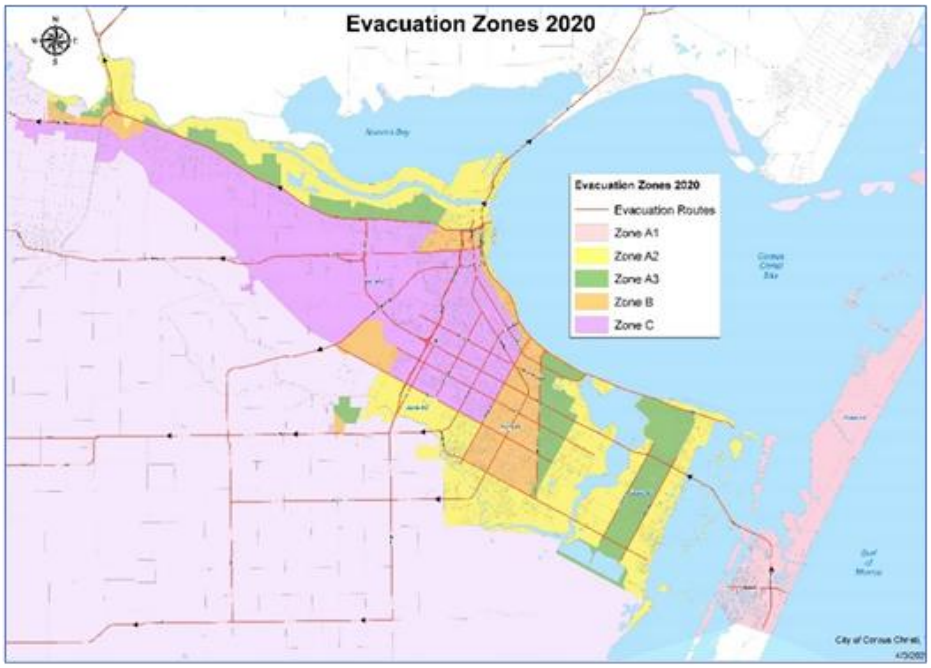


Figure 2: City of Corpus Christi Evacuation Map

Nueces Regional Flood Plan

The Nueces Regional Flood Plan is updated by the Nueces Regional Flood Planning Group, one of 15 regions overseen by the Texas Water Development Board. The Nueces Regional Flood Plan focuses on determining hazards, exposure, and vulnerability to evaluate the current and future flood risk. This includes evaluating the region's susceptibility to flooding, determining what and who will be impacted, and identifying the most vulnerable communities and critical facilities. This Plan provides in-depth information pertaining specifically to flood risks and policy recommendations for mitigation. As part of the vulnerability analyses, it identifies roadways and roadway crossings (bridges, culverts, low water crossings), as well as hazards to the region.

Nueces Regional Flood Plan	
Assets ❖ Roadways ❖ Airports ❖ Bridges ❖ Culverts ❖ Low Water Crossings	Hazards ❖ Flooding ❖ Heat Wave ❖ Sea Level Rise

SUMMARY OF FINDINGS

Asset Summary

Nine of the 10 sources in the literature review elaborated on asset types. Figure 3 provides the reference counts for each asset type; roadways, airports, and railways were mentioned most frequently. Table 1 and Table 2 provide the breakdown for which sources referenced which assets. For instance, the Texas Statewide Resilience Plan mentions eight of the 11 asset types.

Figure 3:Figure 3: Count of Asset Types References in the Literature Review

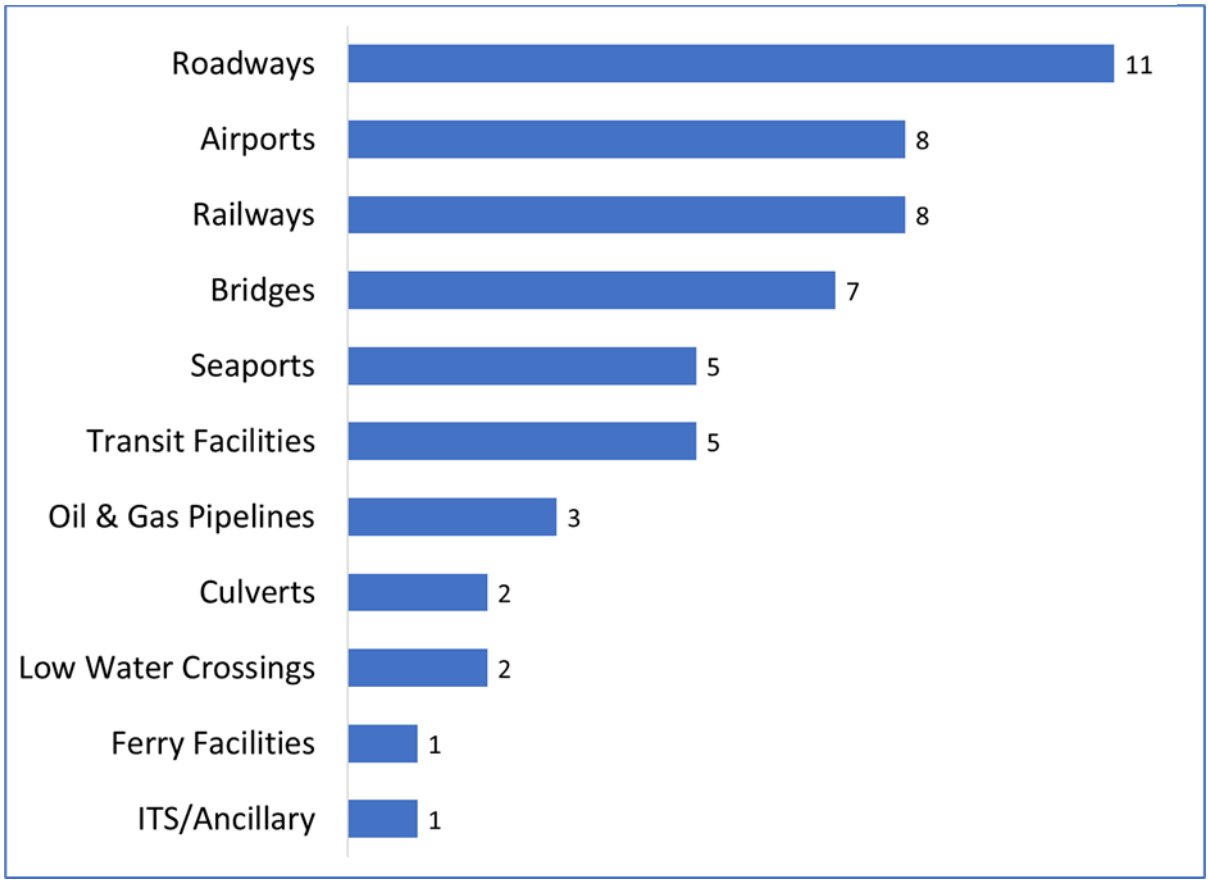


Table 1: Table 1: Asset Type Literature Review Reference Summary Table

Asset Type	Roadways	Railways	Airports	Bridges	Seaports
Total	**11**	**8**	**8**	**7**	**5**
Texas SRP	x	x	x	x	x
Statewide Freight Resiliency Plan	x	x	x		x
Central Texas Extreme Weather and Climate Report	x	x	x	x	
Climate Change/Extreme Weather Risk Assessment	x	x	x	x	
Gulf Coast Study	x	x	x	x	x
TCRS	x	x	x		x
TCRMP	x	x	x	x	x
Resilient Houston	x				
Broward MPO Memo	x			x	
HMAP	x	x			
Nueces Regional Flood Plan	x		x	x	

Table 2: Asset Type Literature Review Reference Summary Table (Continued)

Asset Type	Transit Facilities	Oil & Gas Pipelines	Culverts	Low Water Crossings	Ferry Facilities	ITS/Ancillary Assets
Total	**5**	**3**	**2**	**2**	**1**	**1**
Texas SRP		x	x			x
Statewide Freight Resiliency Plan		x				
Central Texas Extreme Weather and Climate Report	x					
Climate Change/Extreme Weather Risk Assessment						
Gulf Coast Study	x					
TCRS	x	x		x	x	
TCRMP	x					
Resilient Houston	x					
Broward MPO Memo						
HMAP						
Nueces Regional Flood Plan			x	x		

Hazard Summary

All 11 sources considered in the literature review discussed relevant hazards. Figure 4 provides the literature review hazard reference counts. Flood was referenced the most frequently, with each source mentioning it as a hazard (this includes sources that mention storm surge or specific types of floods, like riverine). Heat Waves and Wildfires are mentioned in half the resources with the other hazards being mentioned in fewer than half. Dam/Levee Failure, Lightning, and Expansive Soils were each mentioned once. Tables 3 and 4 display the hazard references for each individual source.

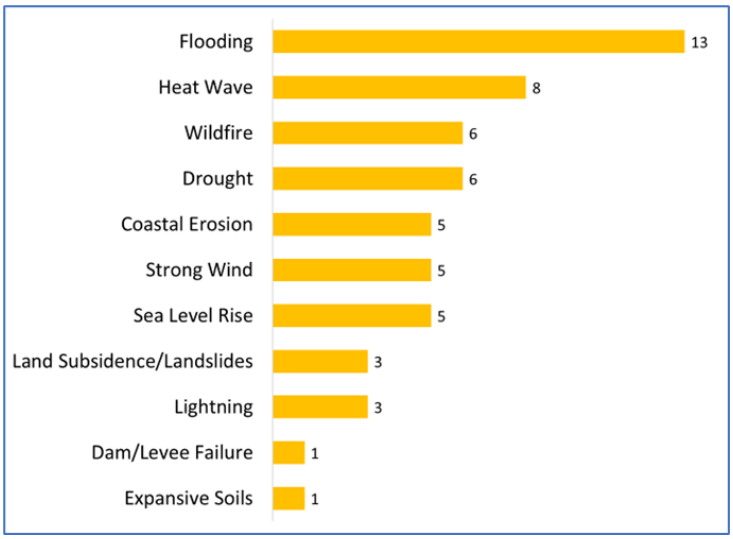


Figure 4: Count of Hazard Types References in the Literature Review

Table 3: Hazard Type Literature Review Reference Summary Table

Asset Type	Flooding	Heat Wave	Wildfire	Drought	Coastal Erosion
Total	**13**	**8**	**6**	**6**	**5**
Texas SRP	X	X	X	X	
Statewide Freight Resiliency Plan	X		X		
Central Texas Extreme Weather and Climate Report	X	X	X	X	
Climate Change/Extreme Weather Risk Assessment	X	X	X		
Gulf Coast Study	X	X			
TCRS	X				X
TCRMP	X				X
Coastal Texas Study	X				X
Extreme Weather Assessment	X	X	X	X	X
Resilient Houston	X	X		X	
Broward MPO Memo	X	X		X	
HMAP	X	X	X	X	X
Nueces Regional Flood Plan	X				

Table 4: Hazard Type Literature Review Reference Summary Table (Continued)

Asset Type	Strong Wind	Sea Level Rise	Land Subsidence/ Landslides	Lightning	Dam/Levee Failure	Expansive Soils
Total	**5**	**5**	**3**	**3**	**1**	**1**
Texas SRP						
Statewide Freight Resiliency Plan	X		X			
Central Texas Extreme Weather and Climate Report						
Climate Change/Extreme Weather Risk Assessment						
Gulf Coast Study		X				
TCRS	X					
TCRMP		X				
Coastal Texas Study		X				
Extreme Weather Assessment	X			X		
Resilient Houston	X	X	X	X		
Broward MPO Memo		X				
HMAP	X		X	X	X	X
Nueces Regional Flood Plan						

Data Assessment

To understand what data is currently available to locate and potentially assess the criticality of the various asset types and hazards in Corpus Christi MPO, the project team reviewed relevant ESRI maps, dashboards, and data hubs. These data sources fall into three groups:

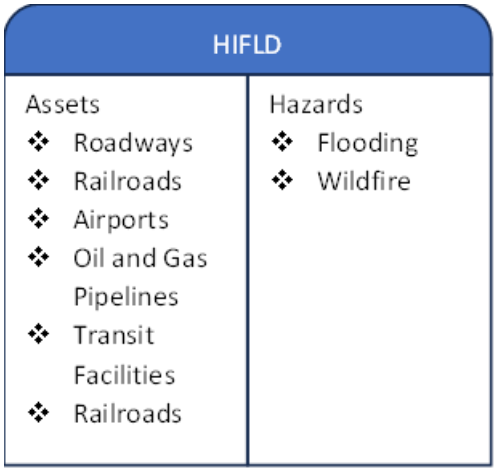
- National-level data sources
    - Homeland Infrastructure Foundation-Level Data (HIFLD)
    - United States Army Corps of Engineers (USACE) National Inventory of Dams (NID)
    - United States Department of Agriculture (USDA) Web Soil Survey (WSS)
    - USACE National Levee Database (NLD)
- Statewide data sources
    - TxDOT Open Data Portal
    - TxDOT Planning Map
    - Texas Railroad Commission Data
    - Texas Water Development Board
- Regional data sources for Corpus Christi MPO and Nueces County
    - GeoRED Hazard Impact and Planning Tool
    - The Coastal Bend Hurricane Evacuation Study Planning Atlas

The project team reviewed each data source to assess the availability of location and criticality information including ridership, demand, and condition. The review covered the 11 asset types: roadways, railways, airports, bridges, seaports, oil and gas pipelines, transit facilities, culverts, ferry facilities, ITS/ ancillary assets, and low water crossings.

The team also considered whether spatial data was available for each hazard type identified through the literature review. The following subsections provide full details of the information each data source covered for each asset and hazard type.

Homeland Infrastructure Foundation-Level Data (HIFLD)

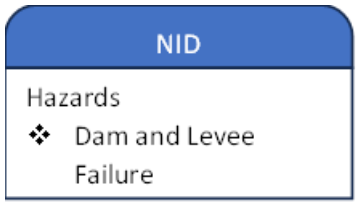
Homeland Infrastructure Foundation-Level Data (HIFLD) is a program within the United States Department of Homeland Security (DHS) that focuses on collecting, maintaining, and providing geospatial data related to critical infrastructure and key resources across the United States. The goal of HIFLD is to enhance the nation's understanding of its infrastructure and to support decision-making processes for emergency management, disaster response, and national security. HIFLD collects data from various federal, state, local, tribal, and private sector sources, and compiles this information into a comprehensive geospatial database. This database includes data about infrastructure such as transportation systems, energy facilities, communication networks, water resources, healthcare facilities, and more.



HIFLD covers six main asset types: roadways, railroads, airports, ferry facilities, transit facilities, and oil and gas pipelines. For roadways, HIFLD provides information about the locations of primary, secondary, and local roads. HIFLD includes the Federal Aviation Administration's aviation facilities dataset, providing precise airport locations. Railroads are also covered, offering insights into their locations. Ferry facilities are comprehensively detailed, revealing essential information such as ferry route locations, lengths, trip durations, passenger numbers, vessel types, and trip types. In terms of transit, HIFLD supplies data on national transit routes and stops. Additionally, the program extends its coverage to oil and gas pipelines, disclosing the locations of major natural gas transmission pipelines, including both interstate and gathering pipelines, as sourced from the U.S. Energy Information Administration.

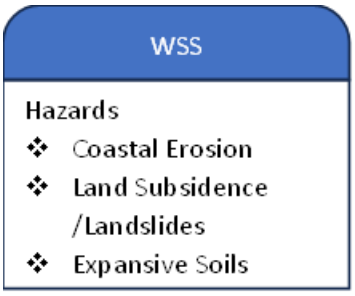
National Inventory of Dams (NID)

The National Inventory of Dams is a database provided by the U.S. Army Corps of Engineers. The focus of the NID is to provide dam location, type, size, purpose, uses and benefits, date of last inspection, other structural and geographical information. The NID also models dam flood inundation to demonstrate what could occur during a dam-related flood. The NID also provides data from the HIFLD for various public works and critical infrastructure, including nuclear power stations, fire stations, and railway lines.



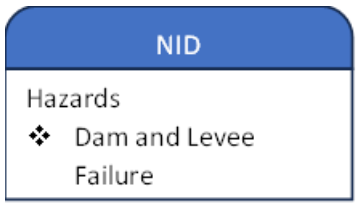
Web Soil Survey (WSS)

The Web Soil Survey is a product provided by the US Department of Agriculture Natural Resources Conservation Service. The WSS provides soil information and data collected through the Cooperative Sil Survey. The soil data was collected to provide information for agriculture purposes but can also be used to assess susceptibility to erosion, land subsidence, and expansive soils.

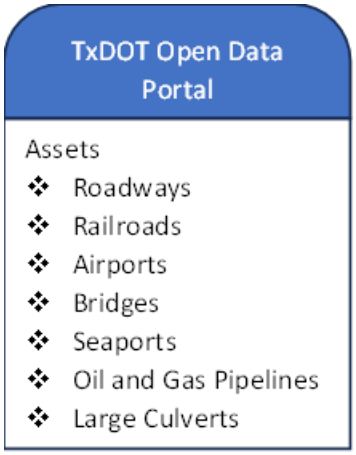


National Levee Database (NLD)

The U.S. Army Corps of Engineers maintains the National Levee Database. The NLD displays a map of levees across the nation with the levees risk (if screened), the area protected by the levee, and an estimate for the damage if the levee fails. The NLD includes four levees in the three counties encompassing Corpus Christi: Nueces County, San Patricio County, and Jim Wells County. The NLD outlines the area that would be impacted if the levees failed, which can be used to determine impacted assets.



TxDOT Open Data Portal



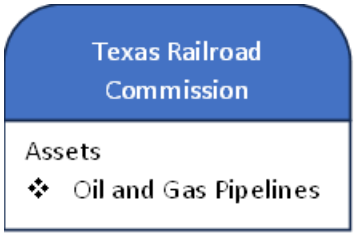
The TxDOT Open Data Portal is TxDOT's platform for exploring and downloading GIS datasets. It serves as the primary location for state transportation inventory data. It has a wide variety of datasets that are referenced and used in other tools and dashboards. This data source is unique because it includes both on-system and off-system roadway inventory. It also has the location and type of seaports and railroads, including their classification such as business lead, industrial lead, main line, side-track, and spur line. Furthermore, the TxDOT Open Data Portal provides access to the statewide oil and gas pipelines data provided by the Texas Railroad Commission.

TxDOT Statewide Planning Map

The TxDOT Statewide Planning Map is an Esri application designed to present a variety of TxDOT transportation geospatial data to facilitate planning operations within the organization. The mapping tool includes the geographic positions and types of seaports and railroads assets. Additionally, the map offers comprehensive details regarding bridges as reported to the National Bridge Inventory (NBI), such as their locations, condition ratings, ages, deck geometries, waterway sufficiency ratings, and lengths.

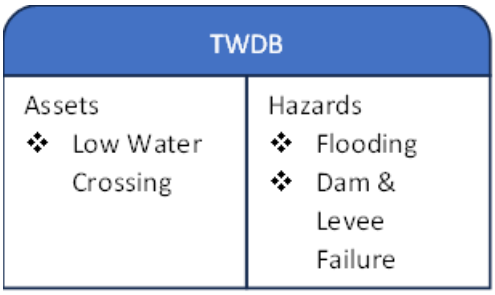
The map also includes a wealth of data about roadway assets including locations, Average Annual Daily Traffic (AADT), Vehicle Miles Traveled (VMT), percentage of truck traffic, geometric characteristics, anticipated future traffic and truck percentages, presence within the Strategic Highway Network, locations of evacuation routes, the top 100 congested roads, as well as both State and National freight networks including critical urban and rural freight corridors.

Texas Railroad Commission



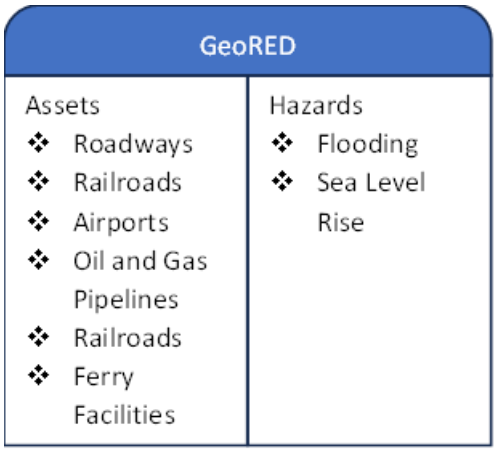
The Railroad Commission (RRC) of Texas is the state agency that regulates the oil and gas industry, gas utilities, pipeline safety, safety in the liquefied petroleum gas industry, and surface coal and uranium mining. RRC publishes Esri maps that have information about oil and gas pipelines (also included in the TxDOT Open Data Portal described above) and wells. Pipelines data include location, diameter, commodity types, and status (active or abandoned). The TRC does not address hazards.

Texas Water Development Board (TWDB)



The Texas Water Development Board (TWDB) is a state agency in Texas responsible for collecting and disseminating water-related data; assisting with regional water supply and flood planning that contributes to preparing the state water plan and state flood plan; and administering cost-effective financial programs for constructing water supply, wastewater treatment, flood control, and agricultural water conservation projects. The TWDB has an open data hub that has data covering the state's hydrological assets and only one transportation asset, which is the low water crossing. TWDB open data hub has the location of the low water crossing assets without information about their criticality. TWDB open data hub also includes data related to flooding and dam or levee failure.

GeoRED - Hazard Impact and Planning Tool



The Regional Resilience Partnership (RRP) developed a GIS platform called the Geospatial Resilient Economic Development (GeoRED), which is a tool for building resilience to disaster and economic risks. The GeoRED online platform has multiple tools for local officials and experts to analyze and share data with other interested stakeholders. One of these tools is the Hazard Impact and Planning Tool, which is an Esri tool that contains data layers focused on hazard planning and response, such as critical infrastructure and facilities, storm surge, and FEMA's National Flood Hazard Layer (NFHL) 1% and 0.2% flood zones. This tool includes the locations of roadways, evacuation routes, airports, railroads, ferry facilities, and transit facilities. It also has spatial files for subsets of these assets that are in FEMA 1% and 0.2% annual flood risk. For oil and gas pipelines, this tool has data showing pipelines locations, diameters, commodity types, and activity status.

The Coastal Bend Hurricane Evacuation Study Planning Atlas

The Coastal Bend Hurricane Evacuation Study Planning Atlas is an ESRI map that has multiple data layers for the coastal bend region and is published as part of the Coastal Bend Hurricane Evacuation Study.

These data layers cover:

- Administrative unit layers, including counties, places, school districts, coastal management zones, and coastal zones.
- Physical risks layers covering:
  - Historic wind and storm tracks.
  - Three sea level rise scenarios.
  - Storm surge models for tropical storms, and storm categories 1 through 5.
- Built environment and critical facilities:
  - Population.
  - Critical facilities including police stations; fire stations, local EOC, EMS, Urgent care, nursing homes, and hospitals.
  - Built environment including hotels, schools, mobile home units, buildings, and infrastructure.
- Social risk layers:
  - Social vulnerability index.
  - Childcare need.
  - Eldercare need.
  - Transportation need.
  - Shelter need.
  - Housing types.
  - Poverty status.
  - Limited English proficiency.
  - Unemployment.
  - Civic capacity.
  - Low to moderate income.
  - Education level.
- Evacuation zones and routes layers.

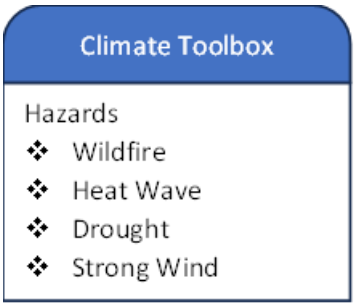
The Coastal Bend Hurricane Evacuation Study Planning Atlas provides data layers encompassing three primary transportation asset types: roadways, airports, and railroads. Within each of these asset types, users can access two key pieces of information: their respective locations and types. The roadway category includes various types such as major highways, US and state highways, farm roads, and city/county roads. Notably, the Atlas includes layers dedicated to evacuation routes, each representing distinct route types, including major evacuation routes, potential

contraflow routes, and evacuation lanes. Moreover, the Atlas features surge-affected routes categorized by storm category.

Texas Geographical Information Office (TxGIO, previously TNRIS)

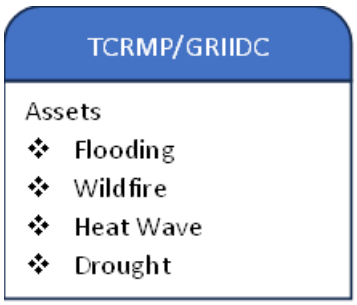
The Texas Geographic Information Office, previously the Texas Natural Resources Information System, is a division of the Texas Water Development Board. It is a geographical information systems resource. It contains maps and data captured by LIDAR, sensors, and imagery. Some data is region specific while others span the entire state. While TxGIO has extensive data for hazards including increased temperature and extreme heat, wind, wildfires, winter storms, and more, only data related for floods and storm surges covering Corpus Christi has been identified by the project team. Regarding assets, only Low Water Crossing data is available.

Climate Toolbox



A University of California Merced project, the Climate Toolbox is a collection of web tools that visualize past and forecasted climate and hydrology for the contiguous US. The applications cover agriculture, climate, fire, and water. One such tool is the Climate Mapper which maps real-time conditions, current forecasts, and future projections of climate information across the United States to assist with decisions related to agriculture, climate, fire conditions, and water. The data employed in the maps is also available for download. Partners for this project include the Climate Impacts Research Consortium, Regional Integrated Sciences and Assessments, the US Department of Agriculture's Northwest Climate Hub, and other regional and national organizations and agencies.

Texas Coastal Resiliency Master Plan (TCRMP) and the Gulf of Mexico Research Initiative Information and Data Cooperative (GRIIDC)



Both the TCRMP 2019 and 2023 installments provide data employed in the written reports. TCRMP 2019 provides an ESRI power map for Region 3, which covers Corpus Christi. The map includes data recording the potential impact of flooding from storm surges.

The data employed in the TCRMP 2023 is published on the GRIIDC. The Gulf of Mexico Research (GoMRI) Initiative is an independent research program funded by BP following the Deepwater Horizon spill to study the impacts of oil spills in the Gulf of Mexico. The GRIIDC is the data center that aims to provide data and information to promote and support research and awareness about the Gulf of Mexico ecosystem. The GRIIDC hosts data and reports from researchers studying the Gulf of Mexico. The GRIIDC satisfies the GoMRI requirement to ensure that relevant data from research is publicly available. The GRIIDC encourages researchers to use available data and share their own data to promote regional research.

DATA ASSESSMENT SUMMARY

Asset Summary

Figure 5 summarizes the findings of the data assessment. Table 5 details the asset data available for each source. For location data availability, roadway and railroads assets are at the top of the list followed by airports and pipelines. On the other hand, no location data were found for small culverts and ITS/ ancillary assets.

If a data source reports asset condition and/or traffic levels/ridership, it is considered to have criticality data for that asset. Furthermore, data sources with evacuation routes information are considered to have criticality data for roadway assets only. With this initial definition of criticality, roadway assets are covered by the largest number of data sources as expected. Bridges come next in order as they are covered by two data sources. On the contrary, none of the data sources have criticality data for seaports, small culverts, airports, railroads, transit facilities, and ITS/ ancillary assets. It is also important to highlight that vulnerability to FEMA 1% and 0.2% annual flood risk is available for roadways, airports, railroads, ferry facilities, and transit facilities, which fit into the hazards data that will be investigated in later tasks.

Regarding low water crossings, TWDB includes point data for low water crossings. The point data can be joined to roadway data from the TxDOT Open Data Portal to determine the criticality of the low water crossing.

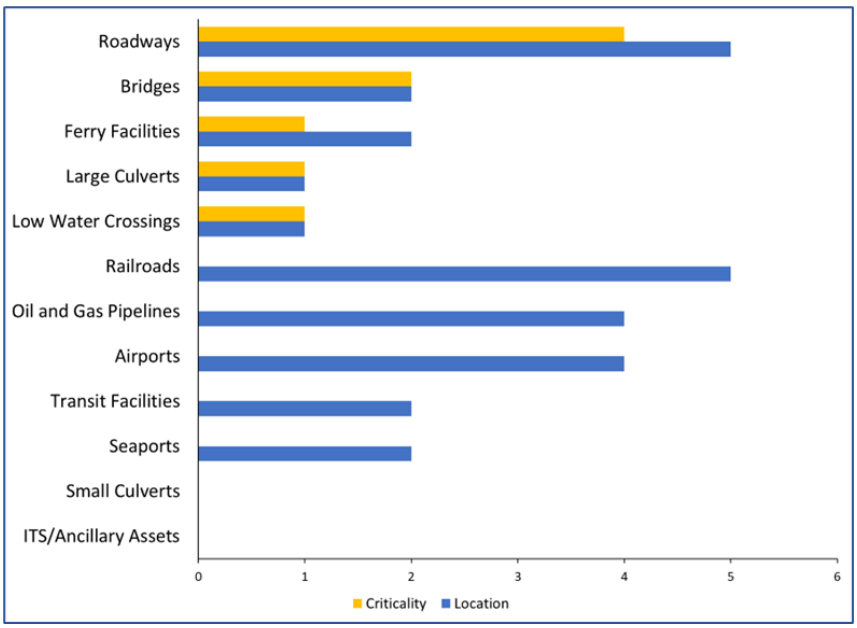
Table 5: Asset Data Assessment Reference Summary Table

Assets	HIFLD	TxDOT Open Data Portal	TxDOT Planning Map	Texas Railroad Commission	GeoRED	Hurricane Planning Atlas	TWDB
Roadways	📍	📍 !	📍 !		📍 !	📍 !	
Railroads	📍	📍	📍		📍	📍	
Airports	📍	📍			📍	📍	
Bridges		📍 !	📍 !				
Seaports		📍	📍				
Oil and Gas Pipelines	📍	📍		📍	📍		
Transit Facilities	📍				📍		
Large Culverts		📍 !					
Small Culverts							
Low Water Crossings		!					📍
Ferry Facilities	📍 !				📍		
ITS/Ancillary Assets							

📍 Asset Locations Available

! Some Criticality Information Available

Figure 5:Location and Criticality Data Availability by Asset Types



Hazard Summary

Table 6 summarizes the hazard data. Notably, each hazard type has at least one data source. Some data hubs reference data from the same resources, for example flood data from FEMA. In a later stage of this project, the asset inventory will be assessed for susceptibility to hazards.

Table 6: Hazard Type Data Review Reference Summary Table

	RAPT	HIFLD	TWDB	GeoRED	Hurricane Planning Atlas	TxGIO	Climate Toolbox	TCRMP/ GRIIDC	Web Soil Survey	NID	National Levee Database
Flooding	✓	✓	✓	✓	✓	✓		✓			
Wildfire	✓	✓					✓				
Heat Wave	✓						✓				
Sea Level Rise	✓			✓				✓			
Coastal Erosion									✓		
Drought	✓						✓				
Land Subsidence /Landslides									✓		
Strong Wind	✓						✓				
Expansive Soils									✓		
Lightning			✓								
Dam and Levee Failure			✓							✓	✓

CRITICALITY FRAMEWORK

Criticality measures how important each asset is to the overall community; they allow transportation assets to be prioritized based on the impact or consequence of failure or disruption. In this Phase 1 analysis, Corpus Christi MPO is objectively evaluating criticality based on criteria from available data sources; future analyses may include opportunities to elicit and add stakeholder input to the criticality framework.

FHWA's Vulnerability and Adaptation Framework cites the USDOT Gulf Coast Study and recommends including criticality measures in three categories[2] :

- Socio-Economic Criteria:
- Use/Operational Criteria
- Health and Safety Criteria

Socio-Economic Criteria

Socio-economic criteria capture information about the communities surrounding an asset and estimate each community's ability to adapt to and/or recover from nearby assets' disruption or failure.

Social Vulnerability

More vulnerable communities may experience disproportionate negative impacts and may be less able to recover when hazards impact or disrupt nearby infrastructure assets. The Federal Emergency Management Agency's (FEMA) National Risk Index rates census tracts' social vulnerability from very low to very high based on the Social Vulnerability Index (SVI). The SVI is an estimate of the "susceptibility of social groups to the adverse impacts of natural hazards[3]" and comprises 16 factors measuring socioeconomic status, household characteristics, racial and ethnic minority status, and housing type and transportation. The SVI score indicates the relative level of social vulnerability in each census tract within Corpus Christ MPO. The SVI will be used to prioritize all assets; where an asset crosses more than one census tract, the weighted average SVI score will be applied to the asset.

Use/Operational Criteria

Use or operational criteria estimate how much each asset is used to transport people and/or freight. It is a measure of how important each asset is for mobility.

Average Annual Daily Traffic

Average annual daily traffic (AADT) provides a metric for determining the importance of roadway-related assets. AADT data is available through the TxDOT Open Data Portal and provides a continuous quantitative metric for establishing assets' importance based on average usage; high AADT indicates that an asset is used frequently and should therefore be prioritized above less heavily trafficked assets. AADT will be used to prioritize roadways, bridges, and low water crossing assets.

Ridership

Ridership counts, like AADT, provide quantitative count to determine the relative importance of ferry terminals. For each ferry terminal, a ridership count based on number of routes and average ridership for each route will be calculated and employed to prioritize ferry terminal assets. The HIFLD and GeoRED provide ferry station, ridership, and route data. Ridership will be used to prioritize ferry terminal assets.

Detour Length

The distance a user would need to travel to circumvent a closed bridge (detour length) is a useful indicator of how important each individual bridge is to the movement of people and goods. The National Bridge Inventory (NBI) includes an estimated detour length for each bridge. Detour length will be used to prioritize bridges; bridges with shorter detour lengths would be given lower priority than those with long detour lengths.

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[2] https://www.fhwa.dot.gov/environment/sustainability/resilience/adaptation_framework/climate_adaptation.pdf
[3] https://www.fema.gov/sites/default/files/documents/fema_national-risk-index_technical-documentation.pdf

HEALTH AND SAFETY CRITERIA

Evacuation Routes

Evacuation routes are vital for emergency management during hazardous events to ensure that residents and visitors can safely leave the region if necessary. The evacuation route criterion offers a binary indicator to assess asset priority. Statewide evacuation route data is available on the TxDOT Statewide Planning Map[4]. Evacuation routes will be used to prioritize roadways, bridges, and low water crossing assets.

Vicinity to Critical Infrastructure

Each asset's vicinity to emergency facilities serves as a proxy for estimating the asset's importance for access to non-transportation infrastructure that officials or residents may need to access during a hazardous event. Assets will be prioritized based on the count of critical infrastructure points within a 0.1 mile buffer radius. Corpus Christi MPO and its stakeholders selected the following types of critical infrastructure (locations drawn from GeoRED) for initial analyses:

- Police Stations
- Fire Stations
- Emergency Medical Facilities
- Schools

Vicinity to critical infrastructure points will be used to prioritize all assets.

Criticality Summary

Table 7 summarizes the criticality prioritization criteria and the asset classes to which they will be applied.

Table 7: Criticality Framework

Asset Class	Social Vulnerability	AADT	Ridership	Detour Length	Evacuation Routes	Critical Infrastructure
Roadways	✓	✓			✓	✓
Bridges	✓	✓		✓	✓	✓
Large Culverts	✓	✓		✓	✓	✓
Ferry Facilities	✓		✓			✓
Low Water Crossings	✓	✓			✓	✓

IMPLEMENTATION RECOMMENDATIONS

Asset Recommendations

Based on the literature review and data assessment, the project team developed recommendations for which assets should continue to be considered in subsequent steps of the Phase 1 Corpus Christi MPO regional resiliency improvement plan. Recommendations are based on whether each asset type i) is included in existing resiliency plans; ii) has location data readily available; and iii) has at least some criticality data readily available (Table 8). The list of assets may be narrowed further if data limitations are identified.

The project team recommends focusing on the following assets for the subsequent stages of this Phase 1 analysis:

[4]Corpus Christi MPO stakeholders indicated that additional routes may serve as "unofficial" evacuation routes in the region; when data becomes available, these routes could be included in future criticality analyses.

Roadways are referenced by each of the eight resources which included assets in the literature review and have numerous data sources for both location and potential criticality criteria, which indicates that they are an important and relevant asset and data is likely to be available to execute the initial prioritization. Moreover, roadways connect to most other transportation assets and serve multiple modes of travel including passenger and freight vehicles, emergency response vehicles, pedestrians, transit, and bicyclists.

Bridges are explicitly referenced in five of eight resources considered in the literature review; in addition, some sources included bridges as part of their definition of "roadway". Bridge location and criticality data are available through multiple TxDOT sources. Similar to roadways, the region's bridges serve multiple modes of travel.

Large Culverts were referenced in the literature review and location and potential criticality data related to large culverts is readily available. In some instances, from the literature review, large culverts are classified as bridges or as part of roadways.

Table 8: Recommendations Summary Table

Asset Class	Recommended	Literature Review	Location	Criticality
Roadways	✓	✓	✓	✓
Bridges	✓	✓	✓	✓
Large Culverts	✓	✓	✓	✓
Ferry Facilities	✓	✓	✓	✓
Low Water Crossings	✓	✓	✓	✓
Railways		✓	✓	
Airports		✓	✓	
Seaports		✓	✓	
Oil & Gas Pipelines		✓	✓	
Transit Facilities		✓	✓	
Small Culverts		✓		
ITS/Ancillary Assets		✓		

Ferry Facilities are relatively unique; while slightly outside of the Corpus Christi MPO boundaries, the Port Aransas ferry is one of only two ferry systems in Texas and provides connection to locations within the MPO boundaries. Ferry facilities were mentioned in the literature review and there are both location and criticality data available, so if desired, ferry facilities could be included in future analysis stages.

Low Water Crossings are not mentioned often, only two times in the literature review. Yet, there is location data available, and since they are sections of roadway, the criticality roadway can be employed to determine the criticality of the low water crossing.

Hazard Recommendations

Considering the hazards mentioned in the literature review and with data available per the data assessment, each hazard could be eligible for analysis. Indeed, employing reference and data availability criteria for inclusion would not remove any hazards from the analysis. Therefore, the High Street team recommends that all hazards be considered going into the next phase of the project. Subsequently, the project team will identify the most relevant hazards based on the number of impacted assets and the potential impact severity on the transportation assets identified in TM1 and above.

Criticality Recommendations

The relevant criticality criteria will be applied to each asset and then combined to calculate an overall criticality score for each asset. Using the asset prioritization spreadsheet, Corpus Christi MPO will be able to modify individual criticality criteria weights based on local knowledge or stakeholder input.

APPENDIX I: ASSET TYPE CROSSWALK

The literature review and data assessment produced a list of 29 distinct asset names, many of which were analogous or overlapping. For the purposes of this memorandum, High Street Team distilled the 29 asset names into a set of 11 as shown in Table 1.

Table A1: Asset Types and Assets Mentioned in Resources Crosswalk

Asset Types	Assets Mentioned in Resources
Airports	Airports Aviation
Bridges	Bridges Bridges and Culverts
Culverts, Large & Small	Bridges and Culverts Culverts
Ferry Facilities	Ferries Ferry Facilities
ITS/Ancillary	Intelligent Transportation Networks
Low Water Crossings	Low Water Crossings
Oil & Gas Pipelines	Oil and Gas Pipelines Pipelines
Railways	Rail Rail Transportation Railroad Lines Railroads Railway Facilities Railways
Roadways	Roads Roadways Evacuation Routes Streets
Seaport	Maritime Maritime Ports Ports Waterways Seaports
Transit Facilities	Transit Facilities Public Transportation

APPENDIX II: ADDITIONAL RESOURCES

The following resources and data sources did not discuss specific assets but may provide valuable hazard and criticality criteria that will be important for later analyses, technical memos, and reports.

FEMA Resilience Analysis and Planning Tool (RAPT)

RAPT is a free, publicly available geographic information systems (GIS) tool developed by Federal Emergency Management Agency (FEMA) to help emergency managers and community partners of all GIS skill levels visualize and assess potential challenges to community resilience. RAPT has over 100 data layers covering buildings and hazards. RAPT is designed to help decision-makers understand the population and infrastructure at risk for forecasted extreme weather, identify at-risk infrastructure assets, prioritize areas for evacuation, with estimates of nursing home and hospital beds.

Establish TxDOT Transportation Resilience Planning Scorecard and Best Practices: Technical Report

This report was developed by the Texas A&M Institute and sponsored by FHWA and TxDOT. It contains an analysis on policies TxDOT can implement to improve resilience and mitigate the impact of natural hazards. The report performs literature review then implements analytical methods on the Texas road network's vulnerability and resilience. Moreover, it aims to provide a scorecard of best practices that Texas can use to evaluate and improve transportation resiliency. The report outlines an in-depth methodology for determining criticality for roadways.

NCHRP Research Report 1014: Developing a Highway Framework to Conduct an All-Hazards Risk and Resilience Analysis

This report, completed in 2023, was conducted by the Transportation Research Board as part of the National Cooperative Highway Research Program (NCHRP). This report presents a framework for performing quantitative risk and resilience evaluations that satisfy recent federal requirements. It includes economic analyses, project prioritization, performance management, and risk and resilience evaluation. Specifically, the study focuses on protecting and reinforcing the highway system.

Vulnerability Assessment Scoring Tool (VAST)

VAST is a tool created by the USDOT to aid transportation organizations such as DOTs and MPOs in evaluating the vulnerability of their assets. VAST uses asset characteristics as indicators of exposure, sensitivity, and adaptive capacity which are used to calculate assets vulnerability scores. VAST covers various asset types like rail, seaports, airports, pipelines, bridges, and roads, along with climate stressors such as temperature changes, floods, sea level rise, storms, wind, drought, wildfires, freeze/thaw and permafrost thaw. VAST, operating in Microsoft Excel, helps users document asset vulnerability by determining the scope of the vulnerability assessment, selecting appropriate indicators, collecting data about those indicators, and devising an approach to convert raw data about indicators into scores. This process facilitates ranking assets by vulnerability and improving transportation planning and adaptation strategies.

Texas Delivers 2050

Texas Delivers 2050 is an in depth TxDOT assessment of the Texas freight network. It covers many topics, from autonomous trucking to maritime and railway freight. The report includes a resilience section, but it does not cover resilience to natural hazards in depth. It discusses methods for creating a flexible network that can withstand a variety of changes, not specifically those related to the climate.