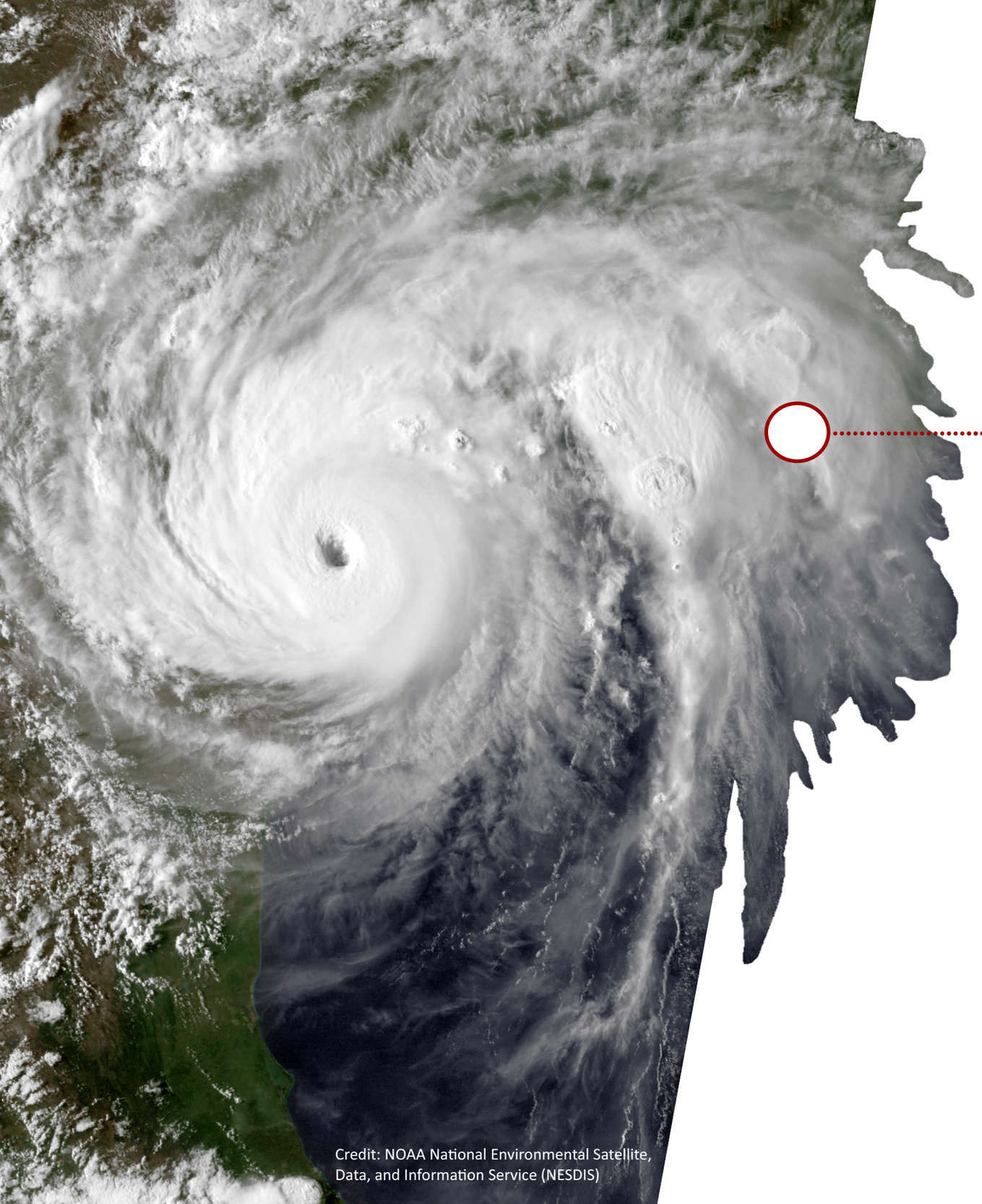


Credit: NOAA National Environmental Satellite, Data, and Information Service (NESDIS)

CHAPTER 11

SECURITY AND RESILIENCE

The metropolitan transportation plan should include appropriate emergency relief and disaster preparedness plans and strategies and policies that support homeland security as appropriate and safeguard the personal security of all motorized and non-motorized users.

CORPUS CHRISTI MPO

METROPOLITAN PLANNING ORGANIZATION

CHAPTER 11

security and resilience

Emergencies of any type can have a devastating effect on people and property. In the years since September 11, 2001, increased emphasis has been placed on emergency preparedness and homeland security issues. According to federal regulations, "*The metropolitan transportation plan should include appropriate emergency relief and disaster preparedness plans and strategies and policies that support homeland security as appropriate and safeguard the personal security of all motorized and non-motorized users.*" Security places an emphasis on protecting people and infrastructure before manmade and natural disasters, while resiliency is ensuring the viability of the transportation system after an event has occurred.

According to the local Multi-Jurisdictional Hazard Mitigation Action Plan, the Corpus Christi MPO region *"...and the jurisdictions therein are susceptible to a wide range of natural hazards, including floods, hurricanes and tropical storms, drought, extreme heat, lightning, coastal erosion, hailstorms, tornadoes, dam and levee failure, land subsidence, expansive soils, and wildfire. These life-threatening hazards can destroy property, disrupt the economic, and lower the overall quality of life for residents. The impact of hazards can be lessened in terms of their effect on people and property through effective hazards mitigation action and planning and implementation.*" In addition to natural disaster vulnerability, human-caused events are a vulnerability within the Corpus Christi MPO's transportation corridors.

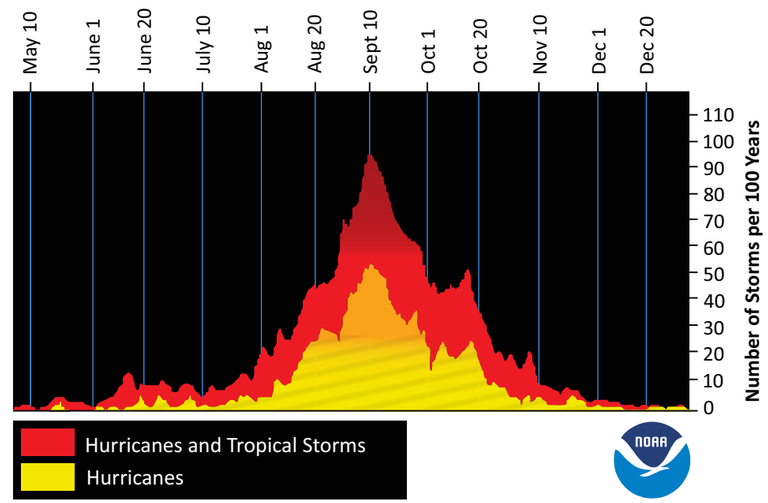
From a transportation-planning perspective, natural disasters such as hurricanes and flooding are common in Texas and can cause death and destruction; while incidents in foreign nations serve as a warning of things that could occur here. Preparation and planning for recovery from these disasters helps protect people and public. The focus of local, state, and federal security-planning efforts is to minimize direct or indirect disruptions caused by natural or human actions upon infrastructure and increase the adaptive capacity of the transportation system.

Prior preparation can make critical facilities "harder" to damage. This is important because when one element in a system breaks down, a cascade of sequential reactions can occur that significantly increase the severity of the original impact. Secondary impacts can then affect transportation, utilities, communications systems, fuel supplies, and/or water supplies. Multiple agencies are responsible for building, maintaining, and protecting the Corpus Christi MPO's transportation system. TxDOT manages the state highway network, Corpus Christi Regional Transportation Authority is responsible for both transit infrastructure and rolling stock, while local governments and private agencies are responsible for their individual assets.

Types of Hazards

A review of the full range of natural hazards suggested under the Federal Emergency Management Agency (FEMA) planning guidance revealed that the principle concerns related to transportation and transportation infrastructure in the Corpus Christi MPO region are described in Exhibit 11-2.

Exhibit 11-1. Chart of Number of Tropical Cyclones per 100-Years



Critical Facilities

FEMA defines critical facilities as hospitals, fire stations, police stations, courthouse, communications, and similar facilities where essential programs/services are provided. Other facilities such as public schools may be deemed by a community to be a critical facility as well. A critical facility should not locate in a floodplain. If located in a floodplain it should be provided a higher level of protection so that it can continue to function and provide services during and after a flood. A goal listed in the Multi-Jurisdictional Hazard Mitigation Action Plan is to develop strategies to ensure that future development has reduced risk of impact by natural hazards while not inhibiting community growth.

Some of the most critical, and vulnerable facilities are the causeways to/from and the roadways on barrier islands, due to long detour lengths and low elevations. The main transportation security concern on North Padre Island and Mustang Island is the lack of redundant roadways. Since there is only one roadway that provides access to the islands and since peak period volumes are currently approaching capacity, a secondary access point may need to be considered in the future. A secondary access point would provide system redundancy in case of an emergency along the John F. Kennedy Causeway or elsewhere on the island.

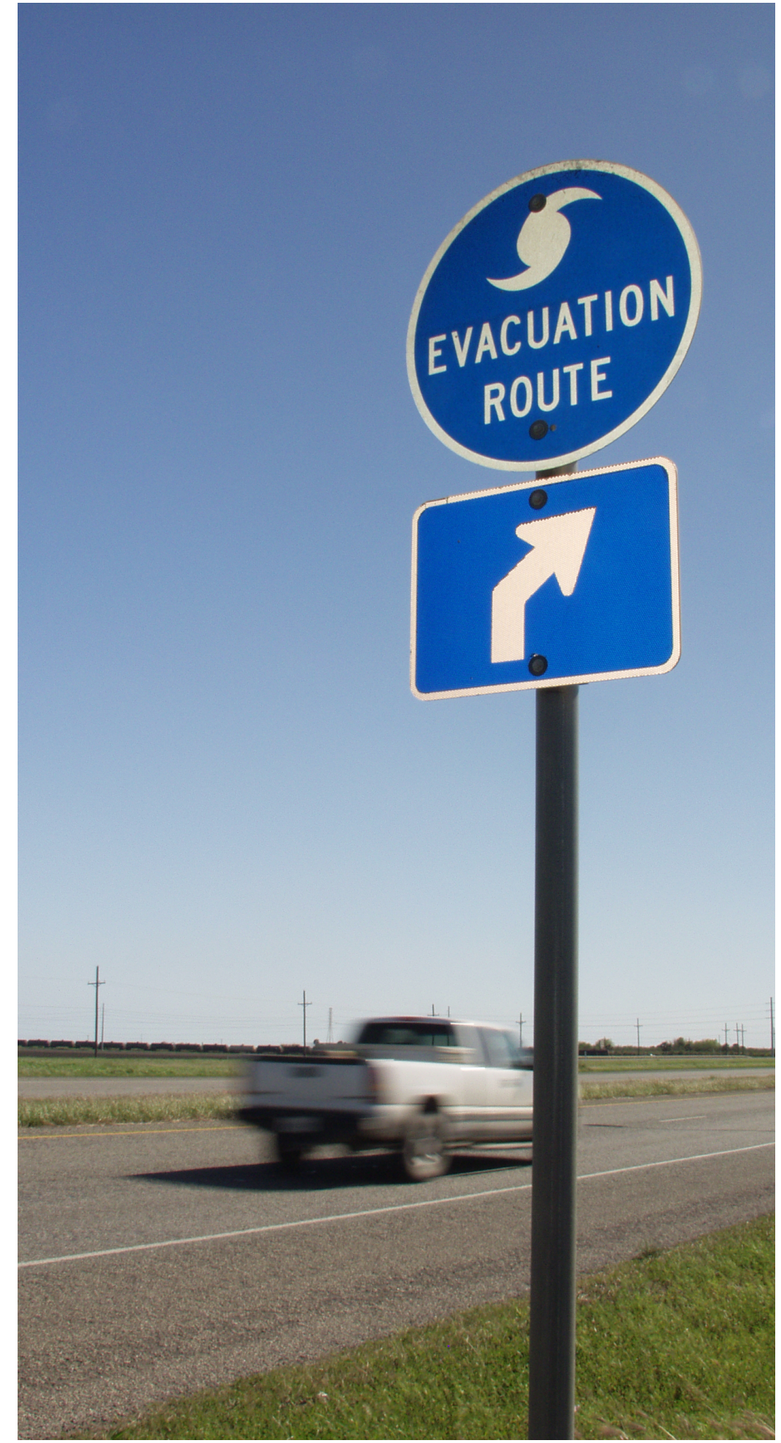
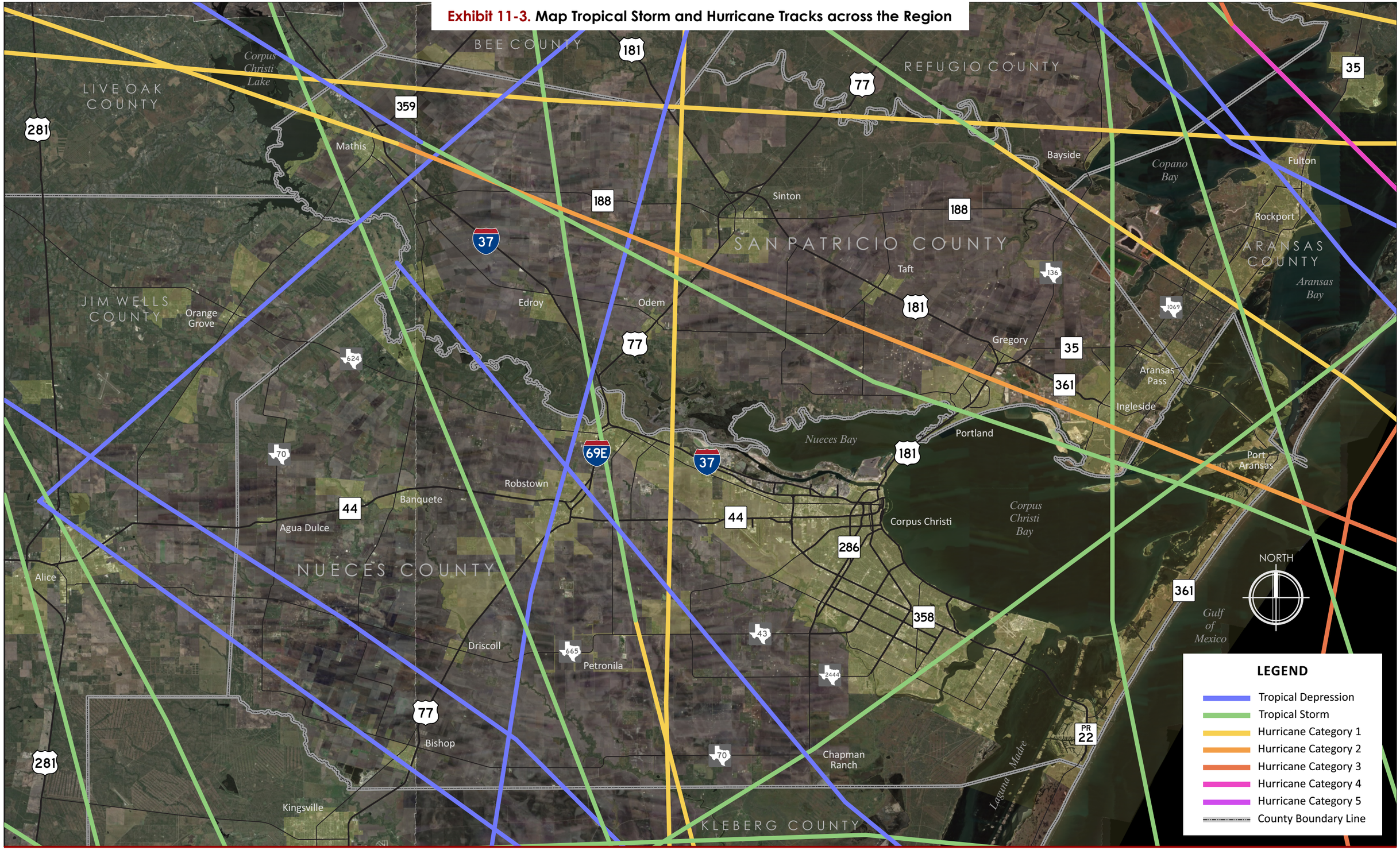


Exhibit 11-2. Table of Full Range of Natural Hazards

Type	Description	Potential Frequency and Serverity
Hurricanes and Tropical Storms	A hurricane is an intense tropical weather system of strong thunderstorms with a well-defined surface circulation and maximum sustained winds of 74 mph or higher. The entirety of Metropolitan Planning Area is identified as a Hurricane-Susceptible Region and is located in Wind Zone III, associated with winds as high as 200 mph.	Given the planning area's coastal location, the participating jurisdictions could potentially experience a Category 5 storm in the future. And can expect three tropical storms/hurricanes to make landfall during the time of this plan (2045).
Flood	A flood is the accumulation of water within a body of water, which results in the overflow of excess water onto adjacent lands, usually floodplains. The floodplain is the land adjoining the channel of a river, stream, ocean, lake or other watercourse susceptible to flooding. Flooding is the partial or complete inundation of otherwise normally dry land. Types of flooding in the Corpus Christi MPO region are: riverine flooding, coastal flooding, and shallow flooding in poorly drained areas.	Flooding is the deadliest natural disaster that occurs in the U.S. each year, and Texas leads the nation most every year in flood-related deaths and damages. Between 1971 and 2017, five non-hurricane, flood-related FEMA disaster declarations took place in Nueces County.
Levee Failure	Levee failure is the collapse, breach, or other failure of a structure resulting in downstream flooding. In the event of a failure, the energy of the water stored behind even a small levee is capable of causing loss of life and severe property damage if development exists downstream. There is no state inspection or safety program for levees, and there is no database for levee systems in Texas. Levee-specific inundation maps and extent data do not exist. However, there are numerous levees owned and maintained by the City of Corpus Christi, the Port of Corpus Christi Authority, and various refineries and industries. Failure of the City of Corpus Christi's Salt Flats levee during a 100-year flood event would expose the City's Downtown district (**see Exhibit 15-4**) to flooding that might result in property damage and possible injury or loss of life. All of the property located in the Downtown flood zone represents roughly $1.1B. A report indicated that Corpus Christi's downtown is located in a 100-year floodplain and the existing Downtown Flood Protection System does not meet current standards for protection from a 100-year event due to the uncertified Salt Flats Levee system. FEMA requires that all components of the levee be certified as "a freeboard deficient reach" which means that it is not vulnerable to a catastrophic failure. The article indicates a report prepared by one of the City's consultants indicates it would cost between $75M and $100M to overhaul the Downtown Flood Protection System to meet a 100-year event.	According to local emergency planning, the probability of a levee failure is "possible" within the next 5 years based on the history of levee failures due to storm events. The 2015 CEPRA report indicates that three hurricanes impact the Texas coast every four years, and since the annual probability of a hurricane, tropical storm or tropical depression striking Nueces County is 6.9%.
Coastal Erosion	Coastal erosion is 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".* Coastal erosion may result in the temporary redistribution of coastal sediments, or the long-term loss of coastal sediments and sediment accumulation. The Texas GLO's Texas Coastal Resiliency Master Plan, dated March 2017, includes the following statement concerning impacts by coastal erosion, *"if left unaddressed, will continue to have adverse impacts on infrastructure, natural resources, economic activities, and the health and safety of residents."* A healthy beach and dune system can reduce damage to property and critical infrastructure by absorbing some of the energy from storm surges and waves. Beach and dune restoration projects to repair damage caused by coastal erosion are a continual economic burden for the coastal jurisdictions. The Coastal Erosion Planning and Response Act (CEPRA) says…	An analysis of the Gulf-facing shoreline erosion rates also indicates that 96.7%, or approximately 19.9 miles, of the Gulf-facing shoreline within Nueces County is experiencing a mean erosion rate of -1.7 feet/year. From 2000 to 2012 the coastal erosion rate for the Gulf shoreline along Nueces County varied between more than -8 feet / year of erosion to more than +8 feet / year of accretion. A comparison of the coastal erosion rates based on 2010 Texas GLO data indicates that 6 miles of the 20.6 miles of Nueces County's Gulf-facing shoreline is classified as critical erosion (i.e., greater than -2 feet/year).
Land Subsidence	Land subsidence is the decrease in the lands surface elevation due to the loss of subsurface support. Land subsidence can be caused by both natural processes and manmade actions. Land subsidence caused by natural processes typically occurs over a long period of time, usually thousands to millions of years. Short-term land subsidence is generally the result of manmade actions such as: excessive ground-water withdrawal, oil and gas drilling, mining operations, collapse of buried infrastructure like pipelines for water, sewer and storm or the leakage of underground pipes that erode adjacent soils. Subsidence from groundwater withdrawal and oil and gas production usually occur over large areas, while subsidence from collapsed or leaking pipelines is generally localized. Land subsidence can cause structural damage to building and transportation systems such as roads and rail; damage buried infrastructure such as pipelines; cause sea level rise along the coast which increases vulnerability of coastal wetlands and beaches to coastal erosion and increased flooding. There are a total of eight areas within the county which have records of historic land subsidence; Areas No. 2 through No. 8 are no longer active. The only area of active subsidence identified within the county extent is the Saxet Oil and Gas Field, and is located within the City of Corpus Christi; this is shown at Area No. 1.	Based upon hazard mitigation reports, with the exception of the area of active subsidence around the Saxet Oil and Gas field, a new land subsidence event is expected no more frequently than once every ten years.
Expansive Soils	Expansive soils are soils and soft rock that tend to swell or shrink due to changes in moisture content. Expansive soils with high clay content can expand to as much as 15 times its original volume. A USDA soil survey for the region indicates that approximately 68% of the land surface consists of clay soil. Expansive soils can be measured as a percent of the volume from moist to dry conditions. This percentage is called the Linear Extensibility Percent (LEP). The shrinking and swelling of soils with Moderate to Very High LEP damages buildings, roads, and buried infrastructure such as pipelines. Uneven shrink/swell cycles causes damage to building foundations, walls, roadway pavement, sidewalks, underground piping and other structures. Foundations and pavement for roads are particularly susceptible damage from the shrink / swell cycle, especially during floods or droughts.	All jurisdictions can expect a Very High Shrink-Swell Class in the future, corresponding to a Linear Extensibility (LEP) over 9%.
Drought	A prolonged period of less than normal precipitation such that the lack of water causes a serious hydrologic imbalance. Common effects of drought include crop failure, water supply shortages, and fish and wildlife mortality. Droughts may initiate or exacerbate other hazards, such as expansive soils, extreme heat or wildfires.	Nearly half (46%) of the months between 1953 and 2016 were considered drought months. Ten percent of the above 63-year period was listed as either Severe or Extreme Drought.
Hazardous Materiels Transportation	A hazardous material (solid, liquid, or gaseous contaminants) of flammable or poisonous material that would be a danger to life or to the environment if released without precaution. TxDOT receives information from railroad companies regarding the type and quantity of hazardous materials being transported on rail lines in order to be more efficient in allocating hazardous materials inspection resources. When hazardous materials spills occur during railroad incidents, TCEQ and the affected Disaster District Committee (DDC) activate resources to assist in coordinating clean-up operations as needed in order to reopen railways.	Texas Department of Public Safety-Texas Critical Infrastructure Protection (CIP) have real time monitoring capabilities for some railroad companies that are transporting hazardous materials within the state.
Pipeline Failure	Fuel pipeline breach or pipeline failure addresses the rare, but serious hazard of an oil or natural gas pipeline that, when breached, has the potential to cause extensive property damage and loss of life. The Railroad Commission of Texas (RRC) is the state agency with primary regulatory and enforcement jurisdiction over pipeline transporters and the hazardous liquid pipeline industry. RRC works with other government entities and private sector providers to conduct pipeline emergency operations. Pipeline operators self-report incidents and accidents on jurisdictional pipelines to the RRC Pipeline Safety Department by telephone at the earliest practical moment, but no later than two hours following discovery.	We do not have a list of pipeline incidents in either county or the Port of Corpus Christi.
Cyber-Attack	A cyber-attack is any type of offensive maneuver employed by individuals or whole organizations that targets computer information systems, infrastructures, computer networks, and/or personal computer devices by various means of malicious acts usually originating from an anonymous source that either steals, alters, or destroys a specified target by hacking into a susceptible system.	
Terrorism	Incidents involving the application of one or more modes of harmful force to the built environment. These modes may include contamination (chemical, biological, radiological, or nuclear), energy (explosives, arson, electromagnetic waves), or denial of service (sabotage, infrastructure breakdown, and transportation service disruption). Terrorism is categorized as either domestic or international.	Texas Parks and Wildlife Department (TPWD) Law Enforcement has primary responsibility for water safety enforcement in all state public waters. State entities work with the US Coast Guard (USCG) and responsible parties to direct resources to stop, contain and clean up maritime spills.
Extreme Heat	Extreme heat is the condition whereby temperatures hover ten degrees or more above the average high temperature in a region for an extended period. If extreme heat conditions persist, it may be considered a heat wave.	The five historical heat events reported by NCDC from 1950 to 2016 suggest that the planning area and all participating jurisdictions can expect a 7.5% annual occurrence of extreme heat events. The expected reoccurrence interval of extreme heat events is about 13.2 years.

Exhibit 11-3. Map Tropical Storm and Hurricane Tracks across the Region



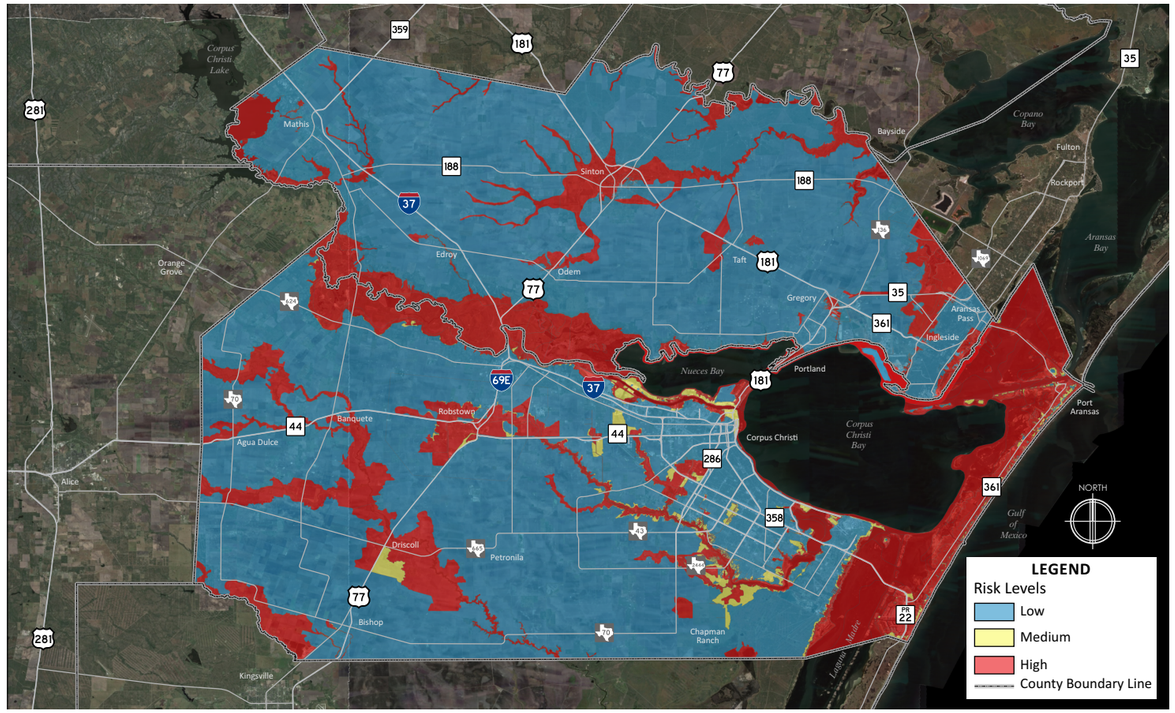


Exhibit 11-4. Map of Flood Hazard Zones

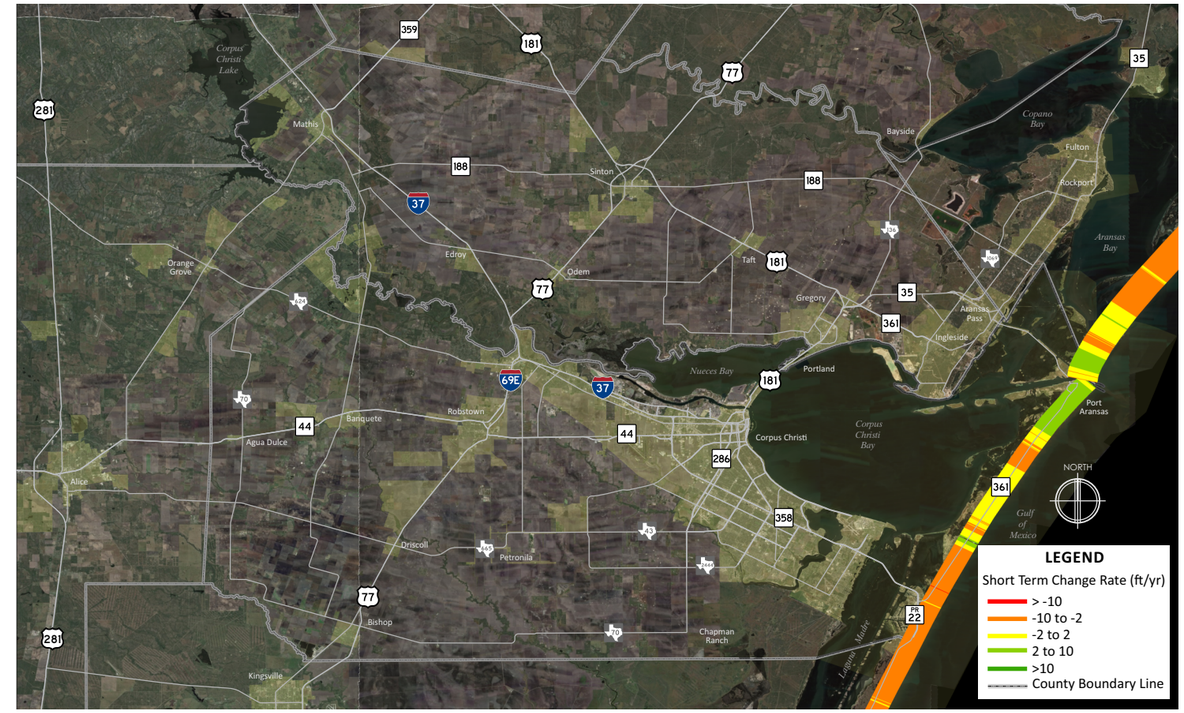


Exhibit 11-5. Map of Critical Erosion Areas

PLANNING FOR SECURITY

In 2004, the US. Department of Homeland Security introduced the National Response Plan and the National Incident Management System. Emergency operations plans address the ability to direct, control, coordinate, and manage emergency operations. The National Response Plan establishes a comprehensive, national, all-hazards approach to domestic incident management. NIMS provides a nationwide template enabling government and non-government emergency responders to use a coordinated and modular approach based on the Incident Command System. Federal preparedness funding is conditioned upon full compliance with NIMS, which means local jurisdictions have:

- Adopted NIMS through resolution or legislation as the local jurisdiction's all hazard, incident response system.
- Had appropriate personnel complete NIMS training.
- Completed regular self-assessments of NIMS programs.

LOCAL ALL-HAZARDS PLANNING

In Texas, the initial response to emergencies and disasters is conducted by local jurisdictions working with city or county emergency management officials. A local government is expected to use its own resources and the resources available to it through mutual aid agreements before requesting assistance from the state. However, early communication and coordination is encouraged when additional resource needs are anticipated. The all-hazards planning approach includes four phases of long-term and short-term preparedness.

Mitigation	1. Identify threats to systems and resources. 2. Develop plans, procedures, and organizational structure to ensure that the safe and timely movement of both the public and emergency services during an incident. 3. Maintain sufficiency ratings and other data such as built plans for primary bridges and critical transportation infrastructure.
Preparedness	1. Identify and maintain a network of available local, county, and state resources to aid safe and timely movement of the public and emergency-service resources. 2. Participate in training sessions and exercises. 3. Evaluate agency emergency operations plans. 4. Ensure that administrative and accounting procedures are in place to document actions taken and costs incurred during incident operations. 5. Ensure that on-call contracts with engineering companies and construction contractors include provisions for emergency services.
Response	1. Select and contact appropriate personnel. 2. Designate personnel authorized to enter affected area and provide this information to the Office of Emergency Management. 3. Provide a representative to the Office of Emergency Management, as requested. 4. Confirm and report the level, severity, and extent of involvement. 5. Provide and coordinate public information through the Emergency Operations Center and Joint Information Center, if activated. 6. Coordinate with law-enforcement personnel for maintaining security of facilities and supplies.
Recovery	1. Coordinate and organize long-term plans for the safe movement of the public and emergency service resources. 2. Provide documentation on injuries and/or deaths of persons resulting from the incident.

If a jurisdiction's response resources are overwhelmed, imminently threatened or a local jurisdiction is anticipating a resource need, the jurisdiction may request aid from the District Disaster Committee (DDC). The DDC is the clearinghouse for local emergency response support from state agencies and entities. When activated, the DDC is also the liaison between the local jurisdictions and the State Operations Center (SOC). The SOC is the coordination and communications hub, allowing personnel to gather, evaluate, and distribute critical information and resources and to respond to emergencies and disasters.

STATE OF TEXAS EMERGENCY OPERATION PLAN

When local government capabilities are taxed, state government has resources and expertise available to provide emergency or disaster assistance. The State of Texas *Emergency Operations Plan* defines the organization, establish operational concepts, assign responsibilities and outline coordination procedures for achieving emergency management. The overall objectives of the State Plan are to:

- Protect all people against the greatest threats and hazards in a manner that allows vital interests and way of life to thrive.
- Reduce the loss of life and property by lessening the impact of disasters.
- Respond quickly to save lives, protect property and the environment, and meet basic human needs in the aftermath of an incident.
- Assist communities recovering from an incident with continued stabilization of vital life support systems and community restoration.

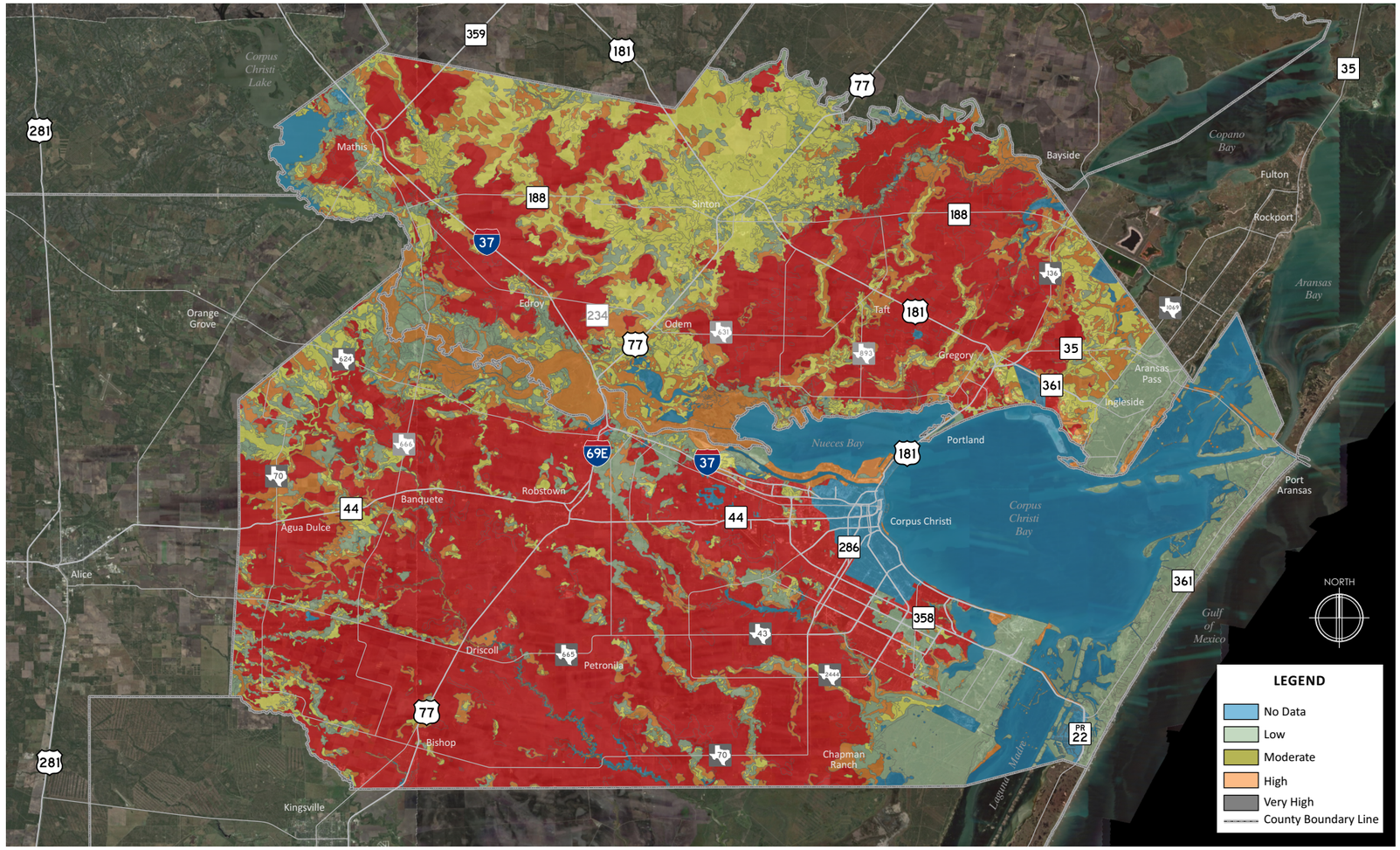


Exhibit 11-6. Map of Soil Distribution by LEP Shrink-Swell Classification

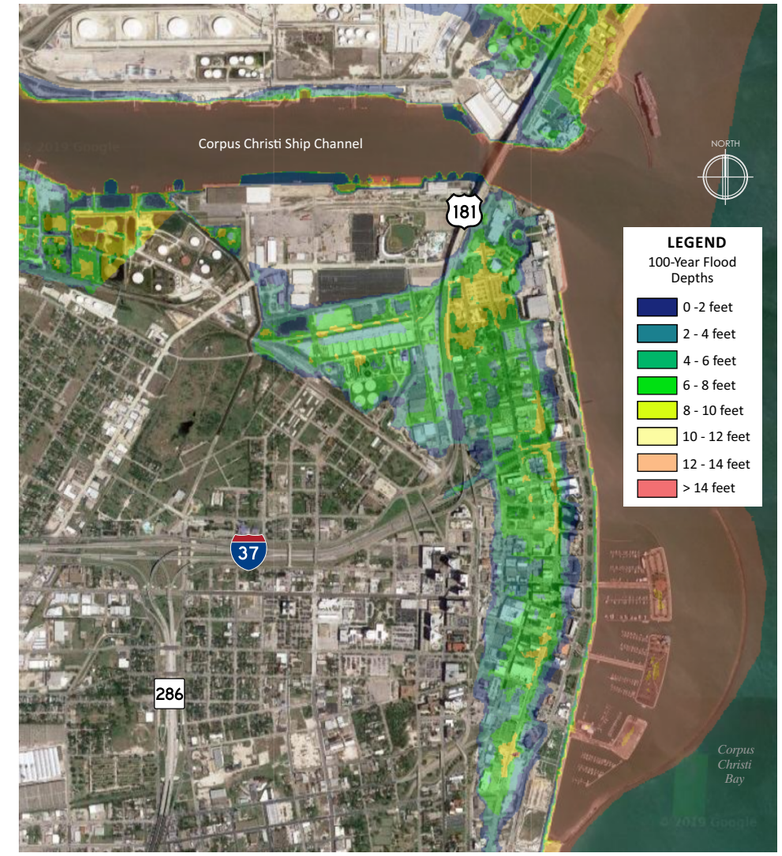


Exhibit 11-7. Map of Downtown Corpus Christi 100-year Flood Depths

Texas Department of Transportation

The Texas Department of Transportation's role in emergency management consists primarily of safeguarding and maintaining the state transportation system in the affected area and facilitating and coordinating evacuation routes that use the state transportation system. TxDOT coordinates with DPS THP and local law enforcement and fire personnel to respond to highway incidents, clear roadways and conduct appropriate repairs. Law enforcement personnel play a critical role in conducting traffic control while accident investigations and roadway clearance are underway. Law enforcement personnel and TxDOT coordinate closely to implement road closures when necessary to respond to immediate life safety threats. TxDOT traffic management centers (TMC) provide operational and project delivery support for the agency's geographical districts. TMCs monitor traffic and transportation systems using real-time video displays. Local and regional TMCs report issues to the TxDOT District in which the incident occurred or to the TxDOT Maintenance Division, which responds to repair highway infrastructure. During emergencies TMCs provide situation reports and can act as communications centers to assist in coordinating the flow of information. TxDOT district maintenance engineers and hazardous materials coordinators work with other government entities such as TCEQ, DPS and local fire departments to ensure all appropriate entities are notified when hazardous materials incidents impact highways.

Corpus Christi MPO Involvement

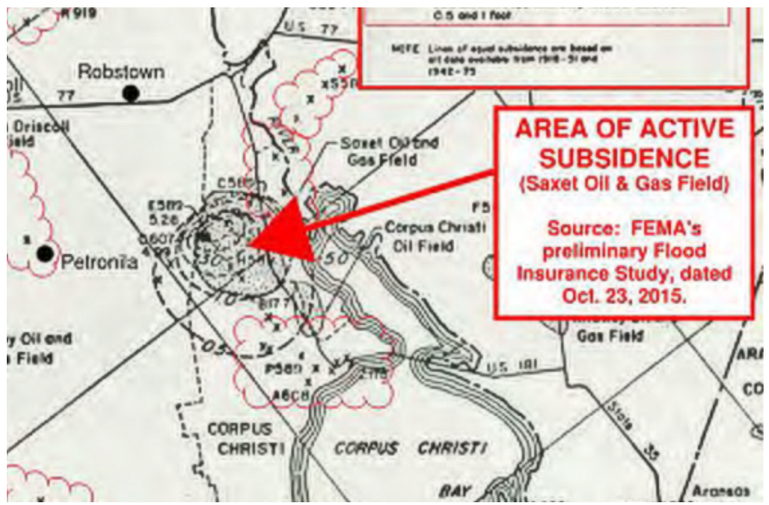
The role of a metropolitan planning organization in security and emergency management efforts varies based upon the political and institutional context of its region. As a facilitator of local government collaboration, the Corpus Christi Metropolitan Planning Organization can assist in multiple ways. The MPO can serve as a forum for cooperative decision-making, or as an advocate for funding of regional transportation strategies. At the technical level, Corpus Christi MPO provides transportation network-based technical analyses to assess impacts of, and needs related to, transportation-related security and emergency management efforts. An example of this is using the regional travel model to assist with planning for hurricane evacuation. The MPO may also facilitate coordination on security matters with other agencies. Opportunities to participate and/or provide direct services vary, but include:

- Conduct vulnerability analyses on regional facilities and services;
- Develop GIS information and data for roadways and bridges
- Disseminate best practices in incident-specific engineering design and emergency responses to agencies involved;
- Encourage regional emergency operations preparedness and response workshops;
- Comment on portions of the locally developed Emergency Preparedness Guide for elected officials;
- Engage non-traditional stakeholders into the planning processes;
- Coordinate with Emergency Management and local officials on road construction projects that may impact evacuation routes.

Transportation Network Resiliency in the Corpus Christi MPO Region

Transportation resiliency is defined as a system's ability to function before, during and after major disruptions through reliance upon multiple mobility options. The Corpus Christi MPO will evaluate all National Highway System roadway links, a critical part of the regional transportation network's resiliency, and has rank them within the two-county area by their security criticality. Our rationale is the knowledge that a small set of key roadways in the region are of enormous value in the case of a security alert of the kinds noted in this chapter. As an example, if a two-way segment of SPID were removed from service, traffic and emergency vehicles would need to find an alternative route. An objective measure of highway-segment criticality provides actionable information to regional planners. For example, certain road segments may require immediate repair if they are compromised, not based on the average annual daily traffic alone, but also on the number or efficiency of alternate routes available and the total regional time lost by using a detour.

Exhibit 11-8. Map of Oil & Gas Field Area of Active Subsidence



REGIONAL NETWORK CRITICALITY ANALYSIS

The critical transportation system includes roadways, ferries, and rail lines that provide accessibility to, and evacuation from, the economic and community centers within the region. The National Highway System consists of roadways important to the nation's economy, defense, and mobility.

Considerations of bridges alone point to some of the increased risks to infrastructure from recurrent extreme weather. For example: bridges in coastal zones exposed to storms with higher water/wave energy than was anticipated in their original design. Bridges that were built outside of currently identified FEMA zones may have been designed with potentially no assessment of surge / flooding risk and these bridges may now be in surge risk areas due to expanding future surge zones.

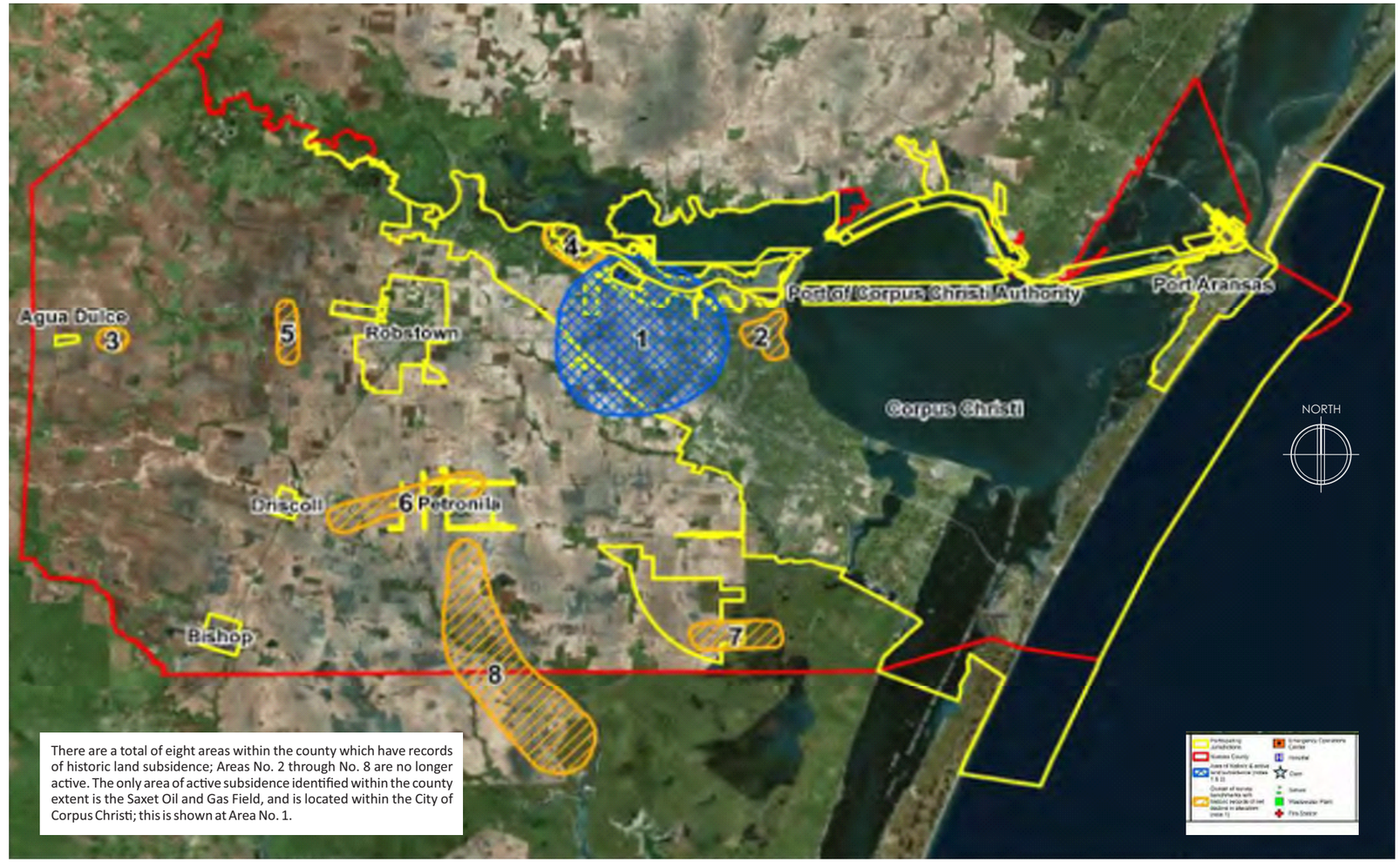


Exhibit 11-9. Map of Subsidence Areas in Corpus Christi MPO Planning Area

Exhibit 11-10. Map of Potential Impacts of Storm Surge

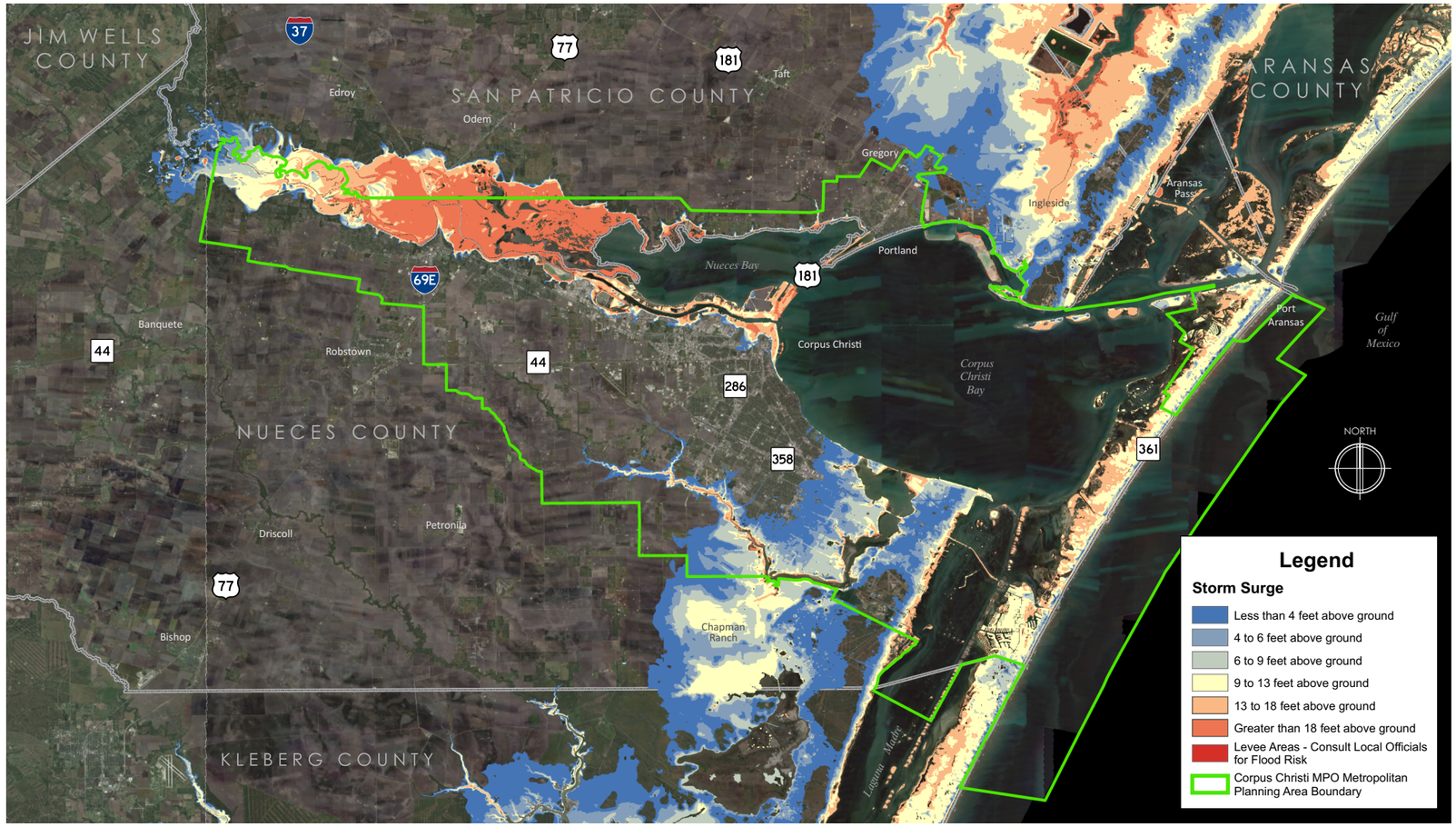
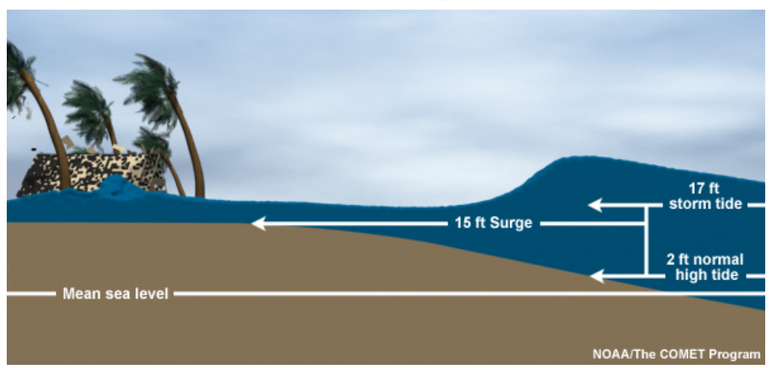


Exhibit 11-11. Illustration of Storm Surge



Findings

Potential Impacts of Storm Surge on Transportation Assets

CORPUS CHRISTI MPO SECURITY AND RESILIENCY POLICY

Decision-making on transportation investments and resiliency is a challenging exercise which requires considering the risk from uncertain events and the effect that those events may have on the transportation system, all while making appropriate financial decisions. This section outlines the rationale and approach developed to identify the set of policies recommended at the conclusion of this report. The recommended strategies in this section are based on the following guiding principles:

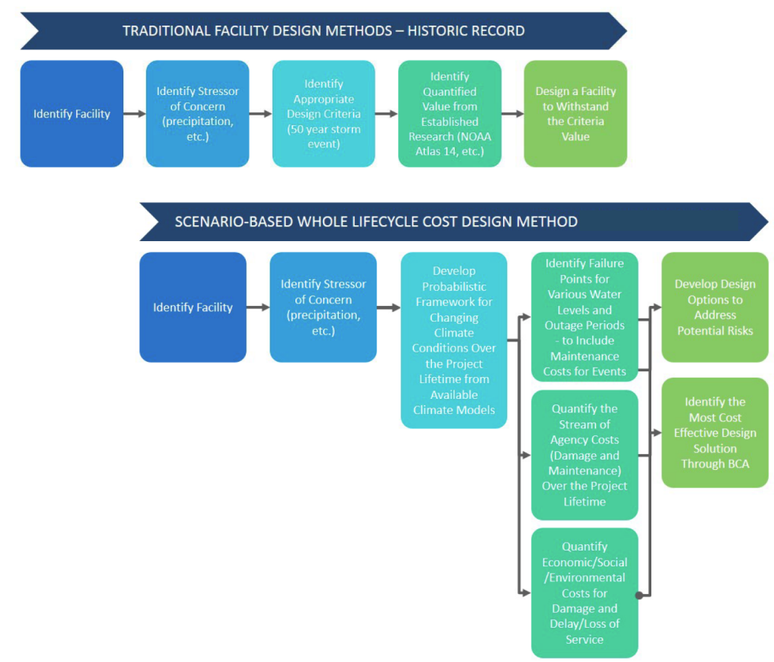
- The likelihood and location of a disaster is uncertain, but actions need to be taken now to reduce risk. Continuing to invest using current practices does not create a resilient system.
- Transportation investments of today should be made to ensure viability for the life-cycle of the infrastructure.
- Investments should be made to reduce potential risk over time and ensure the long-term viability of the transportation system.

From the perspective of long-term transportation investment decisions within the Corpus Christi MPO region, additional study is needed to identify the next steps toward adapting the system to be more resilient. The investment and policy questions that need answering require future detailed study and data collection and will enable the local and state entities to assess recommended projects based on the following key questions:

- How might projects in the existing capital investment programs be reconsidered given the potential risks inherent from extreme weather?
- How should projects be developed and implemented to increase system resiliency to disaster?
- How might transportation investments be affected by disasters in ways that may reduce their lifetimes?

Uncertainties in frequency of occurrence of extreme events has resulted in the development of risk-based methods for facility design. These methods incorporate a design focus that moves away from traditional criteria-based design methods applied today and instead assess the long-term implications of climate change in terms of the implications of change over time and what implications those changes may have on transportation facilities and the customers that utilize them.

Exhibit 11-12. Chart of Facility Design Methods



KEY TRANSPORTATION ASSETS

Key transportation system assets in the Corpus Christi MPO Planning Area include:

- Interstate Highway System
- National Highway System Routes
- Strategic Highway Network Routes, the road system deemed necessary for emergency mobilization and peacetime movement of equipment, fuel, repair parts, food, and other commodities to support U.S. military operations of the two installations.
- Transit system, particularly important relative to its potential contribution to the evacuation of areas.
- Corpus Christi Airport, other airports
- Port of Corpus Christi Authority
- The UP, KCS, BNSF Rail Line Corridor

Most of these facilities are linear in nature, and while risks exist across these networks due to a potential incident, there is built-in redundancy from the supporting network of state, county, and city roadways that can serve as alternate routes. However, there are elements of these networks, such as key bridges, that, if damaged, would have a more significant effect on the operation of the system.

An assessment to identify potentially important bridge facilities should be carried out. The key criteria should include:

- Casualty risk
- Economic disruption
- Military support
- Emergency relief

RECOMMENDED FUTURE ACTIVITIES

The following transportation tasks are included in this plan:

Task 1 - Continue to identify and collaborate with other state and local agency and private-sector efforts to enhance security planning for the transportation system.

Task 2 - Work to provide safe and secure facilities and transportation infrastructure for residents, visitors, and commerce in the Corpus Christi MPO planning area through efforts to reduce injuries, fatalities, and property damage for all modes of transportation, and to minimize security risks at airports, rail stations, rest areas, and public transportation facilities and on roadways and bikeways.

Task 3 - Work with emergency-management officials on the following transportation-related issues, based on priorities established in cooperation with officials, to:

- Complete a risk and vulnerability assessment of transportation assets.
- Assist in development of evacuation routes from important activity areas, and include an assessment of improvement needs in future long-range plans.
- Assist in preparation of alternate route/detour planning to facilitate response to closing major transportation arteries.
- Provide assistance in analyzing the transportation network for redundancies in moving large numbers of people in response to events such as closures of major highway links through various means, including use of alternate routes, adaptive signal control strategies, and dissemination of information through traveler information systems.
- Assist in preparation of demographic profile information and a geographic inventory of transportation-disadvantaged populations that may need assistance during a disaster, to facilitate evacuation and determine if current deployable assets will be available and adequate. This could include assessment of the number of people who may not be able to self-evacuate, planning of staging areas for pick-up and drop-off, and assisting in community outreach on emergency preparedness to populations such as those with limited English proficiency.

As is the case in similar metropolitan areas, system preservation, in many cases through rehabilitation and reconstruction of existing facilities, is one of the most important goals of transportation decision-makers. Given that much of the transportation infrastructure in the Corpus Christi region has been in place for decades and needs rehabilitation in the immediate future, an opportunity exists to use the rehabilitation and reconstruction process to upgrade designs to reduce the threat from disasters.

Redesign drainage systems to handle larger flows. In many ways, this includes recommendations for all project reconstruction and rehabilitation. However, given the importance of drainage systems to projects in the Corpus Christi region, it is called out as a separate recommendation. The handling of water, either in areas subject to high levels of flooding due to intense precipitation, has been a design challenge for decades in the study area. It is likely that this will continue to be a serious challenge in future years as environmental conditions change due to a changing climate. As before, drainage redesign would most likely occur when projects are being reconstructed or going through an upgrade process.

- Harden or armor key infrastructure components (e.g., embankments or bridge piers) against additional extreme weather-related stresses.
- Incorporate “early warning indicators” for potential extreme weather related risks into asset and maintenance management systems.
- Apply updated design criteria – and also if possible, consider realignments or relocation away from high risk areas.
- Identify pre-planned detour routes around critical facilities whose disruption or failure would cause major network degradation.
- Avoid significant disruptions and maintenance demands by “hardening” such items as sign structures and traffic signal wires.
- Keep culverts and drainage structures debris free and maintained to handle flows.
- Consider new road and transit design approaches and standards to minimize potential disruption due to extreme weather events (e.g., profile elevation).
- Identify and apply resiliency performance measures to improve redundancy and the adaptive capacity of the transportation system.
- Identify life-cycle cost prioritization criteria that can be used as part of the project priority / programming processes.
- Update the regional Dune Protection Plan and Erosion Response Plan
- Create a plan to preserve the unique ecosystems encompassing Hazel Bazemore Park by restoring the park's natural resources through the mitigation and protection of its habitat while concurrently providing public access and ecotourism opportunities for park patrons. The objectives of the proposed project are to implement an environmentally engineered plan by executing erosion control techniques, constructing riverbank stabilization, remediation of native vegetation, providing public access through timber walkways and nature overlooks; and protecting and preserving the habitat through interpretive signage educating the public.
- Restore, enhance and expand an existing wetland in the Corpus Christi Beach area by excavating an upland area and creating a hydrologic connection between the wetlands and Corpus Christi Bay. The connection will create a mix of tidal and fresh water and increase the environment available to aquatic species. Educational and informational signs will inform the public about the environment and the ecological value of wetlands and create public awareness to further promote the conservation and protection of the area.
- Design and install foundation watering systems to critical buildings to reduce shrink/swell potential, and to protect these structures from movement during drought conditions.
- Establish underground utilities to current and future County facilities as appropriate to prevent power and communications disruptions during a disaster.
- Incorporate additional flood proofing systems to county owned facilities go protect them from damages incurred during hurricanes.
- Alleviate flooding and nonpoint source water and pollutants entering into the watershed by constructing a stormwater detention pond/swale system Upper Reaches of Oso Creek within Nueces County. incorporating best management practices. The wet ponds will remove pollutants from storm water (bacteria, sediment, and dissolved nutrients) by settling suspended particulates, biological uptake, consumption of pollutants by plants, algae, and bacteria in the water, decomposition of some pollutants, and attenuation of bacterial coliform contaminants. The wet ponds proposed will maintain a permanent pool of water in addition to temporarily detaining stormwater. The large volume of storage in the pond also helps to reduce peak stormwater discharges which in turn help control downstream flooding and reduce scouring/erosion of stream banks.
- Buy-out Repetitive Loss Properties that are on FEMA's Repetitive Loss List for Nueces County.

Transportation Tasks (continued)

- Alleviate flooding and nonpoint source water and pollutants entering into the watershed by constructing a stormwater detention pond/swale system Chapman Ranch Reaches of Oso Creek within Nueces County. incorporating best management practices. The wet ponds will remove pollutants from storm water (bacteria, sediment, and dissolved nutrients) by settling suspended particulates, biological uptake, consumption of pollutants by plants, algae, and bacteria in the water, decomposition of some pollutants, and attenuation of bacterial coliform contaminants. The wet ponds proposed will maintain a permanent pool of water in addition to temporarily detaining stormwater. The large volume of storage in the pond also helps to reduce peak stormwater discharges which in turn help control downstream flooding and reduce scouring/erosion of stream banks.
- Alleviate flooding and nonpoint source water and pollutants entering into the watershed by constructing a stormwater detention pond/swale system Agua Dulce Reaches of the Petronila Creek watershed within Nueces County. incorporating best management practices. The wet ponds will remove pollutants from storm water (bacteria, sediment, and dissolved nutrients) by settling suspended particulates, biological uptake, consumption of pollutants by plants, algae, and bacteria in the water, decomposition of some pollutants, and attenuation of bacterial coliform contaminants. The wet ponds proposed will maintain a permanent pool of water in addition to temporarily detaining stormwater. The large volume of storage in the pond also helps to reduce peak stormwater discharges which in turn help control downstream flooding and reduce scouring/erosion of stream banks.
- Alleviate flooding and nonpoint source water and pollutants entering into the watershed by constructing a stormwater detention pond/swale system Driscoll Reach of the Petronila Creek Watershed within Nueces County. incorporating best management practices. The wet ponds will remove pollutants from storm water (bacteria, sediment, and dissolved nutrients) by settling suspended particulates, biological uptake, consumption of pollutants by plants, algae, and bacteria in the water, decomposition of some pollutants, and attenuation of bacterial coliform contaminants. The wet ponds proposed will maintain a permanent pool of water in addition to temporarily detaining stormwater. The large volume of storage in the pond also helps to reduce peak stormwater discharges which in turn help control downstream flooding and reduce scouring/erosion of stream banks.
- Alleviate flooding and nonpoint source water and pollutants entering into the watershed by constructing a stormwater detention pond/swale system Petronila Reach of the Petronila Creek Watershed within Nueces County. incorporating best management practices. The wet ponds will remove pollutants from storm water (bacteria, sediment, and dissolved nutrients) by settling suspended particulates, biological uptake, consumption of pollutants by plants, algae, and bacteria in the water, decomposition of some pollutants, and attenuation of bacterial coliform contaminants. The wet ponds proposed will maintain a permanent pool of water in addition to temporarily detaining stormwater. The large volume of storage in the pond also helps to reduce peak stormwater discharges which in turn help control downstream flooding and reduce scouring/erosion of stream banks.
- Alleviate flooding and nonpoint source water and pollutants entering into the watershed by constructing a stormwater detention pond/swale system Bishop Reach of the Petronila Creek Watershed within Nueces County. incorporating best management practices. The wet ponds will remove pollutants from storm water (bacteria, sediment, and dissolved nutrients) by settling suspended particulates, biological uptake, consumption of pollutants by plants, algae, and bacteria in the water, decomposition of some pollutants, and attenuation of bacterial coliform contaminants. The wet ponds proposed will maintain a permanent pool of water in addition to temporarily detaining stormwater. The large volume of storage in the pond also helps to reduce peak stormwater discharges which in turn help control downstream flooding and reduce scouring/erosion of stream banks.

Exhibit 11-13. Table of Assets of Concerns

Asset	Issue	Concern	Mitigation
Roadways	Pavement	Potential for pavement washouts	Add design features at edges to reduce washouts
Roadways	Pavement	Extended surge area inland, where pavement design would not likely have considered storm surge	Add anchoring during pavement rehabilitation cycles
Roadways	Embankments	Erosion of embankments - higher surge levels for structures where surge was considered and erosion effects in areas where surge was not previously considered	Add embankment erosion control meaures
Bridges	Decks	Surge impacts on bridge decks - superstructure floating away, damage to anchoring	Explore anchoring or raise the bridge deck
Bridges	Foundation	Increase in flow and velocity undermining foundations through scour for bridges analyzed previously for scour	Add scour protection measures
Bridges	Foundation	Scour potential at bridges where surge was not previously considered, impact on erosion walls, etc.	Add scour protection measures
Bridges	Approaches	Water flowing over approaches causing uplift and damaging approaches	Anchor or redesign approaches
Bridges	Approaches	Flowing water washes out approaches to bridges	Redesign approaches

WHERE TO GET INFORMATION

- During an emergency, accurate information can often be very difficult to come by. Through the LEPC, several emergency notification systems have been put in place. The below information is current as of late 2019.
- **826-INFO (4636)**: The Information Line is a phone number you can call to receive recorded information during a chemical emergency. Please do not call 9-1-1 just for information, 9-1-1 should only be used to report an emergency or request assistance from fire, police, and EMS.
- **KLUX 89.5 FM**: During a major community emergency, 89.5 FM will begin broadcasting emergency information about the incident. This information will come directly from local emergency management officials.
- **NOAA Alert Radio**: These radios can provide important emergency information for all types of hazards, not just weather.
- **Reverse Alert Notification System**: The system notifies you by phone, text, or email about imminent danger. Reverse alerts are automatically sent to residents in areas affected and include information about storms, fires, flash floods, industrial accidents, roadway closures, evacuations, crime bulletins, and other incidents that threaten public safety. Sign up at www.reversealert.org to receive notifications.
- **Local TV/Radio and the Emergency Alert System (EAS)**: The EAS can be used to send emergency information directly to TV and radio stations. Information may be presented in the form of a screen "crawler" or program interruption.
- **Local Emergency Planning Committee (LEPC)**: The City of Corpus Christi-Nueces County Local Emergency Planning Committee is available by phone at (361)826-3960 or for information, go to **www.cclepc.org**.