HAZARD MITIGATION PLAN

Matagorda County

February 2017

Prepared For:
Matagorda County
Office of Emergency Management
2200 7th Street
Bay City, TX 77414

Matagorda County
HAZARD MITIGATION PLAN UPDATE

FEBRUARY 2017

Prepared for:

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Matagorda County
Hazard Mitigation Plan Update

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EXECUTIVE SUMMARY

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The Disaster Mitigation Act of 2000 (DMA) is federal legislation that requires proactive, pre-disaster planning as a prerequisite for some funding available under the Robert T. Stafford Act. The DMA encourages state and local authorities to work together on pre-disaster planning. The planning network called for by the DMA helps local governments articulate accurate needs for mitigation, resulting in faster allocation of funding and more cost-effective risk reduction projects.

Hazard mitigation is the use of long- and short-term strategies to reduce or alleviate the loss of life, personal injury, and property damage that can result from a disaster. It involves strategies such as planning, policy changes, programs, projects, and other activities that can mitigate the impacts of hazards. It is impossible to predict exactly when and where disasters will occur or the extent to which they will impact an area. However, with careful planning and collaboration among public agencies, stakeholders, and citizens, it is possible to minimize losses that disasters can cause. The responsibility for hazard mitigation lies with many, including private property owners; business and industry; and local, state, and federal government.

Matagorda County and a partnership of local governments within the county have developed and maintained a hazard mitigation plan to reduce risks from natural disasters and to comply with the DMA.

PLAN UPDATE

Federal regulations require monitoring, evaluation, and updating of hazard mitigation plans. An update provides an opportunity to reevaluate recommendations, monitor the impacts of implemented actions, and evaluate whether there is a need to change the focus of mitigation strategies. A jurisdiction covered by a hazard mitigation plan that has expired is no longer in compliance with the DMA.

Matagorda County and its communities participated in previous hazard mitigation plans as part of the Texas Colorado River Floodplain Coalition (TCRFC). The TCRFC is a non-profit, 501(c)(3) organization formed in June 2001 by the cities and counties of the Lower Colorado River Authority (LCRA) in response to flood devastation requiring more coordinated damage prevention efforts. In 2004, the TCRFC developed a Hazard Mitigation Action Plan entitled *Creating a Disaster Resistant Lower Colorado River Basin*, which was approved by the Federal Emergency Management Agency (FEMA) in 2004. In 2011, TCRFC completed the *TCRFC Multi-Jurisdictional Hazard Mitigation Plan Update 2011-2016* as a regional partnership of 15 counties (including Matagorda County) and 63 jurisdictions. The 2011-2016 update was completed with technical support from the LCRA and the outside consultant team of H20 Partners, Inc., and PBS&J. This Plan has been developed to be specific to Matagorda County and its participating communities: the Cities of Bay City and Palacios.

The development of this new hazard mitigation plan specific to Matagorda County and the participating communities consisted of the following phases:

- **Phase 1: Organize and Review**—A planning team was assembled to provide technical support for the plan update, consisting of TCRFC representatives, key county and city staff, and a team of technical consultants. The first step in developing the plan update was to re-establish a planning partnership. Planning partners participating in the update were the Cities of Bay City and Palacios. A Steering Committee was assembled to oversee the plan update, consisting of planning partner staff and community representatives from the planning area. Coordination with other county, state, and federal agencies involved in hazard mitigation occurred throughout the plan update process. This phase included a comprehensive review of the previous *TCRFC Multi-Jurisdictional Hazard Mitigation Plan Update 2011-2016*, the 2013 *State of Texas Hazard Mitigation Plan*, and existing programs that may support or enhance hazard mitigation actions.
- **Phase 2: Update the Risk Assessment**—Risk assessment is the process of measuring the potential loss of life, personal injury, economic impact, and property damage resulting from natural hazards. This process assesses the vulnerability of people, buildings, and infrastructure to

natural hazards. All facets of the risk assessment of the plan were re-visited by the planning team and updated with the best available data and technology. The work included the following:

  - Hazard identification and profiling
  - Assessment of the impact of hazards on physical, social, and economic assets
  - Vulnerability identification
  - Estimation of the cost of potential damage

- **Phase 3: Engage the Public**—A public involvement strategy agreed upon by the Steering Committee was implemented by the planning team. All meetings were open to the public. Meetings were held to present the risk assessment as well as the draft plan. The public was encourage to participate through a county-specific hazard mitigation survey and the county website that included information on the plan.
- **Phase 4: Assemble the Updated Plan**—The planning team and Steering Committee assembled key information into a document to meet the DMA requirements for all planning partners.
- **Phase 5: Adopt/Implement the Plan**—Once pre-adoption approval has been granted by the Texas Division of Emergency Management and FEMA Region VI, the final adoption phase will begin. Each planning partner will individually adopt the updated plan. The plan maintenance process includes a schedule for monitoring and evaluating the plan's progress annually and producing a plan revision every 5 years. Throughout the life of this plan, a representative of the original Steering Committee will be available to provide consistent guidance and oversight.

MITIGATION GUIDING PRINCIPLE, GOALS, AND OBJECTIVES

The guiding principle for the Matagorda County Hazard Mitigation Plan Update is as follows:

- To reduce or eliminate the long-term risks to loss of life and property damage in Matagorda County and the participating communities from the full range of natural disasters.

The following plan goals and objectives were determined by the Steering Committee:

- **Goal 1:** Protect public health and safety.
  - **Objective 1.1:** Advise the public about health and safety precautions to guard against injury and loss of life from hazards.
  - **Objective 1.2:** Maximize the utilization of the latest technology to provide adequate warning, communication, and mitigation of hazard events.
  - **Objective 1.3:** Reduce the damage to, and enhance protection of, dangerous areas during hazard events.
  - **Objective 1.4**: Protect critical facilities and services.
- **Goal 2:** Protect existing and new properties.
  - **Objective 2.1:** Reduce repetitive losses to the National Flood Insurance Program.
  - **Objective 2.2:** Use the most cost-effective approaches to protect existing buildings and public infrastructure from hazards.
  - **Objective 2.3:** Enact and enforce regulatory measures to ensure that development will not put people in harm's way or increase threats to existing properties.
- **Goal 3:** Increase public understanding, support, and demand for hazard mitigation.
  - **Objective 3.1:** Heighten public awareness of the full range of natural hazards they face.

  - **Objective 3.2:** Educate the public on actions they can take to prevent or reduce the loss of life or property from natural hazards.
  - **Objective 3.3:** Publicize and encourage the adoption of appropriate hazard mitigation measures.
- **Goal 4:** Build and support local capacity and commitment to continuously become less vulnerable to hazards.
  - **Objective 4.1:** Build and support local partnerships to continuously become less vulnerable to hazards.
  - **Objective 4.2:** Build a cadre of committed volunteers to safeguard the community before, during, and after a disaster.
  - **Objective 4.3:** Build hazard mitigation concerns into planning and budgeting processes.
- **Goal 5:** Promote growth in a sustainable manner.
  - **Objective 5.1:** Incorporate hazard mitigation into the long-range planning and development activities.
  - **Objective 5.2:** Promote beneficial uses of hazardous areas while expanding open space and recreational opportunities.
  - **Objective 5.3:** Utilize regulatory approaches to prevent creation of future hazards to life and property.
- **Goal 6:** Maximize the resources for investment in hazard mitigation.
  - **Objective 6.1:** Maximize the use of outside sources of funding.
  - **Objective 6.2:** Maximize participation of property owners in protecting their properties.
  - **Objective 6.3:** Maximize insurance coverage to provide financial protection against hazard events.
  - **Objective 6.4:** Prioritize mitigation projects, based on cost-effectiveness and starting with those sites facing the greatest threat to life, health, and property.

IDENTIFIED HAZARDS OF CONCERN

For this plan, the Steering Committee considered the full range of natural hazards that could impact the planning area and then listed hazards that present the greatest concern to the county and the participating communities. The process incorporated review of state and local hazard planning documents, as well as information on the frequency, magnitude, and costs associated with hazards that have impacted or could impact the planning area. Anecdotal information regarding natural hazards and the perceived vulnerability of the planning area's assets to hazards was also included. Based on the review, this plan addresses the following natural hazards of concern:

- Coastal Erosion
- Dam/Levee Failure
- Drought
- Expansive Soils
- Extreme Heat
- Earthquake
- Flood
- Hail
- Hurricane and Tropical Storm
- Lightning
- Tornado
- Wildfire
- Wind
- Winter Weather

MITIGATION ACTIONS

Mitigation actions presented in this plan update are activities designed to reduce or eliminate losses resulting from natural hazards. The update process resulted in the identification of 54 mitigation actions targeted for implementation by individual planning partners as listed in Table ES-1. The Steering Committee ranked the mitigation actions in order of priority, with 1 being the highest priority. The highest priority mitigation actions are shown in red on the table, medium priority actions are shown in yellow and low priority actions are shown in green.

TABLE ES-1.
RECOMMENDED MITIGATION ACTIONS

Action No.	Title	Description	Mitigation Action Ranking	Action Type	Applicable Goals	Responsible Department	Estimated Cost	Potential Funding Sources	Timeline	Benefit
MATAGORDA COUNTY										
1	Install automated Flood Warning Systems	Prevent surprise flooding that public might not be aware of especially on the Tres Palacios River.	7	SIP	G1, G2	Emergency Management	$10,000 to $100,000	FMA, CDBG	36	Medium
2	Construct tornado and hurricane safe rooms	Construct tornado and hurricane safe rooms with the proper design for windstorm requirements.	8	EAP	G3, G6	Emergency Management	< $10,000	State and federal grants	48	Medium
3	Waterproofing Ordinance	Require structures to be surrounded by an impermeable apron around the structures to keep water away from the foundation thus minimizing expansive soils and flooding issues – Commissioners' have to approve changes made to the ordinance.	16	SIP EAP	G1, G2	Environmental Health Dept	< $10,000	State and federal grants	36	Medium
4	Education on hail damage	Inform the public on county website on how to prevent or alleviate hail damage: install roofing material of stronger quality, enforce county codes, and encourage farmers to become more educated about protection of crops.	11	EAP	G1, G3,	Public Works	< $10,000	PDM, HMGP	36	Medium
5	Build new water reservoirs for water supply	Build new water reservoirs for water supply & wildfire fighting. The reservoirs would be impounded behind 12- to-15 foot high dikes on farmland.	9	LPR SIP	G1	Emergency Management	< $10,000	County funds	60	Medium
6	Education on tornado awareness and knowledge of insurance needs	Inform the public on county website.	12	EAP	G1, G4	Emergency Management	< $10,000	Rural development grants	36	High

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RECOMMENDED MITIGATION ACTIONS

Action No.	Title	Description	Mitigation Action Ranking	Action Type	Applicable Goals	Responsible Department	Estimated Cost	Potential Funding Sources	Timeline	Benefit
7	Beach Restorations Program	Plant dune vegetation seaward and strengthen dunes. The County will work with Commissioner's Court, Beach Dune Committee and Emergency Management for specific sections of the beach.	2	NSP	G1, G5	Emergency Management	>$100,000	State and federal grants	24	Medium
8	Design & construct drainage improvement projects	Design and construct drainage improvement projects along Perryman Avenue, Humphrey Avenue, Moore Avenue, and Johnson Avenue. These drainage channels will be constructed to carry 25-year flood events.	6	SIP	G1, G2, G6	Public Works	>$100,000	Local, CDBG and FEMA	36	Medium
9	Expand rainfall observer program through CoCoRaHS	This non-profit organization uses volunteers to measure and map precipitation. Sometimes specific rain, hail, and snow totals are unknown in the County.	17	EAP	G3	Emergency Management	< $10,000	County funds, grants	12	Medium
10	Purchase and install generators including auto switch	Purchase generators to use during outages at Precinct Barn's, County Office Building and critical facilities to provide back-up power from hazard events of extreme heat, flood, earthquake, hail, hurricane/tropical storms, lightning, tornado, wildfire, wind, and winter weather.	5	SIP	G1	Emergency Management	< $10,000	HMGP, other grants	36	Medium

TABLE ES-1.
RECOMMENDED MITIGATION ACTIONS

Action No.	Title	Description	Mitigation Action Ranking	Action Type	Applicable Goals	Responsible Department	Estimated Cost	Potential Funding Sources	Timeline	Benefit
11	Conduct outreach and educate public about natural hazards	Conduct outreach at local events and educate public using County website about the full range of hazards we face and how to protect themselves & their homes during drought, extreme heat, flooding, earthquake, hurricanes and tropical storms, lightning, thunderstorms, tornadoes, all winter weather, and wildfire.	13	EAP	G1, G3	Emergency Management	< $10,000	County funds	36	Medium
12	Flood insurance	Promote the benefits of purchasing flood insurance to minimize the financial impact of future floods with pamphlets and county website.	14	EAP	G2, G3	Environmental Health Dept	< $10,000	County funds	36	High
13	Update the Matagorda County Flood Insurance Study and FIRMs	Detailed floodplain information for all streams in needed.	3	LPR	G2, G5	Emergency Management	$10,000 to $100,000	FEMA	24	High
14	Provide support to the TCRFC for flood reduction projects	Flood reduction projects need regional support.	15	SIP	G2, G5	Environmental Health Dept	$10,000 to $100,000	State and federal grants	60	High
15	Install Reverse 911 Emergency Notifications System	Purchase & install Reverse 911 Emergency Notifications System to be used for the following hazard notifications: dam failure, extreme heat, flood, earthquake, hail, hurricane/tropical storms, lightning tornado, wildfire, wind, and winter weather.	1	EAP	G1, G3	Environmental Health Dept	< $10,000	County funds	24	Medium

TABLE ES-1.
RECOMMENDED MITIGATION ACTIONS

Action No.	Title	Description	Mitigation Action Ranking	Action Type	Applicable Goals	Responsible Department	Estimated Cost	Potential Funding Sources	Timeline	Benefit
16	Inspect, improve and certify flood protection levees	Protecting property and residents inside the Ring Levee.	4	NSP	G1, G2	Environmental Health Dept	>$100,000	County, USACE, FEMA	12	Medium
17	Establish Burning Ordinance	During drought conditions, establish burning procedures for new ordinance	10	LPR	G1	Emergency Management	< $10,000	County funds	12	Medium
CITY OF BAY CITY										
1	Update Building Codes	Adopt updated building codes the require tornado, wind, fire, hail, earthquake, ground movement, and impact resistant materials (windows, doors, roofing, construction, siding, roof bracings); dry-proofing buildings; upgrading to higher standard insulation; installing lighting rods and grounding systems; retrofitting for low-flow plumbing; replacing landscaping with drought and fire resistant plants; implementing higher standards for foundations for expansive soils, and using R-value building materials to resist heat for residential and commercial construction.	2	LPR EAP	G1, G2, G5	Public Works	$10,000 to $100,000	Local, CDBG and FEMA	24	Medium

TABLE ES-1.
RECOMMENDED MITIGATION ACTIONS

Action No.	Title	Description	Mitigation Action Ranking	Action Type	Applicable Goals	Responsible Department	Estimated Cost	Potential Funding Sources	Timeline	Benefit
2	Drought and Expansive Soils Contingency Plan	Create & implement a drought emergency plan and criteria for drought/expansive soils related actions. Drought & extreme heat exacerbates expansive soils because large amounts of groundwater are withdrawn & not recharged at normal rates. When water is taken out of the soil, the soil collapse, compacts, and shrinks thus causing damage to infrastructure and structures.	4	LPR NSP	G1, G2, G4, G5	Public Works	>$100,000	Local, CDBG and FEMA	36	Low
3	Adopt sediment regulations	Develop, adopt and enforce a sediment and erosion control ordinance to eliminate erosion and expansive soils associated with construction and land development.	8	LPR	G3, G4, G5	Building Department	< $10,000	Local, CDBG and FEMA	36	Medium
4	Master Generator Plan & Purchase Generators	Develop a master generator plan and purchase generators and associated items. The generators are for identified critical facilities to provide back-up power from hazard events of dam/levee failure, extreme heat, flood, hail, hurricane/tropical storms, lightning, tornado, wildfire, wind, and winter weather.	1	LPR	G1, G2, G4, G5, G6	Public Works	$10,000 to $100,000	Operating budget and grants	36	Medium
5	Construct Regional Detention	Construct regional detention/retention ponds. Identify locations and obtain easements for planned and regulated public use for detention/retention and drainage.	3	LPR	G1, G2, G3, G5, G6	Public Works	< $10,000	Local, CDBG and FEMA	48	Medium

TABLE ES-1.
RECOMMENDED MITIGATION ACTIONS

Action No.	Title	Description	Mitigation Action Ranking	Action Type	Applicable Goals	Responsible Department	Estimated Cost	Potential Funding Sources	Timeline	Benefit
6	Retrofit water supply system	Improve water delivery system to save water by designing a water delivery system to mitigate drought conditions by installing new/upgrade existing systems to eliminate breaks.	13	SIP	G1, G4, G5, G6	Public Works	>$100,000	Local, CDBG and FEMA	36	Medium
7	Education on natural hazards affecting homeowners	Educate homeowners about how to mitigate the damage to homes caused by natural hazards. Inform the public on city website.	7	EAP	G1, G3,	Public Works	< $10,000	PDM, HMGP	60	Medium
8	Adopt Tree Ordinance	Adopt tree ordinance to promote planting of trees that can better withstand hazards with minimal damage to the tree and/or other property. Establish standards for all utilities and citizens regarding tree maintenance and pruning.	11	LPR NSP	G1, G2. G5	Public Works	$10,000 to $100,000	Local, CDBG, and FEMA	48	Medium
9	Institute a flood buy-out program	Create a voluntary buy-out program for residents that have repetitive flood and hurricane/tropical storm damages.	16	SIP	G2	Public Works	>$100,000	PDM, HMGP	48	Low
10	City's floodplain management ordinance	The floodplain management ordinance will be reviewed at a City Council meeting.	14	LPR	G2	Building Department	< $10,000	City funds	12	Medium

TABLE ES-1.
RECOMMENDED MITIGATION ACTIONS

Action No.	Title	Description	Mitigation Action Ranking	Action Type	Applicable Goals	Responsible Department	Estimated Cost	Potential Funding Sources	Timeline	Benefit
11	Flood insurance	Educate the public on the benefits of purchasing flood insurance to minimize the financial impact of future floods with pamphlets and city website.	6	EAP	G2, G3	Public Works	< $10,000	City funds	12	High
12	Design, construct, and maintain drainage improvement projects	Design, construct, and maintain drainage improvement projects to minimize the risk of loss of life and future flood damages by utilizing funding from all sources to improve drainage, specifically by increasing capacity of ditches and structures.	9	SIP	G1, G2, G6	Public Works	>$100,000	Local, CDBG, and FEMA	36	Medium
13	Provide training for CFM and CEM	Provide training for CFM and CEM.	10	EAP	G4	City Administration	< $10,000	Texas Emergency Management	24	Medium
14	Participate in FEMA's CRS.	Review requirements for CRS compared to current ordinance and design standards. Implement policies and procedures to meet CRS requirement and submit documentation for community rating.	15	LPR EAP	G1, G2, G3, G4, G5, G6	Floodplain manager	< $10,000	City funds	36	Medium
15	Inspect, improve, and certify flood protection levees and seawalls in Bay City	Develop and implement inspection and certification of the flood protection levees and flap gates. Use the inspections to plan and budget for necessary improvements.	12	LPR	G1, G2, G4, G6	Public Works	$10,000 to $100,000	Local, CDBG, and FEMA	24	Medium
16	Raise bridges above the BFE	Raise bridge above the BFE because bridges can be impassible during flooding events and homes are being flooded.	5	SIP	G2	Public Works	>$100,000	PDM, HMGP	36	Medium
CITY OF PALACIOS										

TABLE ES-1.
RECOMMENDED MITIGATION ACTIONS

Action No.	Title	Description	Mitigation Action Ranking	Action Type	Applicable Goals	Responsible Department	Estimated Cost	Potential Funding Sources	Timeline	Benefit
1	Construct new hardened Emergency Operation Center	EOC will be hardened by the use of tornado, wind, fire, hail, earthquake, ground movement, and impact resistant materials (windows, doors, roofing, construction, siding, roof bracings); dry-proofing buildings; upgrading to higher standard insulation; installing lighting rods and grounding systems; retrofitting for low-flow plumbing; replacing landscaping with drought and fire resistant plants; implementing higher standards for foundations to mitigate expansive soils, and using R-value building materials to resist heat.	2	SIP	G1	Building Department	>$100,000	Rural development grants	48	High
2	Install generators at City Hall complex and critical facilities	Install generators at City Hall complex to provide back-up power from hazard events of dam/levee failure, earthquakes, extreme heat, flood, hail, hurricane/tropical storms, lightning, tornado, wildfire, wind, and winter weather.	1	SIP	G1	Public Works	$10,000 to $100,000	PDM, Rural development grants, HMGP	36	High
3	Construct bulkhead along the west end of Tres Palacios Bay	Construct breakwater wall along west end of bay to reduce the wave action during storms to prevent erosion to wetlands and property.	7	SIP	G2	Building Department	>$100,000	Rural development grants, HMGP, USACE, CIAP	24	High

TABLE ES-1.
RECOMMENDED MITIGATION ACTIONS

Action No.	Title	Description	Mitigation Action Ranking	Action Type	Applicable Goals	Responsible Department	Estimated Cost	Potential Funding Sources	Timeline	Benefit
4	Extend breakwater jetty and groins to prevent damage to facilities and marina	Construct an extension to the 6th Street breakwater jetty and South Bay rock groins to prevent damage to marina and boat ramp.	9	SIP	G2	Building Department	>$100,000	Rural development grants, HMGP, USACE, CIAP	36	High
5	Purchase NOAA all-hazard radios	Purchase NOAA all-hazard radios available for businesses & residents	21	SIP	G1	Building Department	< $10,000	HMGP	60	Medium
6	Educate builders and homeowners of foundation shifting due to expansive soils	Provide information flyers to builders and homeowners on the effects of expansive soils on foundations and preventative measures around foundations.	16	EAP	G2, G3	Building Department	< $10,000	Rural development grants, USDA Grants	60	Medium
7	Prevention of utility failures	Replace old substandard water and sewer pipes with materials that are conducive to drought, expansive soils, & extreme heat conditions.	3	SIP	G1	Public Works	>$100,000	CDBG, Rural development grants, HMGP	24	High
8	Bury electrical lines to critical facilities	Bury power lines from public power to critical infrastructure to mitigate power outages to critical facilities during thunderstorms and other storms.	6	SIP	G2, G6	Building Department	$10,000 to $100,000	PDM, Rural development grants, HMGP	24	High
9	Building design and construction of roofs and pre-engineered windows	Require builders to engineer roofing systems and windows to sustain high winds or wind gusts.	15	SIP EAP	G1, G2, G5	Public Works	< $10,000	PDM, Rural development grants, HMGP	48	High

TABLE ES-1.
RECOMMENDED MITIGATION ACTIONS

Action No.	Title	Description	Mitigation Action Ranking	Action Type	Applicable Goals	Responsible Department	Estimated Cost	Potential Funding Sources	Timeline	Benefit
10	Education on hail damage	Inform the public on city website. Install roofing material of stronger quality, enforce codes and educate the general public about the damage caused by hail and how to prevent or alleviate it	20	EAP	G1, G3	Public Works	< $10,000	Rural development grants	24	Medium
11	Institute ordinances for tie-down requirements.	Inspect and require all manufactured homes to be tied down.	11	EAP	G1, G4	Public Works	< $10,000	Rural development grants	24	High
12	Raise bridges above the BFE	Bridges can be impassible during flooding events. Raise them above the base flood elevation.	8	SIP	G2	Public Works	>$100,000	Rural development grants	36	Medium
13	Increase drainage for airport property	Airport property has flash flooding problems.	4	SIP	G2	Public Works	$10,000 to $100,000	Rural development grants	36	High
14	Relocate Police Station outside Flood Zone B	Move the police station into old bank building. Also build a safe room inside to store records and use as EOC during disasters.	10	SIP	G2, G6	Public Works	>$100,000	Rural development grants, HMGP	24	High
15	Promote flood insurance	Educate the public on the benefits of purchasing flood insurance to minimize the financial impact of future floods using pamphlets and city website.	13	EAP	G2, G3	Public Works	< $10,000	City funds	24	High

TABLE ES-1.
RECOMMENDED MITIGATION ACTIONS

Action No.	Title	Description	Mitigation Action Ranking	Action Type	Applicable Goals	Responsible Department	Estimated Cost	Potential Funding Sources	Timeline	Benefit
16	Design, construct and maintain drainage improvement projects	Design and construct drainage improvement projects along Perryman Avenue, Humphrey Avenue, Moore Avenue, and Johnson Avenue. These drainage channels will be constructed to carry 25-year flood events.	5	SIP	G1, G2	Public Works	>$100,000	HMPG, FMAP, Rural development grants	24	High
17	Adopt “Higher Standard” riverine flood damage prevention ordinances and standards.	When final maps are approved, ordinance will be revised to include structures in flood prone areas must be built 1 foot above base flood elevation.	14	LPR	G2	Building Department	< $10,000	City funds	24	High
18	Provide training for CFM and CEM.	Provide training for CFM and CEM.	18	EAP	G4	City Administration	< $10,000	Texas Emergency Management	36	Medium
19	Participate in FEMA’s CRS.	This is a voluntary program that communities earn credit points that determine classifications and reduced flood insurance premiums for buildings in the city. The city would need to do activities such as: public information, mapping and regulations, flood damage reduction, and warning and response.	19	LPR	G2, G4, G5, G6	City Administration	< $10,000	City funds	36	High
20	Construct cover over Park N Ride Parking Lot	Reduce the high cost of vehicle damage caused by severe hail storms.	12	SIP	G4, G6	Public Works	$10,000 to $100,000	Public Works	36	Medium

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RECOMMENDED MITIGATION ACTIONS

Action No.	Title	Description	Mitigation Action Ranking	Action Type	Applicable Goals	Responsible Department	Estimated Cost	Potential Funding Sources	Timeline	Benefit
21	Public information on how to reduce water usage	Develop drought & extreme heat education materials to homeowners such as letting your lawn go dormant, Xeriscaping, installing low-flow showerheads & toilets, repairing leaky faucets, etc. in public messages through media outlets.	17	EAP	G1, G3	Building Department	< $10,000	PDM, Rural development grants	24	Medium

Notes:

BFE	Base Flood Elevation
CDBG	Community Development Block Grant
CEM	Community Emergency Managers
CFM	Community Flood Manager
CIAP	Coastal Impact Assistance Program
CoCoRaHS	Community Collaborative Rain, Hail and Snow Network
CRS	Community Rating System
EAP	Education and Awareness Programs
EOC	Emergency Operations Center
FEMA	Federal Emergency Management Agency
FIRM	Flood Insurance Rate Map
FMA	Flood Mitigation Assistance
FMAP	Flood Mitigation Assistance Program
HMGP	Hazard Mitigation Grant Program
LPR	Local Plans and Regulations
NOAA	National Oceanic and Atmospheric Administration
NSP	Natural Systems Protection
PDM	Pre-Disaster Mitigation
SIP	Structure and Infrastructure Project
TCRFC	Texas Colorado River Floodplain Coalition
USACE	U.S. Army Corps of Engineers
USDA	U.S. Department of Agriculture

PART 1
PLAN ELEMENTS AND PARTICIPATING COMMUNITIES

CHAPTER 1. INTRODUCTION

1.1 WHY PREPARE THIS PLAN?

1.1.1 The Big Picture

Hazard mitigation is defined as a way to alleviate the loss of life, personal injury, and property damage that can result from a disaster through long- and short-term strategies. Hazard mitigation involves strategies such as planning, policy changes, programs, projects, and other activities that can mitigate the impacts of hazards. The responsibility for hazard mitigation lies with many, including private property owners; business and industry; and local, state, and federal government.

The federal Disaster Mitigation Act of 2000 (DMA) (Public Law 106-390) required state and local governments to develop hazard mitigation plans as a condition for federal disaster grant assistance. Prior to 2000, federal disaster funding focused on disaster relief and recovery, with limited funding for hazard mitigation planning. The DMA increased the emphasis on planning for disasters before they occur.

The DMA encourages state and local authorities to work together on pre-disaster planning. It promotes "sustainable hazard mitigation," which includes the sound management of natural resources and the recognition that hazards and mitigation must be understood in the largest possible social and economic context. The planning network called for by the DMA helps local governments articulate accurate needs for mitigation, resulting in faster allocation of funding and more cost-effective risk reduction projects.

1.1.2 Local Concerns

This hazard mitigation plan considers local concerns when evaluating natural hazards and developing mitigation actions. Several factors specific to Matagorda County and the participating communities initiated this planning effort:

- Matagorda County and the participating communities are exposed to hazards that have caused past damage.
- Limited local resources make it difficult to be pre-emptive in reducing risk. Eligibility for federal financial assistance is paramount to promote successful hazard mitigation in the area.
- Matagorda County and its partners participating in this plan want to be proactive in preparing for the probable impacts from natural hazards.
- This plan was developed specifically for Matagorda County and its participating communities: the Cities of Bay City and Palacios.
- FEMA approval of the previous hazard mitigation plan will expire in July 2016. If this plan is not updated, Matagorda County and the participating communities would not have a FEMA-approved mitigation plan in place, limiting county and city access to emergency funds after a disaster declaration.

1.1.3 Purposes for Planning

This hazard mitigation plan update identifies resources, information, and strategies for reducing risk from natural hazards. Elements and strategies in the plan were selected because they meet a program requirement and because they best meet the needs of the planning partners and their citizens. One of the benefits of multi-jurisdictional planning is the ability to pool resources and eliminate redundant activities within a planning area that has uniform risk exposure and vulnerabilities. FEMA encourages multi-jurisdictional planning under its guidance for the DMA. This plan will help guide and coordinate mitigation activities throughout the planning area.

This plan update was developed to meet the following objectives:

- Meet or exceed requirements of the DMA.
- Enable all planning partners to continue using federal grant funding to reduce risk through mitigation.
- Meet the needs of each planning partner as well as state and federal requirements.
- Create a risk assessment that focuses on Matagorda County and the participating communities hazards of concern.
- Create a single planning document that integrates all planning partners into a framework that supports partnerships within the county, and puts all partners on the same planning cycle for future updates.
- Coordinate existing plans and programs so that high-priority actions and projects to mitigate possible disaster impacts are funded and implemented.

1.2 WHO WILL BENEFIT FROM THIS PLAN?

All citizens and businesses of Matagorda County and the participating communities are the ultimate beneficiaries of this hazard mitigation plan update. The plan reduces risk for those who live in, work in, and visit the county and the participating communities. It provides a viable planning framework for all foreseeable natural hazards that may impact the county and the participating communities. Participation in development of the plan by key stakeholders helped ensure that outcomes will be mutually beneficial. The resources and background information in the plan are applicable countywide. The plan's goals and recommendations can lay groundwork for the development and implementation of local mitigation activities and partnerships.

1.3 ELEMENTS OF THIS PLAN

This plan includes all federally required elements of a disaster mitigation plan:

- Countywide elements:
  - A description of the planning process
  - The public involvement strategy
  - A list of goals and objectives
  - A countywide hazard risk assessment
  - Countywide mitigation actions
  - A plan maintenance strategy
- Jurisdiction-specific elements for each participating jurisdiction:
  - A description of the participation requirements established by the Steering Committee
  - Jurisdiction-specific mitigation actions

The following appendices include information or explanations to support the main content of the plan:

- Appendix A: A glossary of acronyms and definitions.
- Appendix B: The FEMA Local Mitigation Plan Review Tool.

- Appendix C: Public outreach information, including the hazard mitigation survey and summary, and documentation of public meetings.
- Appendix D: Plan adoption resolutions from planning partners.
- Appendix E: A template for progress reports to be completed as this plan is implemented.

All planning partners will adopt this Matagorda County Hazard Mitigation Plan Update in its entirety.

CHAPTER 2.
PLAN UPDATE—WHAT HAS CHANGED

2.1 THE PREVIOUS PLAN

Matagorda County and its communities participated in previous hazard mitigation plans as part of the TCRFC. The TCRFC is a non-profit, 501(c)(3) organization formed in June 2001 by the cities and counties of the Lower Colorado River Authority (LCRA) in response to flood devastation requiring more coordinated damage prevention efforts. In 2004, the TCRFC developed a Hazard Mitigation Action Plan entitled *Creating a Disaster Resistant Lower Colorado River Basin*, which was approved by FEMA in 2004. In 2011, TCRFC completed the *Multi-Jurisdictional Hazard Mitigation Plan Update 2011-2016* as a regional partnership of 15 counties (including Matagorda) and 63 jurisdictions. The 2011-2016 update was completed with technical support from the LCRA and the outside consultant team of H20 Partners, Inc., and PBS&J.

The 2011-2016 update ranked 13 hazards from high (H) to very low (VL), or not applicable (N/A) for Matagorda County and the participating Cities of Bay City and Palacios. Table 2-1 lists the hazards and their ranking. These 13 hazards were evaluated in the TCRFC plan. These hazards included 3 human-caused hazards: hazardous materials (HAZMAT), pipeline failure, and terrorism. Although the previous plan profiled human-caused hazards, only natural hazards are evaluated in this plan update. Dam failure, drought, extreme heat, flood, hurricane/tropical storm, thunderstorm, and wildfire were the natural hazards ranked high for Matagorda County. In addition, thunderstorms were not profiled separately in this plan update; rather the hazards associated with thunderstorms (hail, wind, lightning, and flooding) were profiled separately.

TABLE 2-1.
HAZARDS EVALUATED IN THE 2011-2016 TCRFC MULTI-JURISDICTIONAL HAZARD MITIGATION PLAN UPDATE

Jurisdiction	Dam Failure	Drought	Extreme Heat	Flood	Hail	HAZMAT	Hurricane / Tropical Storm	Pipeline Failure	Terrorism	Thunderstorm	Tornado	Wildfire	Winter Storm
Matagorda County	**H**	**H**	**H**	**H**	**M**	**H**	**H**	**H**	**H**	**H**	**M**	**H**	**L**
City of Bay City	H	H	H	H	M	H	H	M	H	H	M	H	L
City of Palacios	N/A	M	M	H	L	H	H	M	L	H	H	H	M

The *TCRFC Multi-Jurisdictional Hazard Mitigation Plan Update 2011-2016* identified goals, objectives, and mitigation actions for these hazards. The overall goal of the 2011-2016 TCRFC plan was:

- To reduce or eliminate the long-term risks to loss of life and property damage in the Lower Colorado River Basin from the full range of disasters.

Six goals were identified for mitigating the hazards, with one or more objectives defined for each goal. These goals and their associated objectives are as follows:

- **Goal 1:** Protect public health and safety.
  - **Objective 1.1:** Advise the public about health and safety precautions to guard against injury and loss of life from hazards.

  - **Objective 1.2:** Maximize the utilization of the latest technology to provide adequate warning, communication, and mitigation of hazard events.
  - **Objective 1.3:** Reduce the damage to, and enhance protection of, dangerous areas during hazard events.
  - **Objective 1.4:** Protect critical facilities and services.
- **Goal 2:** Protect existing and new properties.
  - **Objective 2.1:** Reduce repetitive losses to the National Flood Insurance Program.
  - **Objective 2.2:** Use the most cost-effective approaches to protect existing buildings and public infrastructure from hazards.
  - **Objective 2.3:** Enact and enforce regulatory measures to ensure that development will not put people in harm's way or increase threats to existing properties.
- **Goal 3:** Increase public understanding, support and demand for hazard mitigation.
  - **Objective 3.1:** Heighten public awareness of the full range of natural and man-made hazards they face.
  - **Objective 3.2:** Educate the public on actions they can take to prevent or reduce the loss of life or property from all hazards.
  - **Objective 3.3:** Publicize and encourage the adoption of appropriate hazard mitigation measures.
- **Goal 4:** Build and support local capacity and commitment to continuously become less vulnerable to hazards.
  - **Objective 4.1:** Build and support local partnerships to continuously become less vulnerable to hazards.
  - **Objective 4.2:** Build a cadre of committed volunteers to safeguard the community before, during, and after a disaster.
  - **Objective 4.3:** Build hazard mitigation concerns into planning and budgeting processes.
- **Goal 5:** Promote growth in a sustainable manner.
  - **Objective 5.1:** Incorporate hazard mitigation into the long-range planning and development activities.
  - **Objective 5.2:** Promote beneficial uses of hazardous areas while expanding open space and recreational opportunities.
  - **Objective 5.3:** Utilize regulatory approaches to prevent creation of future hazards to life and property.
- **Goal 6:** Maximize the resources for investment in hazard mitigation.
  - **Objective 6.1:** Maximize the use of outside sources of funding.
  - **Objective 6.2:** Maximize participation of property owners in protecting their properties.
  - **Objective 6.3:** Maximize insurance coverage to provide financial protection against hazard events.
  - **Objective 6.4:** Prioritize mitigation projects, based on cost-effectiveness and starting with those sites facing the greatest threat to life, health and property.

The *TCRFC Multi-Jurisdictional Hazard Mitigation Plan Update 2011-2016* then identified one or more mitigation action to accomplish each objective. The current status of each of these actions identified in the plan is shown in Table 2-2. Actions designated as “(Past)” were carried forward from the 2004 TCRFC Plan.

**TABLE 2-2.
MATAGORDA COUNTY PROJECT IMPLEMENTATION WORKSHEET
(UPDATE OF 2011-2016 TCRFC PLAN PROJECTS)**

		Project Status				Funding				
Action No.	Action	Ongoing	Delayed	Completed	Deleted	Budgeted	Apply for Grant	Grant Received	Target Completion	Comments
MATAGORDA COUNTY										
1 (Past)	Install roofing material of stronger quality, enforce codes, encourage farmers to become more educated about protection of crops, and educate the general public about the damage caused by hail and how to prevent or alleviate it.	X								We are always continuing to educate the public and enforce codes. Incorporated into Mitigation Action 6.
2 (Past)	Establish and implement burning standards, build water reservoirs or wells, educate farmers about alternative crops, educate the general public and farmers about water conservation, enact an ordinance authorizing temporary water restrictions.	X								Ongoing; incorporated into Mitigation Action 5.
3 (Past)	Institute and enforce ordinances and codes, including tie-down requirements; educate the public to ensure tornado awareness and knowledge of insurance needs; continue to keep the public informed about the meaning of alerts and evacuation routes.	X								Merged with 5-Past2011. Incorporated into Mitigation Action 6.
4 (Past)	Educate the general public about storm issues, cold weather issues, sand bridges.	X								Merged with 6-Past2011. Incorporated into Mitigation Action 11.

TABLE 2-2.
MATAGORDA COUNTY PROJECT IMPLEMENTATION WORKSHEET
(UPDATE OF 2011-2016 TCRFC PLAN PROJECTS)

Action No.	Action	Project Status				Funding				Comments
		Ongoing	Delayed	Completed	Deleted	Budgeted	Apply for Grant	Grant Received	Target Completion	
5 (Past)	Remove downed trees, establish and implement burning standards, maintain natural environmental features as wind buffers, provide ongoing education for firefighters, and enforce building codes.				X					Volunteer Fire Departments train fireman. County has burn bands when needed.
6 (Past)	Track and record high-water marks, institute a maintenance program for cleaning debris from bridges and clearing out deposits on river banks, establish a buyout program, investigate feasibility of reducing peak flows, encourage the purchase of flood insurance, and limit construction in flood-prone areas.				X					Commissioners and drainage districts take care of clearing debris.
7 (Past)	Institute a buy-out program after enactment of building codes and ordinances, and raise bridges above the BFE.				X					We have not done this; County can't afford buyouts
8 (Past)	Conduct Caney Creek Project to decrease flooding in the lower creek area.				X					Project has not been done, there is a Caney Creek Study.
9 (Past)	Divert water from Caney Creek to the Colorado River and otherwise control flows from tributaries.				X					Not feasible
10 (Past)	Conduct Tres Palacios Project to buy out homes in the floodplain.				X					County can't afford buyouts.
11 (Past)	Conduct studies to determine why areas flood that have not previously flooded (Pledger “C” Zone Flooding).				X					New FEMA Maps to be released. No study.

TABLE 2-2.
MATAGORDA COUNTY PROJECT IMPLEMENTATION WORKSHEET
(UPDATE OF 2011-2016 TCRFC PLAN PROJECTS)

		Project Status				Funding				
Action No.	Action	Ongoing	Delayed	Completed	Deleted	Budgeted	Apply for Grant	Grant Received	Target Completion	Comments
1	Develop a beach restoration program.	X					X	X		Ongoing. Always working on beach. Incorporated into Mitigation Action 7.
2	Design, construct and maintain drainage improvement projects to minimize the risk of loss of life and future flood damages by utilizing funding from federal, state, Capital Improvement Program (CIP), development or stormwater utility fee and other funding sources.	X								Drainage districts work on this, merged with 17-Past2011. Incorporated into Mitigation Action 8.
3	Expand rainfall observer program through the National Weather Service (NWS) within Matagorda County using CoCoRaHS.		X							Would like this, but do not have. Incorporated into Mitigation Action 9.
4	Purchase and install emergency generator hookups for critical facilities including an automatic transfer switch.	X								Merged with 4 -Past2011. Incorporated into Mitigation Action 10.
5	Institute and enforce ordinances and codes, including tie-down requirements. Educate the public to ensure tornado awareness of insurance areas and continue to keep the public well-informed about the meaning of alerts and evacuation routes.	X								Merged with 3-Past2004. Incorporated into Mitigation Action 6.
6	Educate the general public about storm issues, cold weather issues such as ice on bridges.	X								Ongoing as needed (Merged with 4-Past2004). Incorporated into Mitigation Action 11.

TABLE 2-2.
MATAGORDA COUNTY PROJECT IMPLEMENTATION WORKSHEET
(UPDATE OF 2011-2016 TCRFC PLAN PROJECTS)

Action No.	Action	Project Status				Funding				Comments
		Ongoing	Delayed	Completed	Deleted	Budgeted	Apply for Grant	Grant Received	Target Completion	
7	Remove downed trees, establish and implement burning standards and maintain natural environmental features as wind and fire buffers. Provide ongoing education for firefighters to enforce codes.				X					Volunteer Fire Departments train fireman. County has burn bands when needed.
8	Track and record high water marks to institute a maintenance program for clearing debris from bridges and deposits on river banks. Establish a buy-out and investigate the feasibility of reducing peak flows.				X					Do not have
9	Educate the public on the benefits of purchasing flood insurance to minimize the financial impact of future floods.	X								We do this, public awareness presentations. Incorporated into Mitigation Action 12.
10	Institute a buy-out program after enactment of building codes and ordinances and raise bridges above the BFE.				X					We have codes and ordinances, but do not have a buy-out program
11	Create a diversion channel on the Caney Bayou to prevent future flood damages.				X					Do not have
12	Conduct buyouts along the Tres Palacios River.				X					County can't afford buyouts
13	Update the Matagorda County Flood Insurance Study and FIRMs to include detailed floodplain information for all streams in Matagorda County.	X								Preliminary maps are out, waiting on final maps to be released. Incorporated into Mitigation Action 13.

TABLE 2-2.
MATAGORDA COUNTY PROJECT IMPLEMENTATION WORKSHEET
(UPDATE OF 2011-2016 TCRFC PLAN PROJECTS)

		Project Status				Funding				
Action No.	Action	Ongoing	Delayed	Completed	Deleted	Budgeted	Apply for Grant	Grant Received	Target Completion	Comments
14	Adopt “Higher Standard” riverine flood damage prevention ordinances and standards.			X						We have higher standards in floodplain ordinances.
15	Adopt “Higher Standard” coastal flood damage prevention ordinances and standards (Coastal High Hazard Areas – Zone VE and Coastal A Zones).			X						We have higher standards – 2-foot freeboard.
16	Provide Training for Community Floodplain Managers (CFMs), and Community Emergency Managers (CEMs).			X						Completed for present employees
17	Identify and actively pursue funding mechanisms for future drainage improvements.	X								Merged with 2-Past2011. Incorporated into Mitigation Action 8.
18	Establish countywide bench mark network.				X					Do not have
19	Provide support to the TCRFC for flood reduction projects.	X								Incorporated into Mitigation Action 14.
20	Participate in FEMA’s Community Rating System (CRS) program.				X					
21	Create a Matagorda Disaster Response Team.			X						
22	Install additional stream and precipitation gauges in the Colorado Watershed.			X						

TABLE 2-2.
MATAGORDA COUNTY PROJECT IMPLEMENTATION WORKSHEET
(UPDATE OF 2011-2016 TCRFC PLAN PROJECTS)

Action No.	Action	Project Status: Ongoing	Project Status: Delayed	Project Status: Completed	Project Status: Deleted	Funding: Budgeted	Funding: Apply for Grant	Funding: Grant Received	Funding: Target Completion	Comments
23	Install Reverse 911 emergency notification system.		X							County does not have/City does. Incorporated into Mitigation Action 15.
24	Become a NWS “Storm Ready” community.			X						
25	Install emergency generators at critical facilities.		X							Merged with 4-Past2011. Incorporated into Mitigation Action 10.
26	Inspect, improve, and certify flood protection levees and seawalls in Matagorda County.	X								Matagorda Ring Levee in process of being certified. Incorporated into Mitigation Action 16.
CITY OF BAY CITY										
1 (Past)	Install roofing material of stronger quality, enforce codes, encourage farmers to become more educated about protection of crops, and educate the general public about the damage caused by hail and how to prevent or alleviate it.	X								Crop protection not applicable in town. Incorporated into Mitigation Action 7.

TABLE 2-2.
MATAGORDA COUNTY PROJECT IMPLEMENTATION WORKSHEET
(UPDATE OF 2011-2016 TCRFC PLAN PROJECTS)

Action No.	Action	Project Status				Funding				Comments
		Ongoing	Delayed	Completed	Deleted	Budgeted	Apply for Grant	Grant Received	Target Completion	
2 (Past)	Establish and implement burning standards, build water reservoirs or wells, educate farmers about alternative crops, educate the general public and farmers about water conservation, enact an ordinance authorizing temporary water restrictions.			X						Crop protection not applicable in town. Burning in town by permit only (very restrictive). Have implemented water conservation rates and education program for public.
3 (Past)	Institute and enforce ordinances and codes, including tie-down requirements; educate the public to ensure tornado awareness and knowledge of insurance needs; continue to keep the public informed about the meaning of alerts and evacuation routes.			X						Codes in place and enforced. City participates in Local Emergency Planning Committee to educate public.
4 (Past)	Educate the general public about storm issues, cold weather issues, and bridges.			X						City participates in Local Emergency Planning Committee to educate public.
5 (Past)	Remove downed trees, establish and implement burning standards, maintain natural environmental features as wind buffers, provide ongoing education for firefighters, and enforce building codes.	X								Removing downed trees and education are ongoing. Incorporated into Mitigation Action 8.
6 (Past)	Institute a buy-out program after enactment of building codes and ordinances, and raise bridges above the BFE.	X								Incorporated into Mitigation Actions 9 and 16.
7 (Past)	Conduct studies to determine why areas flood that have never flooded before (Pledger "C" Zone Flooding).				X					

TABLE 2-2.
MATAGORDA COUNTY PROJECT IMPLEMENTATION WORKSHEET
(UPDATE OF 2011-2016 TCRFC PLAN PROJECTS)

		Project Status				Funding				
Action No.	Action	Ongoing	Delayed	Completed	Deleted	Budgeted	Apply for Grant	Grant Received	Target Completion	Comments
8 (Past)	Undertake a review of the city's floodplain management ordinance.	X								Incorporated into Mitigation Action 10.
1	Implement standard that businesses and private property adhere to the BFE.			X						Codes are enforced. Must be 2 feet above BFE.
2	Buy generators for lift stations to keep sewer water from backing up.	X								Incorporated into Mitigation Action 4.
3	Build new warehouse with safe room for personnel during an emergency event.			X						Warehouse has safe room. City plans to use FEMA dome once completed.
4	Educate the public on the benefits of purchasing flood insurance to minimize the financial impact of future floods.	X								Ongoing effort. Incorporated into Mitigation Action 11.
5	Design, construct and maintain drainage improvement projects to minimize the risk of loss of life and future flood damages by utilizing funding from federal, state, CIP, development or stormwater utility fee and other funding sources.	X								Ongoing effort. Incorporated into Mitigation Action 12.
6	Adopt "higher standard" riverine flood damage prevention ordinances and standards.			X						

TABLE 2-2.
MATAGORDA COUNTY PROJECT IMPLEMENTATION WORKSHEET
(UPDATE OF 2011-2016 TCRFC PLAN PROJECTS)

		Project Status				Funding				
Action No.	Action	Ongoing	Delayed	Completed	Deleted	Budgeted	Apply for Grant	Grant Received	Target Completion	Comments
7	Provide training for CFMs and CEMs.	X								Ongoing effort. Incorporated into Mitigation Action 13.
8	Participate in FEMA's CRS.		X							Not participating but not sure of status due to employee turnover. Incorporated into Mitigation Action 14.
9	Become a NWS "Storm Ready" community.				X					Not participating but not sure of status due to employee turnover.
10	Inspect, improve and certify flood protection levees and seawalls in City of Bay City.	X								Incorporated into Mitigation Action 15.
11	Prepare and submit the Cottonwood Creek LOMR to FEMA for approval.			X						New FIRM map is under review and is planned to be approved in 2016.

TABLE 2-2.
MATAGORDA COUNTY PROJECT IMPLEMENTATION WORKSHEET
(UPDATE OF 2011-2016 TCRFC PLAN PROJECTS)

		Project Status				Funding				
Action No.	Action	Ongoing	Delayed	Completed	Deleted	Budgeted	Apply for Grant	Grant Received	Target Completion	Comments
CITY OF PALACIOS										
1 (Past)	Install roofing material of stronger quality, enforce codes and educate the general public about the damage caused by hail and how to prevent or alleviate it.	X								"Encourage farmers to become more educated about protection of crops" has been deleted from action. Incorporated into Mitigation Action 10.
2 (Past)	Establish and implement burning standards and enact an ordinance authorizing temporary water restrictions.			X						"Build water reservoirs or wells, educate farmers about alternative crops, educate the general public and farmers about water conservation" has been deleted from action.
3 (Past)	Institute and enforce ordinances and codes, including tie-down requirements; educate the public to ensure tornado awareness and knowledge of insurance needs; continue to keep the public informed about the meaning of alerts and evacuation routes.	X								Incorporated into Mitigation Action 11.
4 (Past)	Educate the general public about storm issues, cold weather issues, and bridges.				X					
5 (Past)	Remove downed trees, maintain natural environmental features as wind buffers, provide ongoing education for firefighters, and enforce building codes.				X					"Establish and implement burning standards" has been deleted from action.

TABLE 2-2.
MATAGORDA COUNTY PROJECT IMPLEMENTATION WORKSHEET
(UPDATE OF 2011-2016 TCRFC PLAN PROJECTS)

Action No.	Action	Project Status				Funding				Comments
		Ongoing	Delayed	Completed	Deleted	Budgeted	Apply for Grant	Grant Received	Target Completion	
6 (Past)	Raise bridge above the BFE.	X								"Institute a buy-out program after enactment of building codes and ordinances" has been deleted from action. Incorporated into Mitigation Action 12.
7 (Past)	Conduct studies to determine why areas flood that have never flooded before (Pledger "C" Zone Flooding).				X					Has been removed from action.
8 (Past)	Undertake a review of the city's floodplain management ordinance.	X								Merged with 7-Past2011. Incorporated into Mitigation Action 17.
1	Create a Kawak trail and raise Bride Road to improve wetland and low lying areas.				X					Has been removed from action.
2	Begin a rainfall observer program within the City of Palacios as part of CoCoRaHS through the NWS.			X						
3	Increase drainage for airport property.	X								Incorporated into Mitigation Action 13.
4	Move existing police station, currently in Flood Zone "B" on FIRMs into old bank building, which is located in Flood Zone "C" on FIRMs, and build a safe room inside to store records and use as EOC during disasters.	X								Incorporated into Mitigation Action 14.

TABLE 2-2.
MATAGORDA COUNTY PROJECT IMPLEMENTATION WORKSHEET
(UPDATE OF 2011-2016 TCRFC PLAN PROJECTS)

		Project Status				Funding				
Action No.	Action	Ongoing	Delayed	Completed	Deleted	Budgeted	Apply for Grant	Grant Received	Target Completion	Comments
5	Educate the public on the benefits of purchasing flood insurance to minimize the financial impact of future floods.	X								Incorporated into Mitigation Action 15.
6	Design, construct, and maintain drainage improvement projects to minimize the risk of loss of life and future flood damages by utilizing funding from federal, state, CIP, development of other funding sources.	X								"Development of Stormwater Utility Fee" has been removed from action. Incorporated into Mitigation Action 16.
7	Adopt “Higher Standard” riverine flood damage prevention ordinances and standards.	X								Incorporated into Mitigation Action 17.
8	Provide Training for CFMs and CEMs.	X								Incorporated into Mitigation Action 18.
9	Participate in FEMA’s CRS.	X								Incorporated into Mitigation Action 19.
10	Become a NWS “Storm Ready” community.			X						

TABLE 2-2.
MATAGORDA COUNTY PROJECT IMPLEMENTATION WORKSHEET
(UPDATE OF 2011-2016 TCRFC PLAN PROJECTS)

		Project Status				Funding				
Action No.	Action	Ongoing	Delayed	Completed	Deleted	Budgeted	Apply for Grant	Grant Received	Target Completion	Comments

"(Past)" in the action number column indicates that the action was first identified in the 2004 TCRFC Hazard Mitigation Plan and was carried forward into the 2011-2016 Plan Update.

BFE	Base Flood Elevation
CEM	Community Emergency Managers
CFM	Community Floodplain Managers
CIP	Capital Improvement Program
CoCoRaHS	Community Collaborative Rain, Hail and Snow Network
CRS	Community Rating System
EOC	Emergency Operations Center
FEMA	Federal Emergency Management Agency
FIRM	Flood Insurance Rate Map
LOMR	Letter of Map Revision
MUD	Municipal Utility District
NFIP	National Flood Insurance Program
NOAA	National Oceanic and Atmospheric Administration
NWS	National Weather Service
VFD	Volunteer Fire Department

2.2 WHY UPDATE?

Title 44 of the Code of Federal Regulations (44 CFR) stipulates that hazard mitigation plans must present a schedule for monitoring, evaluating, and updating the plan. As mentioned previously, Matagorda County and the participating communities participated in a mitigation planning process in 2011 as part of the TCRFC. This plan included 15 counties and will expire in 2016. Regional plans are no longer acceptable by FEMA. This update process provides an opportunity to reevaluate recommendations, monitor the impacts of actions that have been accomplished, and evaluate whether there is a need to change the focus of mitigation strategies. A jurisdiction covered by a plan that has expired is not able to pursue elements of federal funding under the Robert T. Stafford Act for which a current hazard mitigation plan is a prerequisite.

2.3 THE PLAN—WHAT IS DIFFERENT?

The previous regional TCRFC plan has been improved to focus on Matagorda County and its participating communities using the best and most current data and technology available. All participating municipalities were fully involved in the preparation of this plan update. The updated plan includes a more robust hazard analysis. Mitigation actions were reviewed and amended to include only those that would move the community towards a higher degree of resiliency while being feasible, practical, and implementable given current finances. Federal and state funds for projects have become difficult to obtain. The update recommends 54 mitigation actions:

- 17 countywide actions
- 16 actions specifically for the City of Bay City
- 21 actions specifically for the City of Palacios

Actions from the previous TCRFC plan were carried forward into the mitigation actions if they were identified as delayed or in progress. These actions are indicated on Table 2-2.

2.4 LOCAL MITIGATION PLAN REVIEW TOOL

The Local Mitigation Plan Review Tool demonstrates how the Local Mitigation Plan meets the regulation in 44 CFR §201.6 and offers States and FEMA Mitigation Planners an opportunity to provide feedback to the community.

- The Regulation Checklist provides a summary of FEMA's evaluation of whether the Plan has addressed all requirements.
- The Plan Assessment identifies the plan's strengths as well as documents areas for future improvement.
- The Multi-jurisdiction Summary Sheet is an optional worksheet that can be used to document how each jurisdiction met the requirements of the each Element of the Plan (Planning Process; Hazard Identification and Risk Assessment; Mitigation Strategy; Plan Review, Evaluation, and Implementation; and Plan Adoption).

The FEMA Mitigation Planner must reference the *Local Mitigation Plan Review Guide* when completing the Local Mitigation Plan Review Tool. The Local Mitigation Plan Review Tool is included in this hazard mitigation plan as Appendix B.

CHAPTER 3.
PLAN METHODOLOGY

3.1 GRANT FUNDING

The current TCRFC Hazard Mitigation Plan will expire in 2016. Therefore, TCRFC initiated steps to begin the next update in 2013. The TCRFC Board selected the JSWA Team to assist with development and implementation of the plan update. The JSWA Team consists of JSW & Associates, Tetra Tech, Inc., and Halff Associates. TCRFC worked with the JSWA Team to apply for hazard mitigation funding through FEMA's Pre-Disaster Mitigation Grant Program. The JSWA Team was successful in obtaining grants for Matagorda County and the participating communities of the Cities of Bay City and Palacios. Each participating member contributed both monetarily and through in-kind contributions.

3.2 ESTABLISHMENT OF THE PLANNING PARTNERSHIP

Matagorda County opened this planning effort to all eligible local governments in the county. The planning partners covered under this plan are shown in Table 3-1.

TABLE 3-1.
COUNTY AND CITY PLANNING PARTNERS

Jurisdiction	Point of Contact	Title
Matagorda County	Lisa Krobot	Floodplain Administrator
City of Bay City	Marla Jasek	Floodplain Administrator
City of Palacios	David Kocurek	City Manager

Each jurisdiction wishing to join the planning partnership was asked to commit to the process and have a clear understanding of expectations. These include:

- Each partner will support and participate in the Steering Committee meetings overseeing the development of the plan update. Support includes making decisions regarding plan development and scope on behalf of the partnership.
- Each partner will provide support as needed for the public involvement strategy developed by the Steering Committee in the form of mailing lists, possible meeting space, and media outreach such as newsletters, newspapers, or direct-mailed brochures.
- Each partner will participate in plan update development activities such as:
  - Steering Committee meetings
  - Public meetings or open houses
  - Workshops and planning partner training sessions
  - Public review and comment periods prior to adoption

  Attendance will be tracked at these activities, and attendance records will document participation for each planning partner. All participating communities are expected to attend and actively participate in all meetings and activities.
- Each partner will be expected to review the risk assessment and identify hazards and vulnerabilities specific to its jurisdiction. Contract resources will provide jurisdiction-specific mapping and technical consultation to aid in this task, but the determination of risk and vulnerability ranking will be up to each partner.

- Each partner will be expected to review the mitigation recommendations chosen for the overall county and evaluate whether they will meet the needs of its jurisdiction. Projects within each jurisdiction consistent with the overall plan recommendations will need to be identified, prioritized, and reviewed to identify their benefits and costs.
- Each partner will be required to sponsor at least one public meeting to present the draft plan at least two weeks prior to adoption.
- Each partner will be required to formally adopt the plan.
- Each partner will agree to the plan implementation and maintenance protocol.

Failure to meet these criteria may result in a partner being dropped from the partnership by the Steering Committee, and thus losing eligibility under the scope of this plan.

3.3 DEFINING THE PLANNING AREA

The planning area was defined to consist of all of Matagorda County. All partners to this plan have jurisdictional authority within this planning area. Planning partners include the Cities of Bay City and Palacios (Figure 3-1).

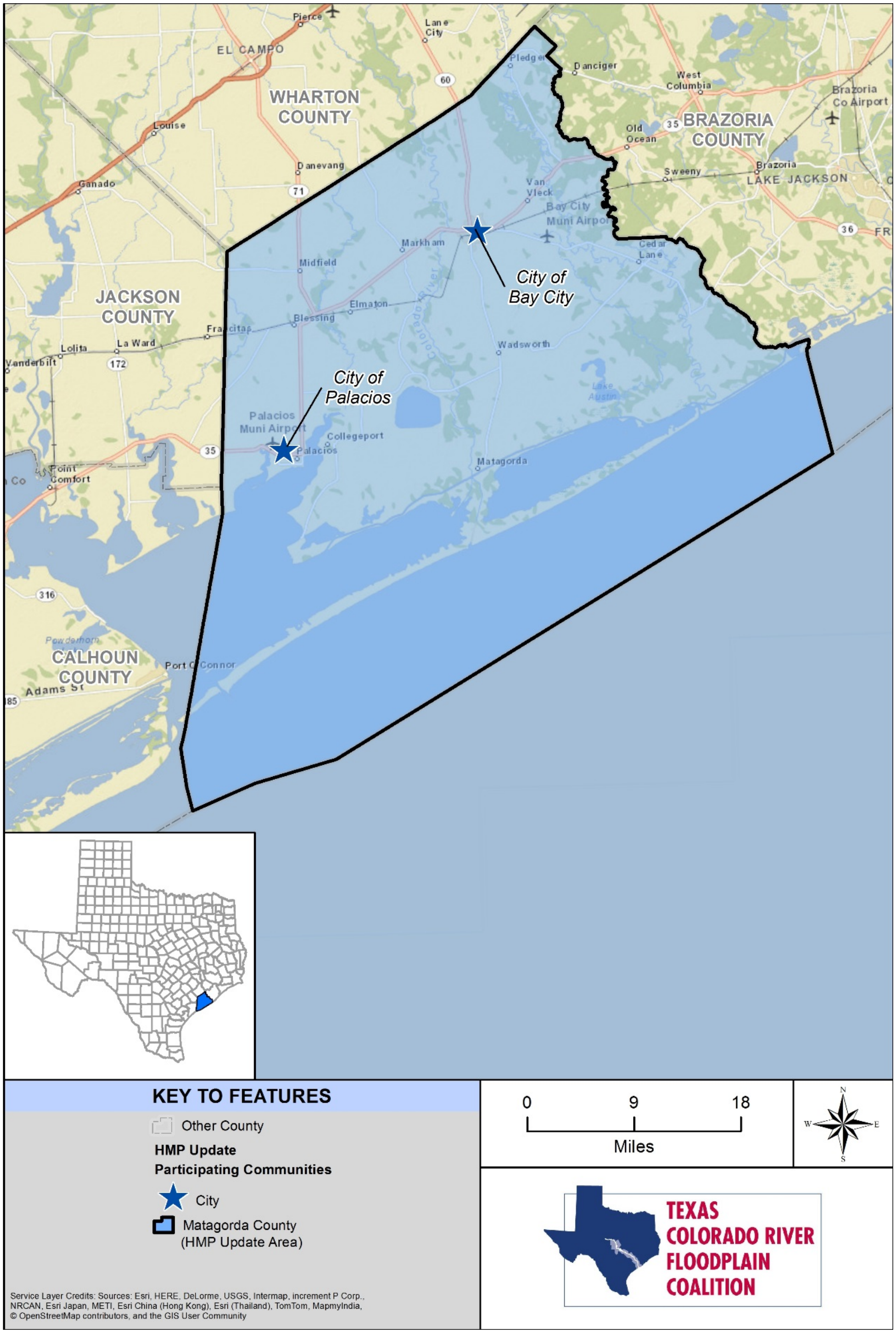


Figure 3-1. Matagorda County Planning Area and Participating Communities

3.4 THE STEERING COMMITTEE

Hazard mitigation planning enhances collaboration and support among diverse parties whose interests can be affected by hazard losses. A Steering Committee was formed to oversee all phases of the plan update. The members of this committee included key planning partner staff, citizens, and other stakeholders from the planning area. Table 3-2 lists the committee members.

TABLE 3-2.
STEERING COMMITTEE MEMBERS

Name	Title	Jurisdiction
Lisa Krobot	Floodplain Administrator	Matagorda County
Doug Matthes	Emergency Management Director	Matagorda County
Marla Jasek	Public Works Assistant Director	City of Bay City
David Kocurek	City Manager	City of Palacios
Robert Garrett	Police Chief (Former)	City of Palacios
David Miles	Police Chief	City of Palacios

The Steering Committee agreed to meet a minimum of three times or as needed throughout the course of the plan's development. The JSWA Team and the TCRFC Executive Director facilitated each Steering Committee meeting, which addressed a set of objectives based on the work plan established for the plan update. The Steering Committee met three times from March 2015 through August 2015. Meeting agendas, notes, and attendance logs can be found in Appendix C of this document.

The planning team made a presentation at a Steering Committee meeting on March 10, 2015, to introduce the mitigation planning process. The Steering Committee, planning partners, and the public were encouraged to participate in the plan update process. Key meeting objectives at the March meeting were as follows:

- Steering Committee purposes and responsibilities
- Plan partners and signators responsibilities
- Purpose and goals of the update process
- Review and amend mitigation goals and objectives
- Review previous mitigation actions from 2011 plan
- Critical facilities discussion
- Next steps (including the capabilities assessment, hazard analysis review, and community participation)

3.5 COORDINATION WITH OTHER AGENCIES

Opportunities for involvement in the planning process must be provided to neighboring communities, local and regional agencies involved in hazard mitigation, agencies with authority to regulate development, businesses, academia, and other private and non-profit interests (44 CFR, Section 201.6(b)(2)). This task was accomplished by the planning team as follows:

- **Steering Committee Involvement**—Agency representatives were invited to participate on the Steering Committee. Ms. Lisa Krobot, Matagorda County Floodplain Administrator, was the primary lead / point of contact for stakeholder and community outreach. Matagorda County took a proactive approach in inviting and seating the Steering Committee for the development of this hazard mitigation plan. The County invited and requested the active participation of a variety of stakeholder interests to form the Matagorda County HMP Steering Committee. The Steering Committee Members that were invited by the County and participated as stakeholders in the Matagorda County mitigation plan are listed on Table 3-2.

The County utilized personal communication including telephone and email outreach, attendance at various public meetings and forums as well as the County website to inform and invite participation of the Steering Committee. The Steering Committee Members were encouraged to attend and actively participate in meetings as well as to review the draft plan and provide questions and comments. Public notices were posted in and around the County offices and the community notifying them of the planning process, upcoming meeting dates and inviting community participation.

In addition, TCRFC also undertook stakeholder/community outreach activities in support of Matagorda County. An informational email was sent in the early weeks of the planning process advising various stakeholders and special interest groups about the planning process and inviting interested members to attend the committee meetings. TCRFC drafted and sent newsletters to various interest groups and also made the newsletters available to the County for their outreach efforts. Informational items and project updates were also posted on the TCRFC Web Site.

The County coordinated the response to all questions and comments. Any changes to the plan as part of this stakeholder outreach were coordinated thru the County.

The Matagorda County meetings were held in tandem with neighboring counties and communities. Announcements were made in all meetings regarding the outreach and meeting schedules in the other communities. Attendance and participation was encouraged.

- **Agency Notification**—The TDEM was invited to participate in the plan development process from the beginning and was kept apprised of plan development milestones. TDEM received meeting announcements, meeting agendas, and meeting minutes by e-mail throughout the plan development process. TDEM supported the effort by attending meetings or providing feedback on issues.
- **Pre-Adoption Review**—Agency representatives on the Steering Committee and TDEM were provided an opportunity to review and comment on this plan, primarily through the hazard mitigation plan website (see Section 3.7). Each agency was sent an e-mail message informing them that draft portions of the plan were available for review. In addition, the complete draft plan was sent to TDEM for a pre-adoption review to ensure program compliance.

This update process was initiated by TCRFC, a regional partnership of cities and counties in the Colorado River basin and the surrounding areas. The process was initiated by and was under the direction of Mr. Mickey Reynolds, Executive Director of TCRFC. Although separate plans were prepared for each county, 15 counties and 46 cities and towns in TCRFC updated their hazard mitigation plans simultaneously. Steering Committee meetings were held with adjacent counties so neighboring communities were aware of the planning process and could share ideas and information throughout the region. Steering Committee meetings for Matagorda County and the participating communities were held along with Colorado, Wharton, and Jackson Counties and the Cities of Columbus and Eagle Lake in Colorado County, the Cities of East Bernard, El Campo, and Wharton in Wharton County, and the Cities of Edna and Ganado in Jackson County. The full list of attendees from other neighboring communities at each Steering Committee meeting is included in Appendix C. In addition, the planning team presented the plan update process at the TCRFC annual meeting on July 31, 2015.

3.6 REVIEW OF EXISTING PROGRAMS

Hazard mitigation planning must include review and incorporation, if appropriate, of existing plans, studies, reports and technical information (44 CFR, Section 201.6(b)(3)). Chapter 6 of this plan provides a review of laws and ordinances in effect within the planning area that can affect hazard mitigation actions. In addition, the following programs can affect mitigation within the planning area:

- Matagorda County
  - Subdivision Regulations
  - Floodplain Management Plan
  - Basic Emergency Operations Plan
- City of Bay City
  - Comprehensive Plan
  - Code of Ordinances
- City of Palacios
  - Comprehensive Planning and Capacity Study
  - Code of Ordinances
  - Consolidated Zoning Ordinance

An assessment of all planning partners' regulatory, technical, and financial capabilities to implement hazard mitigation actions is presented in Chapter 7. Many of these relevant plans, studies, and regulations are cited in the capability assessment.

The review of existing programs and the assessment of capabilities identify the plans, regulations, personnel, and funding mechanisms available to the county and planning partners to impact and mitigate the effects of natural hazards. The review also helps identify opportunities for the planning partners to strengthen their abilities to proactively mitigate natural hazards in the community through the expansion of existing departments and programs; completion of applicable plans; adoption of necessary regulations or ordinances; creation and hiring of new departments and staff; or mutual aid agreements and memorandums of understanding with neighboring communities. The planning partners reviewed the findings of the capabilities assessment during the second Steering Committee meeting and used this information to identify mitigation actions.

3.7 PUBLIC INVOLVEMENT

Broad public participation in the planning process helps ensure that diverse points of view about the planning area's needs are considered and addressed. The public must have opportunities to comment on disaster mitigation plans during the drafting stages and prior to plan approval (44 CFR, Section 201.6(b)(1)). The strategy for involving the public in this plan emphasized the following elements:

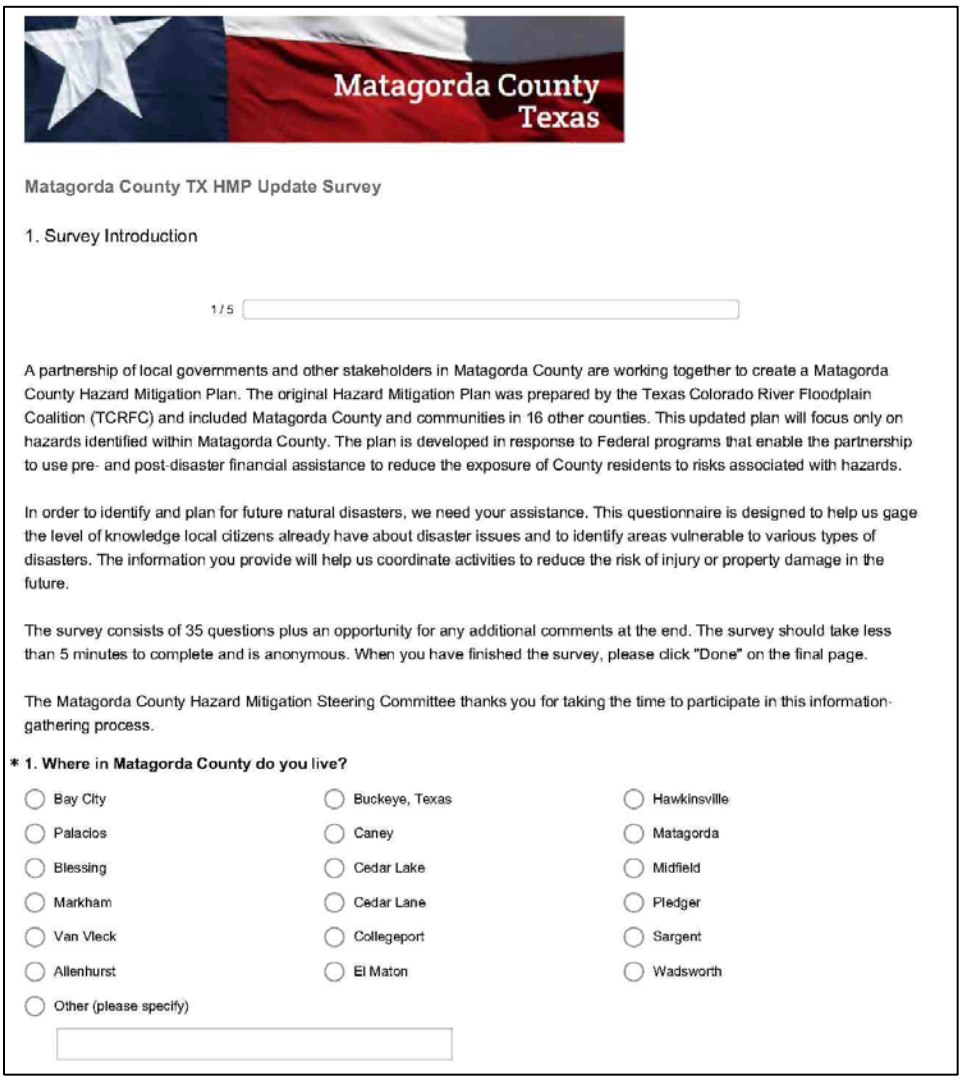
- Include members of the public on the Steering Committee
- Use a community survey/questionnaire to evaluate whether the public's perception of risk and support of hazard mitigation has changed since the initial planning process
- Attempt to reach as many planning area citizens as possible using multiple media
- Identify and involve planning area stakeholders
- Solicit public feedback at each stage of plan implementation, monitoring, and evaluation.

3.7.1 Stakeholders and the Steering Committee

Stakeholders are the individuals, agencies, and jurisdictions that have a vested interest in the recommendations of the hazard mitigation plan, including planning partners. The effort to include stakeholders in this process included stakeholder participation on the Steering Committee. Stakeholders were encouraged to attend and participate in all committee meetings.

3.7.2 Survey/Questionnaire

A hazard mitigation plan questionnaire (see Figure 3-2) was developed to gauge household preparedness for natural hazards; the level of knowledge of tools and techniques that assist in reducing risk and loss from natural hazards; and the perceived impact of natural hazards on Matagorda County and the participating communities' residents and businesses. This on-line questionnaire was designed to help identify areas vulnerable to one or more natural hazards. The answers to these 35 questions helped guide the Steering Committee in prioritizing hazards of impact and in selecting goals, objectives, and mitigation strategies. Approximately 65 questionnaires were completed during the course of this planning process.


Matagorda County
Texas

Matagorda County TX HMP Update Survey

1. Survey Introduction

1 / 5

A partnership of local governments and other stakeholders in Matagorda County are working together to create a Matagorda County Hazard Mitigation Plan. The original Hazard Mitigation Plan was prepared by the Texas Colorado River Floodplain Coalition (TCRFC) and included Matagorda County and communities in 16 other counties. This updated plan will focus only on hazards identified within Matagorda County. The plan is developed in response to Federal programs that enable the partnership to use pre- and post-disaster financial assistance to reduce the exposure of County residents to risks associated with hazards.

In order to identify and plan for future natural disasters, we need your assistance. This questionnaire is designed to help us gage the level of knowledge local citizens already have about disaster issues and to identify areas vulnerable to various types of disasters. The information you provide will help us coordinate activities to reduce the risk of injury or property damage in the future.

The survey consists of 35 questions plus an opportunity for any additional comments at the end. The survey should take less than 5 minutes to complete and is anonymous. When you have finished the survey, please click "Done" on the final page.

The Matagorda County Hazard Mitigation Steering Committee thanks you for taking the time to participate in this information-gathering process.

*** 1. Where in Matagorda County do you live?**

Bay City	Buckeye, Texas	Hawkinsville
Palacios	Caney	Matagorda
Blessing	Cedar Lake	Midfield
Markham	Cedar Lane	Pledger
Van Vleck	Collegeport	Sargent
Allenhurst	El Maton	Wadsworth
Other (please specify)		

Figure 3-2. Sample Page from Questionnaire Distributed to the Public

3.7.3 Meetings

Three Steering Committee meetings were held during the planning process. These meetings were held along with the adjacent counties of Wharton, Colorado, and Jackson. Meetings were held on March 10, 2015, June 2, 2015, and August 11, 2015, in the City of Wharton (see Figure 3-3). The meeting format allowed attendees to access handouts, maps, and other resources and ask questions during the meetings. Additionally, project staff and county personnel remained after the meeting to have direct conversations with interested attendees. Details regarding the planning and information generated for the risk assessment were shared with attendees via a PowerPoint presentation. Planning partners and the planning team were present to answer questions.

Matagorda County and the planning partners held public meetings to present the draft plan, discuss the benefits of the plan, and solicit public comments. Unless otherwise noted below, the public meetings were held as part of a regularly scheduled public meeting and the plan was discussed as an item on the meeting agenda. Notice of the public meeting was provided in compliance with the communities' individual requirements. A member of the planning team was available during all meetings to answer questions from the public on the development of the hazard mitigation plan.

Matagorda County and the planning partners held a public meeting on January 25, 2016 to present the draft plan and solicit public comments. The draft plan was available for review in hard copy at the Matagorda County Environmental Health Department for review by interested parties beginning on January 12, 2016. In addition, the draft was posted on the Matagorda County website on January 13, 2016. No comments that resulted in changes to the plan were received from the public electronically or in person at the County Environmental Health Department or during the public meeting. The draft plan was presented and reviewed in a public meeting before the Matagorda County Commissioners Court on XXX XX, 2016.

The City of Bay City held a public meeting on January 28, 2016 to present the draft plan and solicit public comments. The draft plan was available for review in hard copy at the City Hall for review by interested parties beginning on January 26, 2016. No comments that resulted in changes to the plan were received from the public electronically or in person at the City Hall or during the public meeting. In addition, the draft was posted on the City of Bay City website on January 12, 2016.

The City of Palacios held a public meeting on February 9, 2016 to present the draft plan and solicit public comments. The draft plan was available for review in hard copy at the City Hall and posted to the City of Palacios website for review by interested parties beginning on January 15, 2016. No comments that resulted in changes to the plan were received from the public electronically or in person at the City Hall or during the public meeting.

Figure 3-3. Steering Committee Meeting August 11, 2015

3.7.4 Press Releases/News Articles

Press releases were distributed over the course of the plan's development as key milestones were achieved and prior to each public meeting. TCRFC released an informational brochure to its members.

3.7.5 Internet

At the beginning of the plan development process, the TCRFC posted information regarding the update process, a link to the community survey, and a link to the mitigation plan on the TCRFC website (http://www.tcrfc.org/). The TCRFC website keeps the public informed on plan development milestones and to solicit relevant input. Information on the plan development process, the Steering Committee, the questionnaire, and phased drafts of the plan were available to the public on the site throughout the process. After the plan's completion, the TCRFC website will keep the public informed about successful mitigation projects and future plan updates. The City of Bay City posted a notice of the plan update process and encouraged the public to complete the online survey in postings on the city's Facebook page on June 15, 2015.

The draft plan was posted on the Matagorda County website on January 13, 2016, on the City of Bay City website on January 12, 2016, and on the City of Palacios website on January 15, 2016 to allow the public to review the plan as described in Chapter 3.7.3.

Figure 3-4. Sample Pages from the TCRFC Website

3.8 PLAN DEVELOPMENT, CHRONOLOGY, MILESTONES

Table 3-3 summarizes important milestones in the development of the plan update.

TABLE 3-3.
PLAN DEVELOPMENT MILESTONES

Date	Event	Description	Attendance
2013			
9/16	Submit grant application	Seek funding for plan development process	N/A
8/5	Initiate consultant procurement	Seek a planning expert to facilitate the process	N/A
10/1	Select JSWA Team to facilitate plan development	Facilitation contractor secured	N/A
2015			
2/25	Notified grant funding secured	Funding secured	N/A
2/25	Contract signed	Notice to proceed given to Tetra Tech, Inc.	N/A
2/26	Identify Steering Committee	Formation of the Steering Committee	N/A
3/10	Steering Committee/ Stakeholder Meeting #1	Presentation on plan process given, participation, review of goals and objectives	Matagorda County; Cities of Bay City and Palacios
6/2	Steering Committee Meeting #2	Review community survey, review hazard identification and risk assessment, review and update plan goals and objectives	Matagorda County; Cities of Bay City and Palacios
8/11	Steering Committee Meeting #3	Mitigation actions presentation and project development	Matagorda County; Cities of Bay City and Palacios
Ongoing	Public Outreach	News articles and website posting	N/A
9/18	Draft Plan	Internal review draft provided to Steering Committee	N/A
2016			
1/12	Public Comment Period	Initial public comment period of draft plan opens. Draft plan posted in hard copy at the County Environmental Health Department with press release notifying public of plan availability	Matagorda County
1/12	Public Outreach	Draft plan posted to City website	City of Bay City
1/13	Public Outreach	Draft plan posted to the Matagorda County website	Matagorda County
1/15	Public Outreach	Draft plan posted to City website and in hard copy at City Hall	City of Palacios
1/25	Public Outreach	Public meeting conducted to review the draft with interested parties	Matagorda County
1/26	Public Outreach	Draft plan posted in hard copy at City Hall	City of Bay City
1/28	Public Outreach	Public meeting conducted to review the draft with interested parties	City of Bay City
2/9	Public Outreach	Public meeting conducted to review the draft with interested parties	Palacios
5/19	Plan Review	Final draft plan submitted to Texas Division of Emergency Management for review	N/A
2/21/17	Plan Approval Pending Adoption	Plan approval pending adoption by FEMA	N/A
X/X	Adoption	Adoption window of final plan opens	N/A

**TABLE 3-3.
PLAN DEVELOPMENT MILESTONES**

X/X	Plan Approval	Final plan approved by FEMA	N/A

FEMA Federal Emergency Management Agency
JSWA Team JSW & Associates, Tetra Tech, Inc., and Halff Associates
N/A Not Applicable

CHAPTER 4.
GUIDING PRINCIPLE, GOALS, AND OBJECTIVES

Hazard mitigation plans must identify goals for reducing long-term vulnerabilities to identified hazards (44 CFR Section 201.6(c)(3)(i)). The Steering Committee established a guiding principle, a set of goals, and measurable objectives for this plan, based on data from the preliminary risk assessment and the results of the public involvement strategy. The guiding principle, goals, objectives, and actions in this plan all support each other. Goals were selected to support the guiding principle. Objectives were selected that met multiple goals. Actions were prioritized based on the action meeting multiple objectives.

4.1 GUIDING PRINCIPLE

A guiding principle focuses the range of objectives and actions to be considered. This is not a goal because it does not describe a hazard mitigation outcome, and it is broader than a hazard-specific objective. The guiding principle for the Matagorda County Hazard Mitigation Plan Update is as follows:

- To reduce or eliminate the long-term risks to loss of life and property damage in Matagorda County and the participating communities from the full range of natural disasters.

4.2 GOALS

The following are the mitigation goals for this plan:

- **Goal 1:** Protect public health and safety.
- **Goal 2:** Protect existing and new properties.
- **Goal 3:** Increase public understanding, support, and demand for hazard mitigation.
- **Goal 4:** Build and support local capacity and commitment to continuously become less vulnerable to hazards.
- **Goal 5:** Promote growth in a sustainable manner.
- **Goal 6:** Maximize the resources for investment in hazard mitigation.

4.3 OBJECTIVES

The objectives are used to help establish priorities and support the agreed upon goals. The objectives are as follows:

- Objectives in support of Goal 1:
  - **Objective 1.1:** Advise the public about health and safety precautions to guard against injury and loss of life from hazards.
  - **Objective 1.2:** Maximize the utilization of the latest technology to provide adequate warning, communication, and mitigation of hazard events.
  - **Objective 1.3:** Reduce the damage to, and enhance protection of, dangerous areas during hazard events.
  - **Objective 1.4**: Protect critical facilities and services.
- Objectives in support of Goal 2:
  - **Objective 2.1:** Reduce repetitive losses to the National Flood Insurance Program.
  - **Objective 2.2:** Use the most cost-effective approaches to protect existing buildings and public infrastructure from hazards.

    - **Objective 2.3:** Enact and enforce regulatory measures to ensure that development will not put people in harm's way or increase threats to existing properties.

- Objectives in support of Goal 3:
    - **Objective 3.1:** Heighten public awareness of the full range of natural hazards they face.
    - **Objective 3.2:** Educate the public on actions they can take to prevent or reduce the loss of life or property from all natural hazards.
    - **Objective 3.3:** Publicize and encourage the adoption of appropriate hazard mitigation measures.
- Objectives in support of Goal 4:
    - **Objective 4.1:** Build and support local partnerships to continuously become less vulnerable to hazards.
    - **Objective 4.2:** Build a cadre of committed volunteers to safeguard the community before, during, and after a disaster.
    - **Objective 4.3:** Build hazard mitigation concerns into planning and budgeting processes.
- Objective in support of Goal 5:
    - **Objective 5.1:** Incorporate hazard mitigation into the long-range planning and development activities.
    - **Objective 5.2:** Promote beneficial uses of hazardous areas while expanding open space and recreational opportunities.
    - **Objective 5.3:** Utilize regulatory approaches to prevent creation of future hazards to life and property.
- Objectives in support of Goal 6:
    - **Objective 6.1:** Maximize the use of outside sources of funding.
    - **Objective 6.2:** Maximize participation of property owners in protecting their properties.
    - **Objective 6.3:** Maximize insurance coverage to provide financial protection against hazard events.
    - **Objective 6.4:** Prioritize mitigation projects, based on cost-effectiveness and starting with those sites facing the greatest threat to life, health, and property.

CHAPTER 5.
IDENTIFIED HAZARDS OF CONCERN AND RISK ASSESSMENT METHODOLOGY

Risk assessment is the process of measuring the potential loss of life, personal injury, economic injury, and property damage resulting from natural hazards. It allows emergency management personnel to establish early response priorities by identifying potential hazards and vulnerable assets. The process focuses on the following elements:

- **Hazard identification -** Use all available information to determine what types of disasters may affect a jurisdiction, how often they can occur, and their potential severity.
- **Vulnerability identification -** Determine the impact of natural hazard events on the people, property, environment, economy, and lands of the region.
- **Cost evaluation -** Estimate the cost of potential damage or cost that can be avoided by mitigation.

The risk assessment for this hazard mitigation plan update evaluates the risk of natural hazards prevalent in the planning area and meets requirements of the DMA (44 CFR, Section 201.6(c)(2)).

5.1 IDENTIFIED HAZARDS OF CONCERN

For this plan, the Steering Committee considered the full range of natural hazards that could impact the planning area and then listed hazards that present the greatest concern. The process incorporated review of state and local hazard planning documents, as well as information on the frequency, magnitude, and costs associated with hazards that have impacted or could impact the planning area. Anecdotal information regarding natural hazards and the perceived vulnerability of the planning area’s assets to them was also used. Table 2-1 lists the hazards identified in the previous 2011-2016 TCRFC plan and the hazard ranking. Based on the review, this plan addresses the following hazards of concern:

- Coastal Erosion
- Dam/Levee Failure
- Drought
- Expansive Soils
- Extreme Heat
- Earthquake
- Flood
- Hail
- Hurricane and Tropical Storm
- Lightning
- Tornado
- Wildfire
- Wind
- Winter Weather

Several of these hazards were profiled together because of their common occurrence or damage assessments, such as drought and extreme heat, and lightning, hail, and wind. Thunderstorms were profiled in the 2011-2016 TCRFC plan but were not profiled separately in this plan update; however, the hazards associated with thunderstorms (hail, wind, lightning, and flooding) were profiled. Furthermore, the steering committee considered the probability and potential impacts of the land subsidence hazard in the planning area and determined it to be of negligible risk in Matagorda County. Therefore, land subsidence is not profiled in this plan update.

5.2 CLIMATE CHANGE

Climate includes patterns of temperature, precipitation, humidity, wind, and seasons. Climate plays a fundamental role in shaping natural ecosystems, and the human economies and cultures that depend on them. The term “climate change” refers to changes over a long period of time. It is generally perceived that climate change will have a measurable impact on the occurrence and severity of natural hazards around the world. Impacts include the following:

- Snow cover losses will continue, and declining snowpack will affect snow-dependent water supplies and stream flow levels around the world.
- The risk of drought and the frequency, intensity, and duration of heat waves are expected to increase.
- More extreme precipitation is likely, increasing the risk of flooding.
- The world’s average temperature is expected to increase.

Climate change will affect communities in a variety of ways. Impacts could include an increased risk for extreme events such as drought, storms, flooding, and wildfires; more heat-related stress; and the spread of existing or new vector-born disease into a community. In many cases, communities are already facing these problems to some degree. Climate change influences the frequency, intensity, extent, or magnitude of the problems.

This hazard mitigation plan update addresses climate change as a secondary impact for each identified hazard of concern. Each chapter addressing one of the hazards of concern includes a section with a qualitative discussion on the probable impacts of climate change for that hazard. While many models are being developed to assess the potential impacts of climate change, none are currently available to support hazard mitigation planning. As these models are developed in the future, this risk assessment may be enhanced to better measure these impacts.

5.3 METHODOLOGY

The risk assessments in Chapter 8 through Chapter 18 describe the risks associated with each identified hazard of concern. Each chapter describes the hazard, the planning area’s vulnerabilities, and probable event scenarios. The following steps were used to define the risk of each hazard:

- **Identify and profile each hazard -** The following information is given for each hazard:
  - Geographic areas most affected by the hazard
  - Event frequency estimates
  - Severity estimates
  - Warning time likely to be available for response
- **Determine exposure to each hazard -** Exposure was evaluated by overlaying hazard maps, when available, with an inventory of structures, facilities, and systems to identify which of them would be exposed to each hazard. When hazard mapping was not available, a more qualitative discussion of exposure is presented.
- **Assess the vulnerability of exposed facilities -** Vulnerability of exposed structures and infrastructure was evaluated by interpreting the probability of occurrence of each event and assessing structures, facilities, and systems that are exposed to each hazard. Tools such as geographic information system (GIS) and FEMA’s hazard modeling program called *Hazards, United States – Multi-Hazard*, or HAZUS-MH were used to perform this assessment for the dam/levee failure, earthquake, flood, and hurricane hazards. Outputs similar to those from HAZUS were generated for other hazards, using maps generated by the HAZUS program.

5.4 RISK ASSESSMENT TOOLS

5.4.1 Dam Failure, Earthquake, Flood, and Hurricane - HAZUS-MH

Overview

In 1997, FEMA developed the standardized HAZUS model to estimate losses caused by earthquakes and identify areas that face the highest risk and potential for loss. HAZUS was later expanded into a multi-hazard methodology, HAZUS-MH, with new models for estimating potential losses from dam failures, hurricanes, and floods.

HAZUS-MH is a GIS-based software program used to support risk assessments, mitigation planning, and emergency planning and response. It provides a wide range of inventory data, such as demographics, building stock, critical facility, transportation, and utility lifeline, and multiple models to estimate potential losses from natural disasters. The program maps and displays hazard data and the results of damage and economic loss estimates for buildings and infrastructure. Its advantages include the following:

- Provides a consistent methodology for assessing risk across geographic and political entities.
- Provides a way to save data so that it can readily be updated as population, inventory, and other factors change, and as mitigation planning efforts evolve.
- Facilitates the review of mitigation plans because it helps to ensure that FEMA methodologies are incorporated.
- Supports grant applications by calculating benefits using FEMA definitions and terminology.
- Produces hazard data and loss estimates that can be used when communicating with local stakeholders.
- Is administered by the local government and can be used to manage and update a hazard mitigation plan throughout its implementation.

Levels of Detail for Evaluation

HAZUS-MH provides default data for inventory, vulnerability, and hazards; this default data can be supplemented with local data to provide a more refined analysis. The model can carry out three levels of analysis, depending on the format and level of detail of information about the planning area:

- **Level 1** – All of the information needed to produce an estimate of losses is included in the software's default data. These data are derived from national databases and describe in general terms the characteristic parameters of the planning area.
- **Level 2** – More accurate estimates of losses require more detailed information about the planning area. To produce Level 2 estimates of losses, detailed information is required about local geology, hydrology, hydraulics, and building inventory, as well as data about utilities and critical facilities. This information is needed in a GIS format.
- **Level 3** – This level of analysis generates the most accurate estimate of losses. It requires detailed engineering and geotechnical information to customize it for the planning area.

Application for This Plan

This risk assessment was conducted using HAZUS and GIS-based analysis methodology. The default HAZUS inventory database for Matagorda County and the participating communities was updated with the updated with 2010 U.S. Census Data and 2014 RS Means Square Foot Costs. This enabled a HAZUS Level 2 analysis to be performed on some of the profiled hazards.

The following methods were used to assess specific hazards for this plan:

- **Dam/Levee Failure -** Dam failure inundation mapping for the planning area was not available in a format usable with HAZUS. Therefore, dam failure inundation maps were not used for performing HAZUS risk analysis.
- **Earthquake -** A Level 2 analysis is typically performed to assess earthquake risk and exposure for counties with a peak ground acceleration (PGA) greater than 3%g (*FEMA How-To Guidance, Understanding Your Risks*, FEMA 386-2, p. 1-7). No earthquake scenarios were selected for this plan since an earthquake event for the planning area is rare according to the *2013 State of Texas Hazard Mitigation Plan*.
- **Flood -** A Level 2 flood analysis was performed using HAZUS.
- **Hurricane -** A HAZUS Level 2 analysis was performed to assess hurricane and tropical storm risk and exposure for coastal and near coastal communities. The probabilistic option in the HAZUS hurricane module was used for analysis of this hazard.

5.4.2 Other Hazards of Concern

For hazards of concern that are not directly modeled in HAZUS, annualized losses were estimated using GIS-based analysis, historical data analysis, and statistical risk assessment methodology. Event frequency, severity indicators, expert opinions, and historical knowledge of the region was used for this assessment. The primary data source was the updated HAZUS inventory data updated with 2010 U.S. Census Data and 2014 RS Means Square Foot Costs and augmented with state and federal data sets. Additional data sources for specific hazards were as follows:

- **Drought -** National Drought Mitigation Center, Census of Agriculture
- **Extreme Heat -** Western Regional Climate Center
- **Hail, Lightning, Tornado, Wind, and Winter Weather -** Data provided by National Oceanic and Atmospheric Administration (NOAA) National Climatic Data Center Storm Events Database.
- **Wildfire -** Information on wildfire hazards areas was provided by the Texas A&M Forest Service Wildfire Risk Assessment Portal (TxWRAP), U.S. Geological Survey (USGS) Federal Wildfire History, Fire Program Analysis Fire-Occurrence Database (FPA-FOD), and the U.S. Department of Agriculture (USDA) Wildfire Hazard Potential data.

5.4.3 Limitations

Loss estimates, exposure assessments, and hazard-specific vulnerability evaluations rely on the best available data and methodologies. Uncertainties are inherent in any loss estimation methodology and arise in part from incomplete scientific knowledge concerning natural hazards and their effects on the built environment. Uncertainties also result from the following:

- Approximations and simplifications necessary to conduct a study
- Incomplete or outdated inventory, demographic, or economic parameter data
- The unique nature, geographic extent, and severity of each hazard
- Mitigation measures already employed
- The amount of advance notice residents have to prepare for a specific hazard event

These factors can affect loss estimates by a factor of two or more. Therefore, potential exposure and loss estimates are approximate and not deterministic. The results do not predict precise results and should be used only to understand relative risk for planning purposes and not engineering. Over the long term, Matagorda County and its planning partners will collect additional data to assist in estimating potential losses associated with other hazards.

CHAPTER 6.
MATAGORDA COUNTY PROFILE

Matagorda County covers approximately 1,613 square miles and is located in Coastal Prairie region of Texas. A total of 512 square miles of the county is water. Matagorda County is adjacent to the Gulf of Mexico; and the Tres Palacios, Matagorda, and East Matagorda Bays (Figure 6-1). The Colorado River (which dissects the county) contributes to the South Texas Project Reservoir. Major watercourses in the county include Caney, Peach, Peyton's, Turtle, Cash's, Big Boggy, Cottonwood, and Little Boggy Creeks; the Tres Palacios and Colorado Rivers; Live Oak and Linville Bayous; and Little Robbins Slough. The City of Bay City is the largest city and holds the county seat for Matagorda County. As of the 2010 U.S. Census, Matagorda County had a population of 36,702. The county has two hospitals, Matagorda Regional Medical Hospital, located in the City of Bay City, and the Palacios Community Medical Center, located in the City of Palacios.

Figure 6-1. Location of the Matagorda County Planning Area within the State of Texas

Rice is grown extensively in Matagorda County, as well as sorghum, soybeans, wheat, hay, cotton, potatoes, peaches, and pecans. In addition, offshore oil rigs and natural gas extraction facilities are located throughout the county. Two petrochemical processing plants and the South Texas Project nuclear power plant operate within the county. Matagorda County has extensive forests, wetlands, prairie, and coastal regions. The Gulf Coast floodplain is conducive to a variety of ecosystems and recreational activities and includes the highest count of migrating birds in the U.S. Fishing (on and offshore), hunting, and scuba diving are large parts of the recreation industry due to the Colorado River, the county’s forests, and Matagorda Bay. Recreational facilities include the Rio Colorado Golf Course and a bird watching park on the Colorado River near the

State Highway 35 Bridge. There are a significant number of wildlife preserves around the county. Some of the preserved land was purchased and set aside by the two major petrochemical refineries and nuclear plant in the county.

6.1 HISTORICAL OVERVIEW

Matagorda County, a part of Stephen F. Austin's Colony, was one of the original Texas counties formed on March 17, 1836. Matagorda County is named for the canebrakes that once grew along the coast. Matagorda is a Spanish word meaning “thick bush”. The majority of this historical overview section was summarized from the *Handbook of Texas Online* (Kleiner 2010).

The first settlers of the area were the Karankawa Indians who were later displaced by the Tonkawa Indians of Central Texas as European exploration began. European explorers arrived in the region in approximately 1528. The first recorded European expedition was led by Spanish explorer Alvar Nunez Cabeza De Vaca. Settlement by Anglo-Americans began in 1822 when the schooner *Only Son* landed immigrants for Stephen F. Austin’s colony at the mouth of the Colorado River. Austin gave grants in the area to 52 families, principally from New York. In 1827, he received permission to settle 300 more families within 30 leagues of the coast in areas where settlement had previously been forbidden by the Mexican government. The Town of Matagorda, at the mouth of the Colorado River, was founded in 1829 after Austin had convinced the Mexican government that a military post was needed to protect incoming settlers. The town grew and settlement proceeded inward from the coast, initially along Caney Creek. A custom house established at Matagorda in 1831 was maintained until the Texas Revolution. Steamers and sailing vessels approached within six miles of the town on Matagorda Bay; other county transportation was also largely by water. The municipality of Matagorda, which comprised the southeast corner of the original Austin grants, was established in 1834 while the area remained under Mexican control.

After the Texas Revolution in 1836, Matagorda County was organized as one of the first 23 counties by the Republic of Texas and Matagorda was designated as the county seat. As Texas’s second major seaport and a port of entry for Texas immigrants from 1840 to 1865, Matagorda developed transportation and industry.

By 1858, roughly 30% of the improved acreage in the county was used to raise cotton, 6% was devoted to sugar, and 20% to corn; sea-island cotton was grown on Matagorda Peninsula during this period. In the late 1850s, major towns in the county included Matagorda, with 1,200 residents, and Tres Palacios (also known simply as Palacios), which was located west of the Colorado River on a high point of land between Matagorda and Tres Palacios Bays. By 1860, there were 3,454 people living in Matagorda County.

Railroad construction in Matagorda County started in the early 20th Century and helped encourage development by tying the area to national markets and encouraging immigration. This line later became part of the Southern Pacific Railroad. The discovery of oil and sulfur in the county helped diversify the local economy during this period.

During the Great Depression, cotton cultivation declined and rice cultivation was revived. Cropland harvests increased during the 1930s. The county’s population continued to grow during the 1930s and by 1940, there were 20,033 people living in Matagorda County.

6.2 MAJOR PAST HAZARD EVENTS

Federal disaster declarations are typically issued for hazard events that cause more damage than state and local governments can handle without assistance from the federal government. However, no specific dollar loss threshold has been established for these declarations. A federal disaster declaration puts federal recovery programs into motion to help disaster victims, businesses, and public entities. Some of the programs are matched by state programs. The planning area has experienced 21 events since 1967 for which federal disaster declarations were issued. These events are listed in Table 6-1.

Review of these events helps identify targets for risk reduction and ways to increase a community's capability to avoid large-scale events in the future. Still, many natural hazard events do not trigger federal disaster declaration protocol but have significant impacts on their communities. These events are also important to consider in establishing recurrence intervals for hazards of concern. More detailed event tables can be found in the individual hazard profile sections.

TABLE 6-1.
FEDERAL DISASTER DECLARATIONS IN MATAGORDA COUNTY

Disaster Declaration[a]	Description	Incident Date
DR-4029	Wildfires	8/30/2011 - 12/31/2011
DR-1791	Hurricane Ike	9/7/2008 - 10/2/2008
EM-3294	Hurricane Ike	9/7/2008 - 9/26/2008
EM-3290	Hurricane Gustav	8/27/2008 - 9/7/2008
EM-3277	Hurricane Dean	8/17/2007 - 9/5/2007
DR-1624	Extreme Wildfire Threat	11/27/2005 - 5/14/2006
DR-1606	Hurricane Rita	9/23/2005 - 10/14/2005
EM-3261	Hurricane Rita	9/20/2005 - 10/14/2005
EM-3216	Hurricane Katrina Evacuation	8/29/2005 - 10/1/2005
DR-1479	Hurricane Claudette	7/15/2003 - 7/28/2003
DR-1434	Tropical Storm Fay	9/6/2002 - 9/30/2002
EM-3142	Extreme Fire Hazards	8/1/1999 - 12/10/1999
DR-1257	Texas Flooding 10/18/98	10/17/1998 - 11/15/1998
DR-1245	Hurricane Georges - Texas	9/9/1998 - 10/5/1998
DR-1239	Tropical Storm Charley	8/22/1998 - 8/31/1998
DR-1041	Severe Thunderstorms and Flooding	10/14/1994 - 11/8/1994
DR-930	Severe Thunderstorms	12/20/1991 - 1/14/1992
DR-689	Hurricane Alicia	8/18/1983 - 8/20/1983
DR-603	Severe Storms and Flooding	9/25/1979 - 9/25/1979
DR-398	Severe Storms and Flooding	7/11/1973 - 7/11/1973
DR-232	Hurricane Beulah	9/28/1967 - 9/28/1967

a. Federal disaster declarations are coded as follows: DR = Major Disaster Declaration; EM = Emergency Declaration

Source: FEMA Disaster Declarations Summary - Open Government Dataset (http://www.fema.gov/media-library/assets/documents/28318?id=6292)

6.3 CLIMATE

Matagorda County and the participating communities have a humid, subtropical climate, with hot summer days however, the coast is frequently cooled by sea breezes. Average temperatures range from 90°F in the summer to 46°F in the winter. The Western Regional Climate Center reports data from the City of Palacios Municipal Airport weather station in Matagorda County. Table 6-2 contains temperature summaries for the station. Figure 6-2 graphs the daily temperature averages and extremes from 1943 through 2013. Figure 6-3 and Figure 6-4 show the geographic distribution of annual average minimum and annual average maximum temperatures from 1981 to 2010 in Matagorda County compared to the State of Texas.

TABLE 6-2.
MATAGORDA COUNTY TEMPERATURE SUMMARIES PALACIOS MUNICIPAL AIRPORT STATION

Period of record	1943-2013
Winter[a] Average Minimum Temperature	46.4°F
Winter[a] Mean Temperature	55.7ºF
Summer[a] Average Maximum Temperature	90.2°F
Summer[a] Mean Temperature	69.9ºF
Maximum Temperature	103°F; June 26, 2012
Minimum Temperature	9°F; December 23, 1989
Average Annual Number of Days >90°F	76.5
Average Annual Number of Days <32°F	9.3

a. Winter: December, January, February; Summer: June, July, August
Source: Western Regional Climate Center, http://www.wrcc.dri.edu/cgi-bin/cliMAIN.pl?tx6750

Source: Western Regional Climate Center, http://www.wrcc.dri.edu/cgi-bin/cliMAIN.pl?tx6750

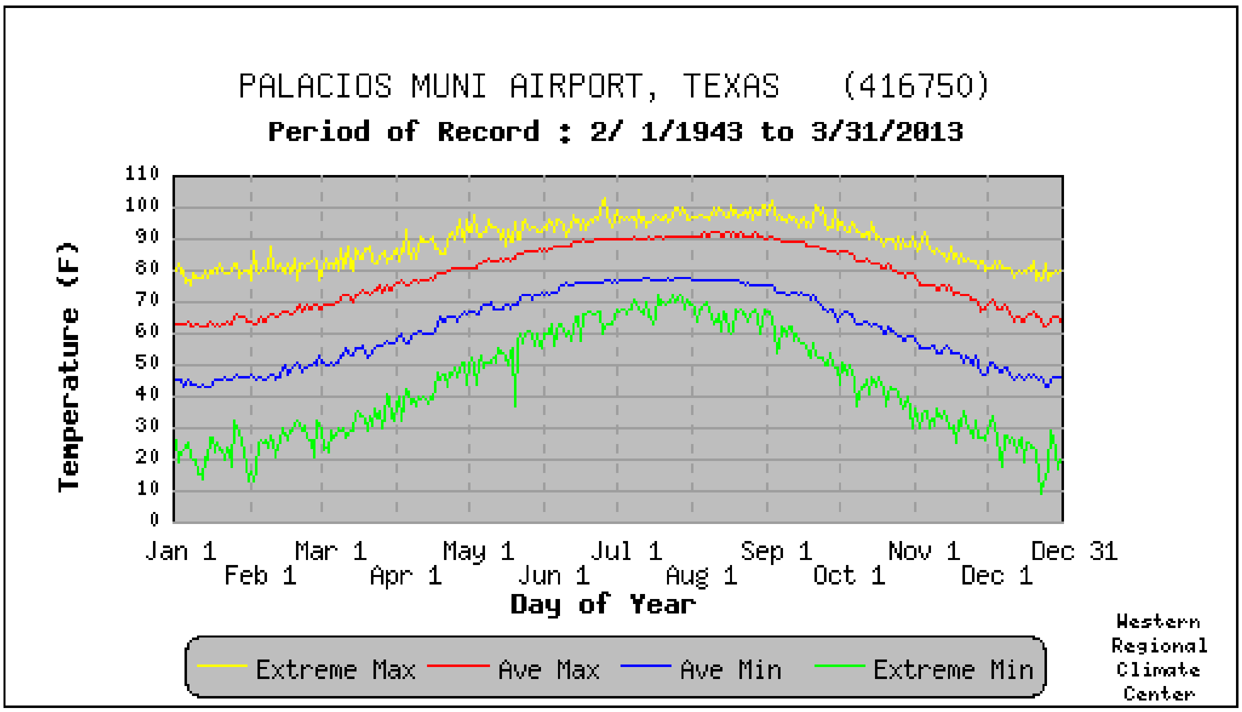


Figure 6-2. City of Palacios Municipal Airport Station Monthly Temperature Data (1943-2013)

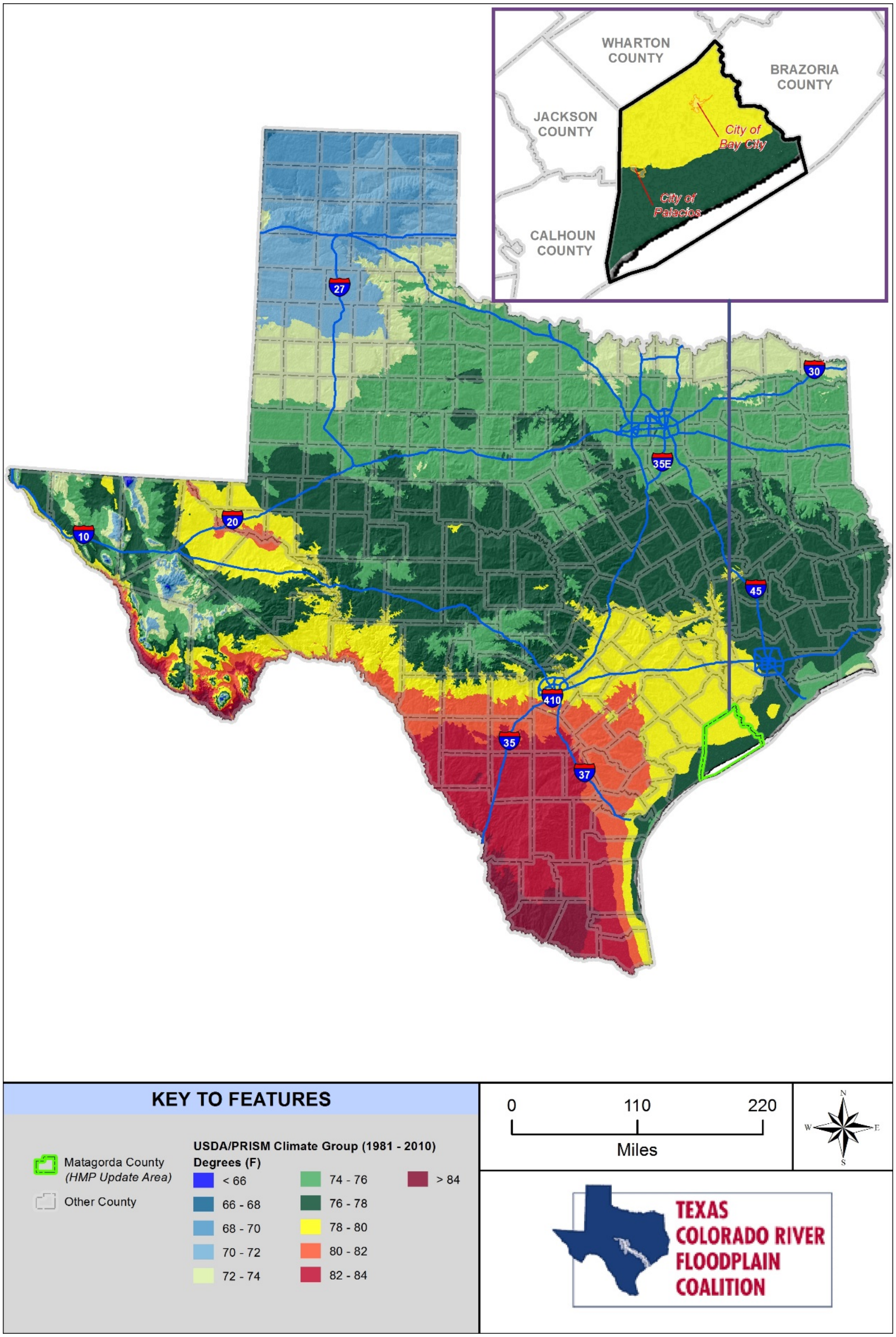


Figure 6-3. Annual Average Maximum Temperature (1981-2010)

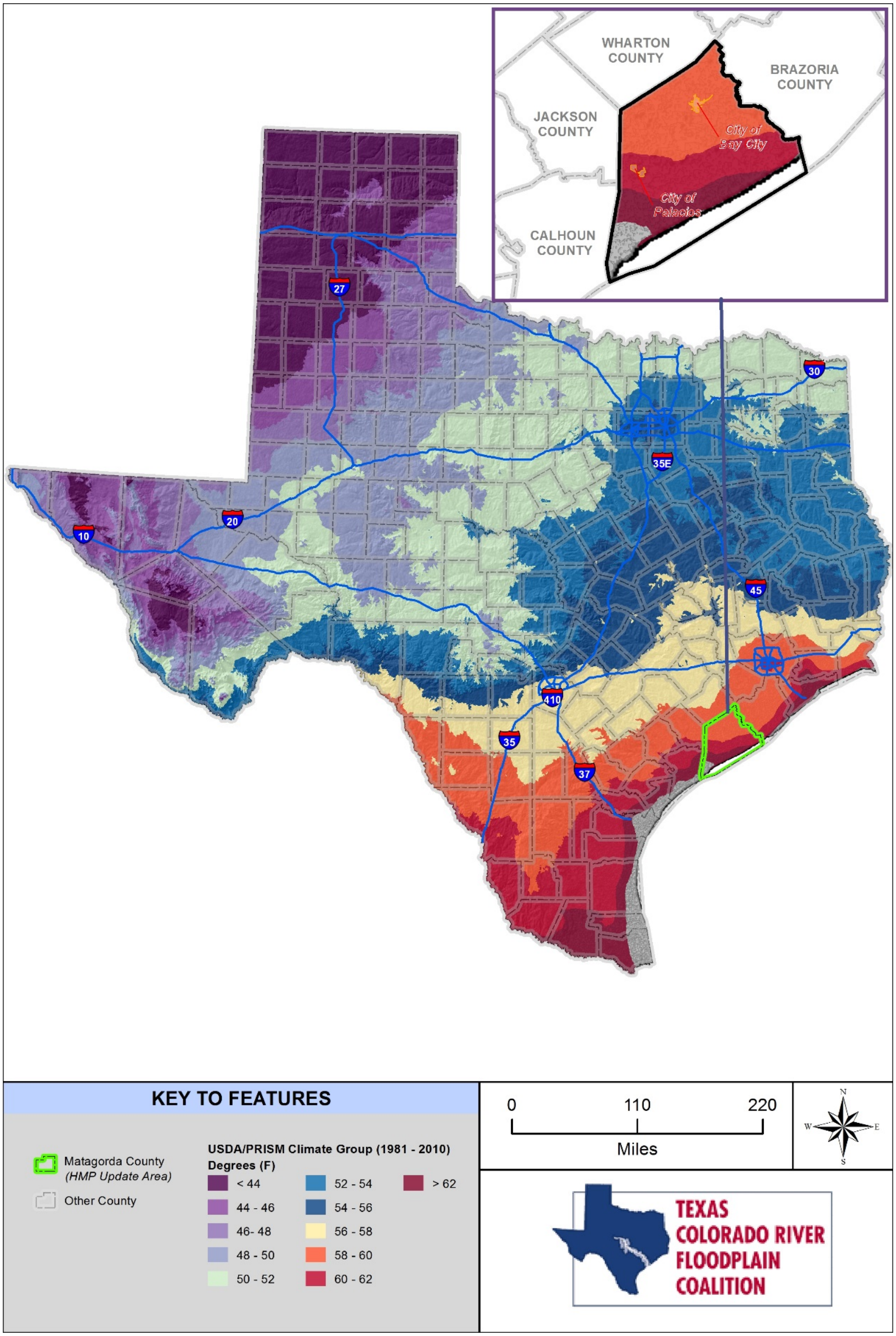


Figure 6-4. Annual Average Minimum Temperature (1981-2010)

Precipitation in Matagorda County and the participating communities is greatest in September. The average annual precipitation is 43.28 inches. Severe thunderstorm occur mostly in the spring. Based on information measured by the National Lightning Detection Network, the State of Texas is ranked 17th in the nation for cloud-to-ground lightning flashes per square mile from 1997 to 2010. The average flashes during this timeframe was 11.3 per square mile. Figure 6-5 shows the average monthly precipitation in Matagorda County from the Palacios Municipal Airport location. Figure 6-6 shows geographic distribution of annual average precipitation in Matagorda County compared to the State of Texas.

Source: http://www.wrcc.dri.edu/cgi-bin/cliMAIN.pl?tx6750

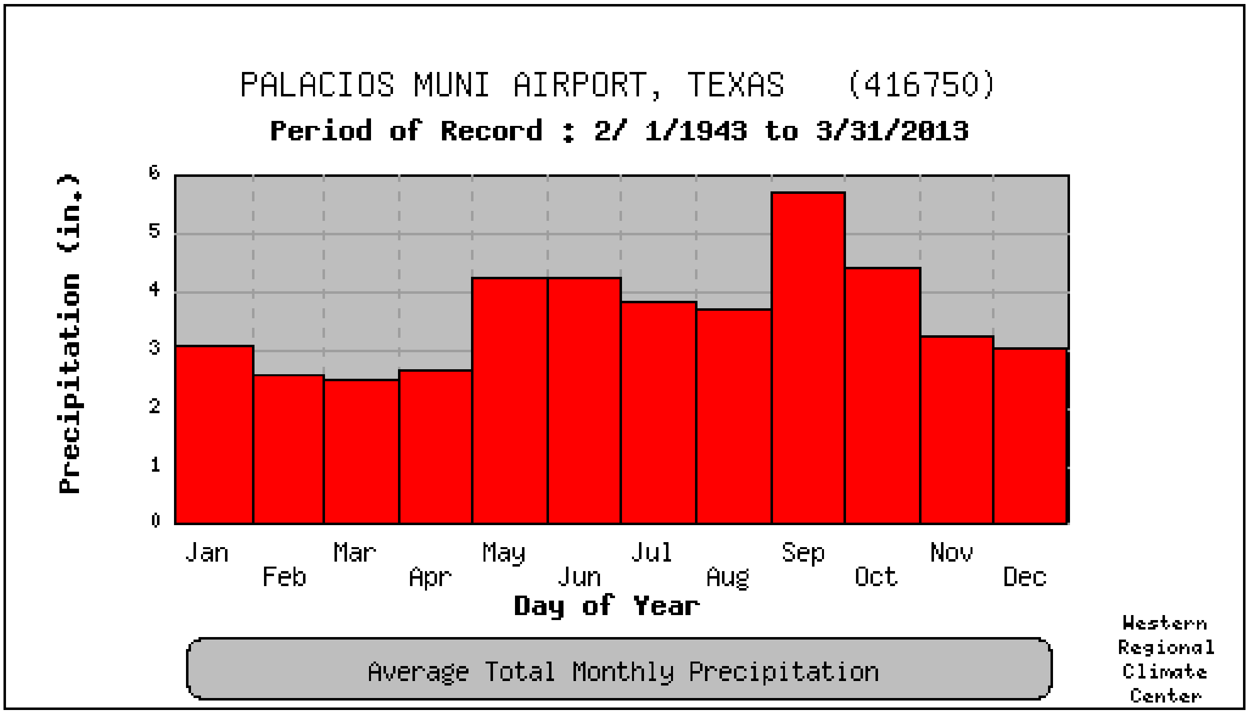


Figure 6-5. Average Monthly Precipitation (1943-2013)

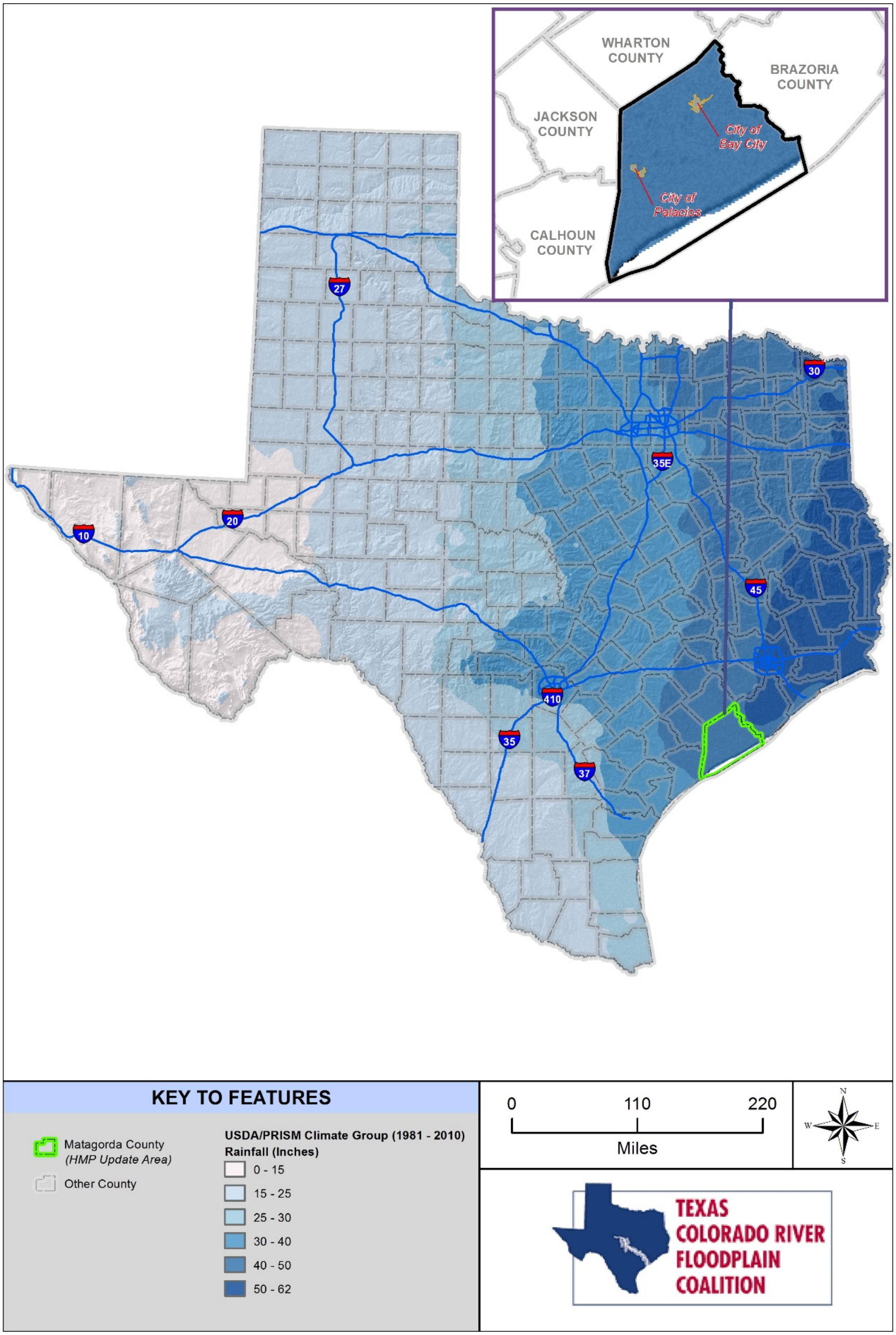


Figure 6-6. Geographic Distribution of Annual Average Precipitation (1981-2010)

6.4 GEOLOGY AND SOILS

Texas is broadly divided into four regions by physical geography features such as landforms, climate, and vegetation. Matagorda County and the participating communities are in the southeastern part of Texas, along the Gulf of Mexico. It lies in two major land resource areas: the Gulf Coast Prairies and the Gulf Coast Saline Prairies. Matagorda County and the participating communities are within the Colorado River Basin Watershed. Figure 6-7 shows the Texas natural regions with Matagorda County and the participating communities highlighted.

The county is roughly rectangular, measuring approximately 35 miles from north to south and 40 miles from east to west. Matagorda Bay makes up a major part of the water areas. The bay is divided into East Bay and West Bay, which are separated by a delta extending from the Town of Matagorda to the Matagorda Peninsula. The peninsula separates Matagorda Bay from the Gulf of Mexico. The terrain is nearly level. A majority of the few sloping areas in Matagorda County are next to the Colorado River, the Tres Palacios River, Caney Creek, Peyton Creek, and Wilson Creek.

Clayey and loamy soils make up about 57% of the soils in the county. These soils are fertile and well suited to crops and grasses. The native vegetation in the county generally consists of live oak, other hardwoods, with an understory of woody shrubs and grasses.

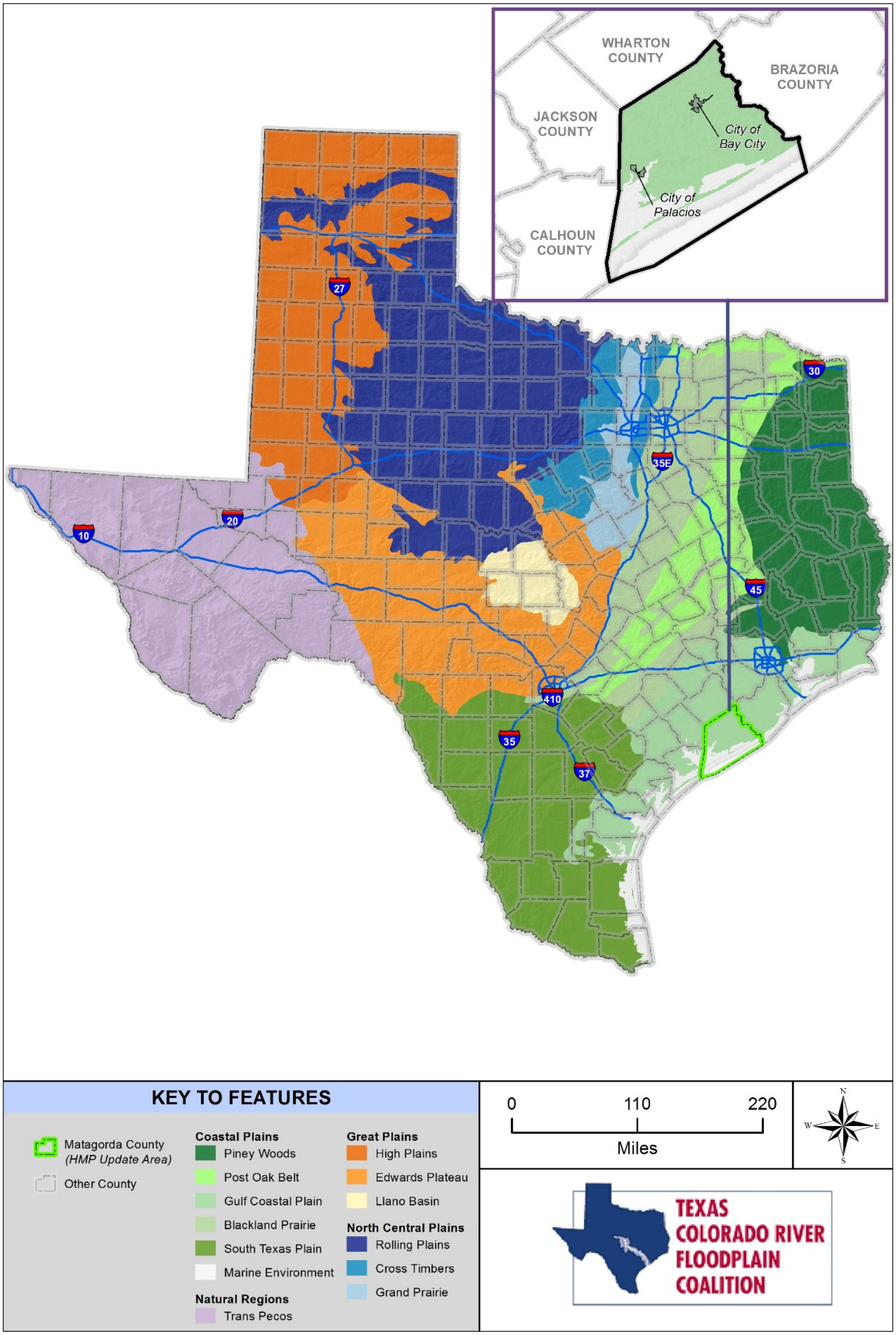


Figure 6-7. Natural Regions of Texas and Matagorda County

6.5 CRITICAL FACILITIES AND INFRASTRUCTURE

Critical facilities and infrastructure are essential to the health and welfare of the population. These assets become especially important after a hazard event. As defined for this hazard mitigation plan update, critical facilities include but are not limited to the following:

- Essential services facilities:
  - Public safety facilities (police stations, fire and rescue stations, emergency vehicle and equipment storage, and, emergency operation centers)
  - Emergency medical facilities (hospitals, ambulance service centers, urgent care centers having emergency treatment functions, and non-ambulatory surgical structures but excluding clinics, doctors' offices, and non-urgent care medical structures that do not provide these functions)
  - Designated emergency shelters
  - Communications (main hubs for telephone, broadcasting equipment for cable systems, satellite dish systems, cellular systems, television, radio, and other emergency warning systems, but excluding towers, poles, lines, cables, and conduits)
  - Public utility plant facilities for generation and distribution (hubs, treatment plants, substations and pumping stations for water, power and gas, but not including towers, poles, power lines, buried pipelines, transmission lines, distribution lines, and service lines)
  - Air transportation lifelines (airports [municipal and larger], helicopter pads and structures serving emergency functions, and associated infrastructure [aviation control towers, air traffic control centers, and emergency equipment aircraft hangars])
- Hazardous materials facilities:
  - Chemical and pharmaceutical plants
  - Laboratories containing highly volatile, flammable, explosive, toxic, or water-reactive materials
  - Refineries
  - Hazardous waste storage and disposal sites
  - Aboveground gasoline or propane storage or sales centers
- At-risk population facilities:
  - Elder care centers (nursing homes)
  - Congregate care serving 12 or more individuals (day care and assisted living)
  - Public and private schools (pre-schools, K-12 schools, before-school and after-school care serving 12 or more children)
- Facilities vital to restoring normal services:
  - Essential government operations (public records, courts, jails, building permitting and inspection services, community administration and management, maintenance and equipment centers)
  - Essential structures for public colleges and universities (dormitories, offices, and classrooms only)

Table 6-3 and Table 6-4 summarize the critical facilities and infrastructure in each municipality and unincorporated county areas. This information was obtained from HAZUS-MH, county assessor data, or from community personnel.

**TABLE 6-3.
CRITICAL FACILITIES IN THE PLANNING AREA**

Facility Type	City of Bay City	City of Palacios	Unincorporated or Other	**Total**
Fire Stations	1	1	1	**3**
Police Stations	3	1	0	**4**
Medical and Health	1	1	0	**2**
Emergency Operations Center	0	0	0	**0**
School	10	3	6	**19**
Hazardous Materials	0	1	14	**15**
Government Functions	2	1	0	**3**
Total	**17**	**8**	**21**	**46**

**TABLE 6-4.
CRITICAL INFRASTRUCTURE IN THE PLANNING AREA**

Facility Type	City of Bay City	City of Palacios	Unincorporated or Other	**Total**
Communication	1	0	5	**6**
Power Facility	0	0	5	**5**
Wastewater Facility	0	0	5	**5**
Dam Location	1	0	14	**15**
Airport Facility	0	1	1	**2**
Airport Runway	0	3	1	**4**
Other Transportation	1	20	3	**24**
Bridge	20	4	142	**166**
Total	**23**	**28**	**176**	**227**

Figure 6-8 through Figure 6-13 show the location of critical facilities and infrastructure in the county and the participating communities. Due to the sensitivity of this information, a detailed list of facilities is not provided. The list is on file with each planning partner. Critical facilities and infrastructure were analyzed in HAZUS to help rank risk and identify mitigation actions. The risk assessment for each hazard discusses critical facilities and infrastructure with regard to that hazard.

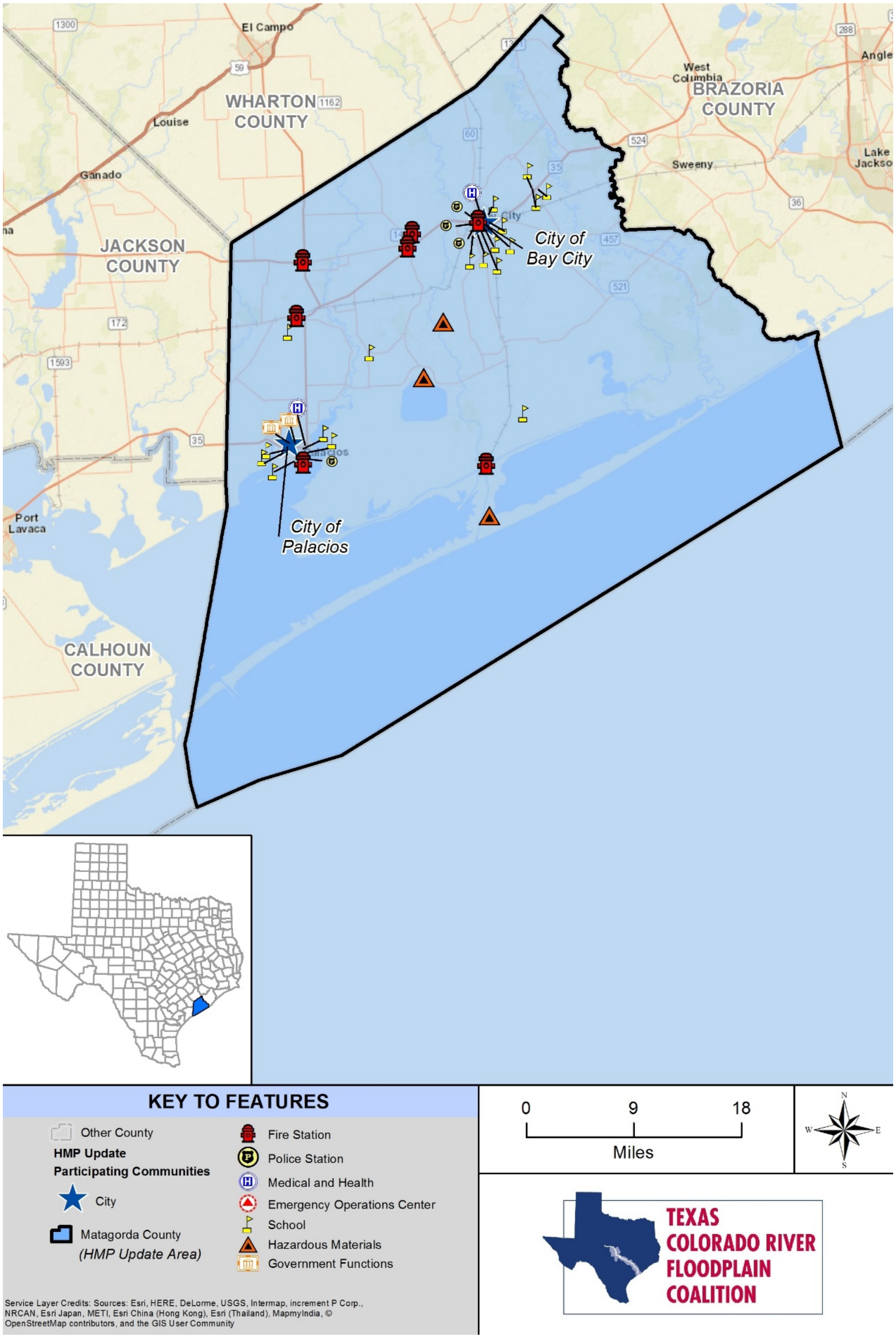


Figure 6-8. Critical Facilities in Matagorda County

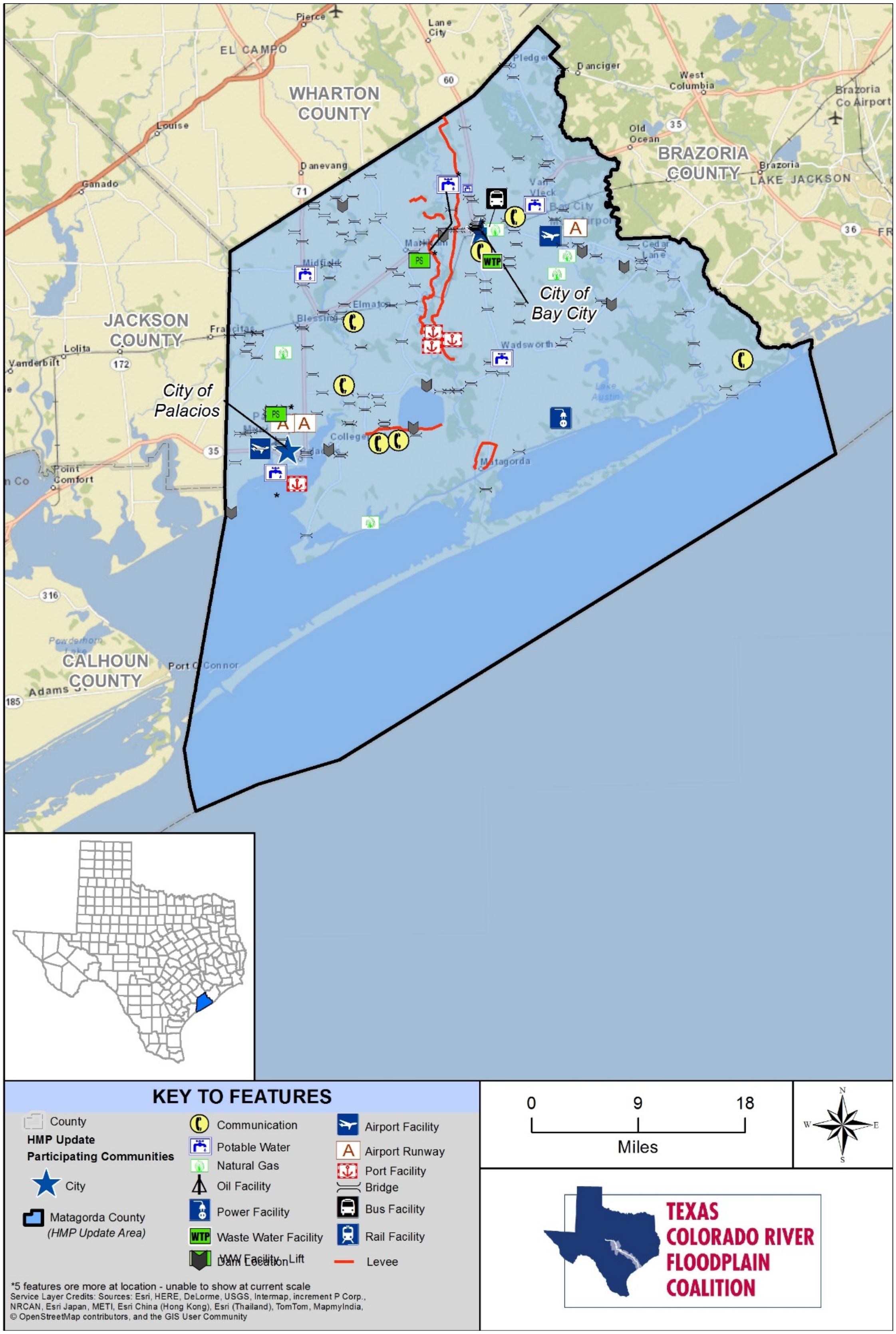


Figure 6-9. Critical Infrastructure in Matagorda County

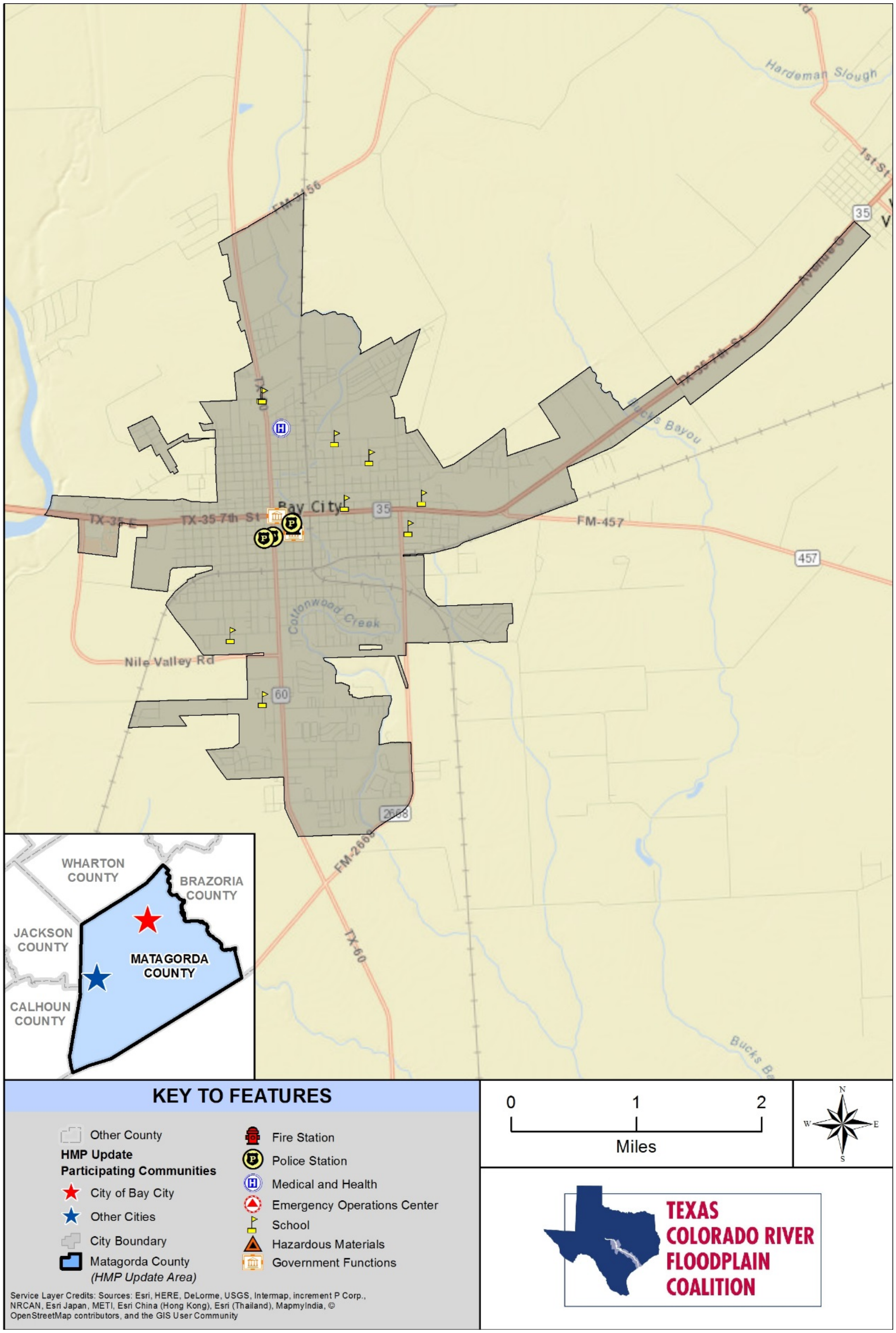


Figure 6-10. Critical Facilities in the City of Bay City

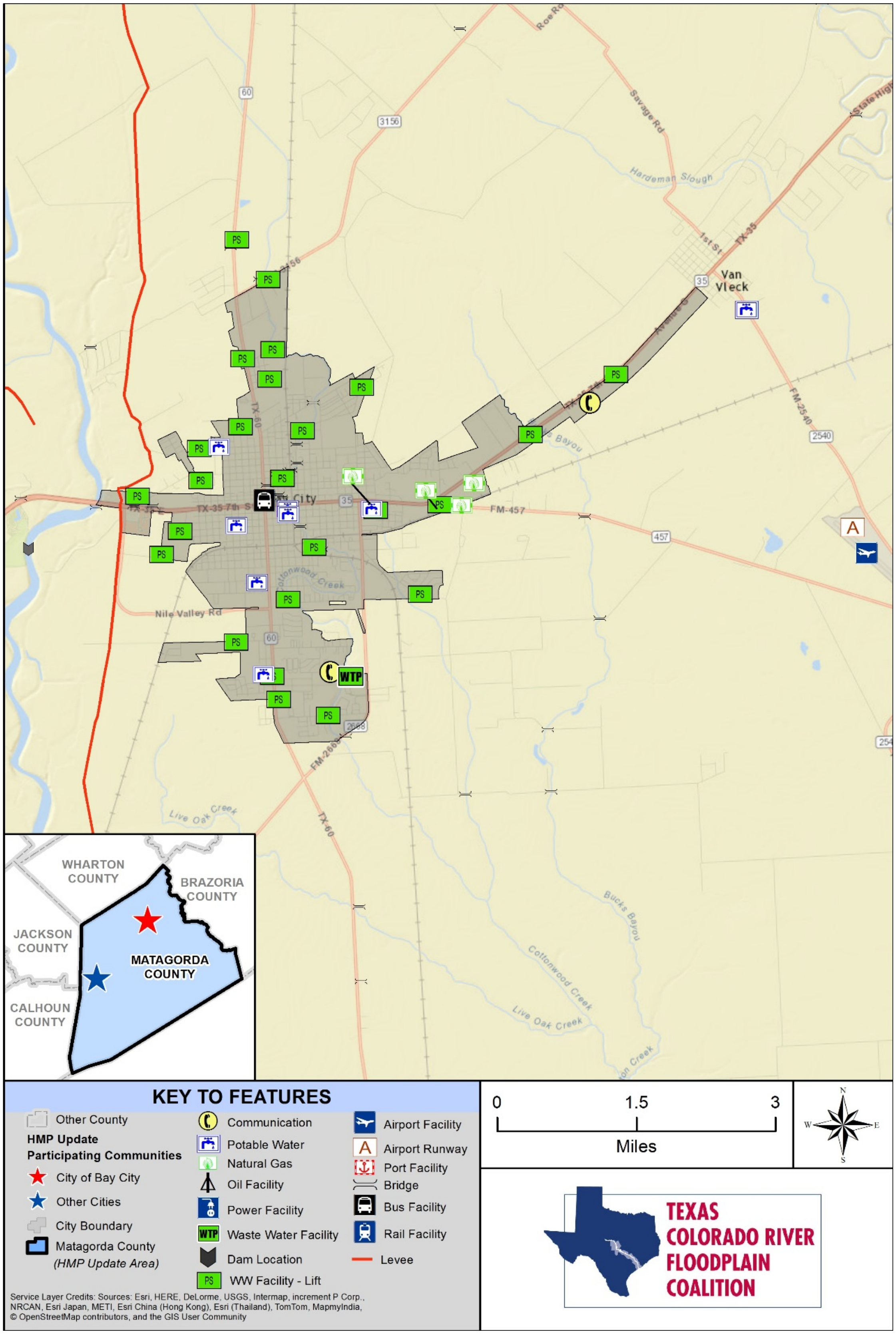


Figure 6-11. Critical Infrastructure in the City of Bay City

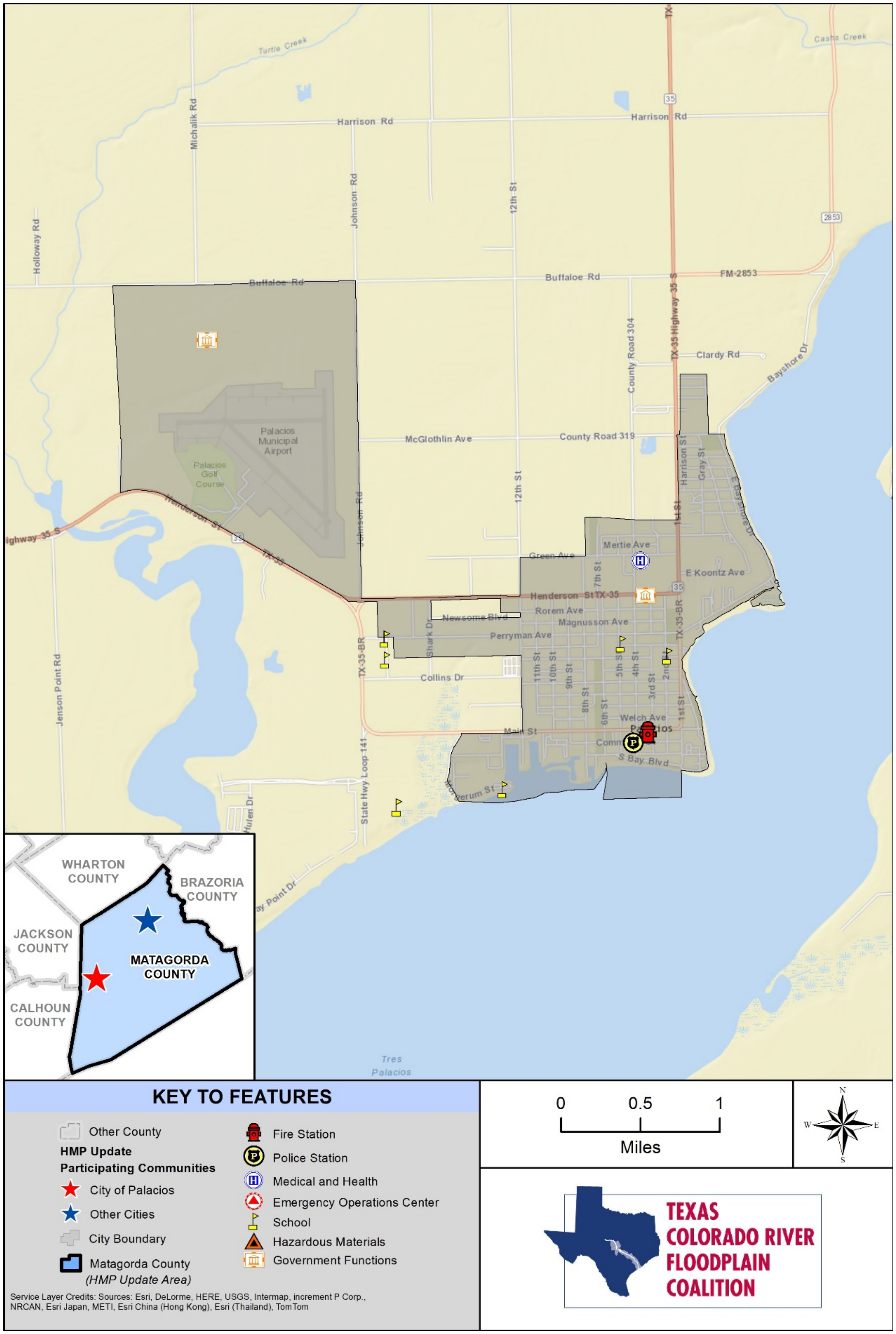


Figure 6-12. Critical Facilities in the City of Palacios

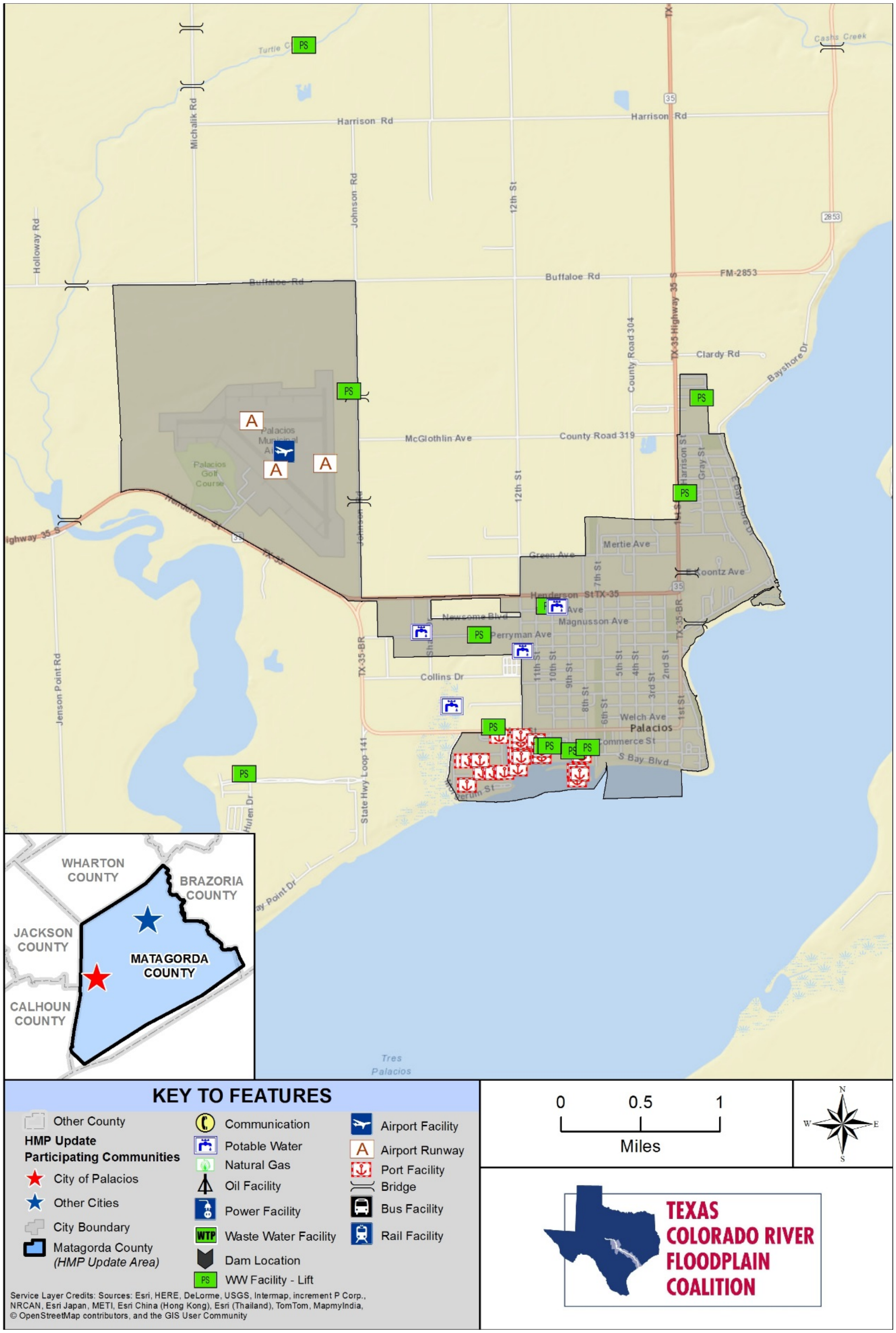


Figure 6-13. Critical Infrastructure in the City of Palacios

6.6 DEMOGRAPHICS

Information on current and historic population levels and future population projections is needed for making informed decisions about future planning. Population directly relates to land needs such as housing, industry, stores, public facilities and services, and transportation. Population changes are useful socio-economic indicators, as a growing population generally indicates a growing economy, and a decreasing population signifies economic decline.

Some populations are at greater risk from hazard events because of decreased resources or physical abilities. Elderly people, for example, may be more likely to require additional assistance. Research has shown that people living near or below the poverty line, the elderly (especially older single men), the disabled, women, children, ethnic minorities and renters all experience, to some degree, more severe effects from disasters than the general population. These vulnerable populations may vary from the general population in risk perception; living conditions; access to information before, during and after a hazard event; capabilities during an event; and access to resources for post-disaster recovery. Indicators of vulnerability—such as disability, age, poverty, and minority race and ethnicity—often overlap spatially and often in the geographically most vulnerable locations. Detailed spatial analysis to locate areas where there are higher concentrations of vulnerable community members would assist the county and the participating communities in extending focused public outreach and education to these most vulnerable citizens. Select U.S. Census demographic and social characteristics for Matagorda County and the participating communities are shown in Table 6-5.

TABLE 6-5.
MATAGORDA COUNTY DEMOGRAPHIC AND SOCIAL CHARACTERISTICS (2013)

	Matagorda County	City of Bay City	City of Palacios
Gender/Age (% of Total Population)			
Male	49.9	50.2	52.0
Female	50.1	49.8	48.0
Under 5 years	7.1	8.5	7.1
65 years and over	14.6	12.2	13.2
Race/Ethnicity (% of Total Population)			
White	80.6	76.3	78.7
American Indian/Alaska Native	0.3	0.6	0.0
Asian	2.1	1.0	10.1
Black or African American	10.7	14.3	0.5
More Than One Race	3.2	4.1	5.9
Hispanic or Latino (of any race)[1]	39.0	40.6	60.5
Education			
High School Graduate or Higher (% of Total Population, 25+ years)	78.1	78.9	71.5

Source: U.S. Census Bureau, factfinder.census.gov

[1]The U.S. Census Bureau considers the Hispanic/Latino designation an ethnicity, not a race. The population self-identified as "Hispanic/Latino" is also represented within the categories in the "Race" demographic.

6.6.1 Population

The U.S. Census Bureau estimated a population of 36,592 for Matagorda County as of July 2013. Table 6-6 shows planning area population data from 1990 through 2013. The total Matagorda County population increased only 1% from 1990 to 2000 and decreased approximately 1% from 2000 to 2013; thus, the population has not changed significantly since 1990.

TABLE 6-6.
MATAGORDA COUNTY POPULATION

	Total Population			
	1990	2000	2010	2013[1]
City of Bay City	18,170	18,667	17,614	17,509
City of Palacios	4,418	5,153	4,718	4,661
Unincorporated Areas[2]	15,340	14,137	14,370	14,422
County Total	**37,928**	**37,957**	**36,702**	**36,592**

Source: Texas State Library and Archives Commission and Texas Association of Counties
https://www.tsl.texas.gov/ref/abouttx/population.html
http://www.county.org/about-texas-counties/county-data/Documents/towns.html[1]

[1] Data from Texas Association of Counties
[2] Includes non-participating communities

The Cities of Bay City and Palacios are the county's principal population centers. As shown above, the population of the Cities of Bay City and Palacios and the county have remained stable since 1990.

Figure 6-14 shows 5-year population changes in the planning area and the State of Texas from 1990 to 2010 and the 3-year change from 2010 to 2013. Between 1990 and 2013, the State of Texas' population grew by 53% (about 4.1% per year) while the planning area's population decreased by approximately 1%).

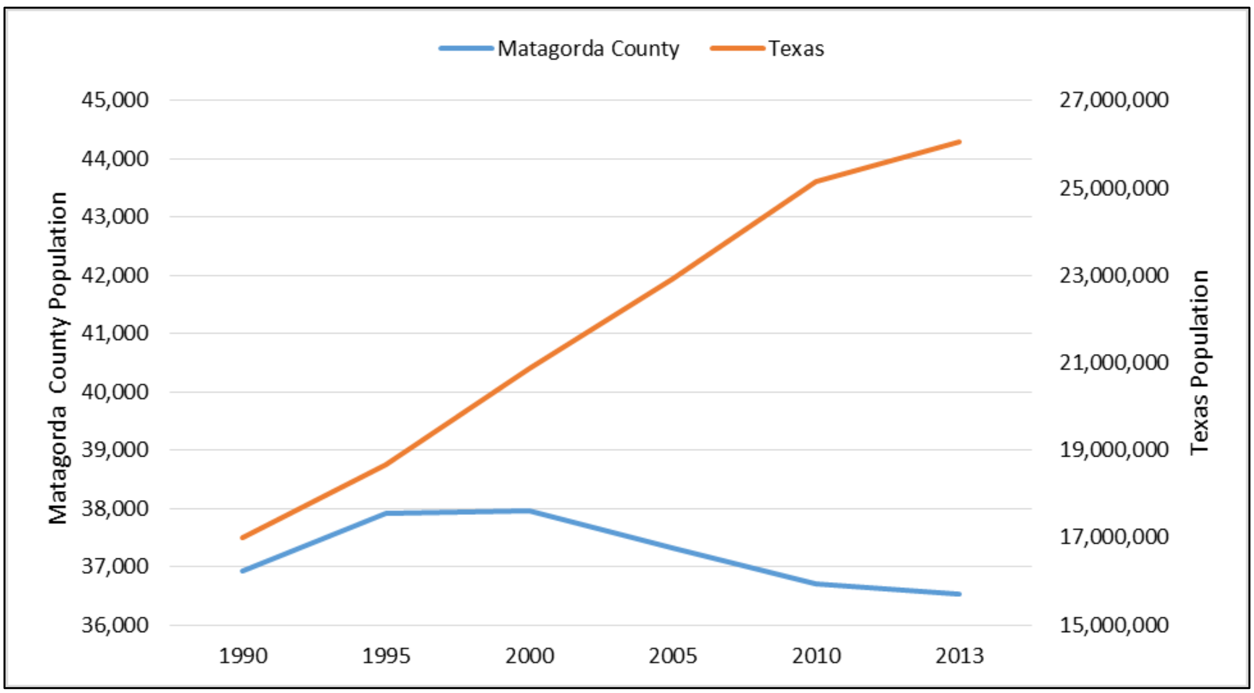


Figure 6-14. State of Texas and Matagorda County Population Growth

6.6.2 Age Distribution

As a group, the elderly are more apt to lack the physical and economic resources necessary for response to hazard events and are more likely to suffer health-related consequences making recovery slower. They are more likely to be vision, hearing, or mobility impaired, and more likely to experience mental impairment or dementia. Additionally, the elderly are more likely to live in assisted-living facilities where emergency preparedness occurs at the discretion of facility operators. These facilities are typically identified as "critical facilities" by emergency managers because they require extra notice to implement evacuation. Elderly residents living in their own homes may have more difficulty evacuating their homes and could be stranded in dangerous situations. This population group is more likely to need special medical attention, which may not be readily available during natural disasters due to isolation caused by the event. Specific planning attention for the elderly is an important consideration given the current aging of the national population.

Children under 14 are particularly vulnerable to disaster events because of their young age and dependence on others for basic necessities. Very young children may additionally be vulnerable to injury or sickness; this vulnerability can be worsened during a natural disaster because they may not understand the measures that need to be taken to protect themselves from hazards.

The overall age distribution for the planning area is illustrated in Figure 6-15. Based on U.S. Census data estimates, 14.6% of the planning area's population is 65 or older. U.S. Census data does not provide information regarding disabilities in the planning area's over-65 population. Census estimates for 2013 indicate that 25% of Matagorda County families have children under 18 and are below the poverty line.

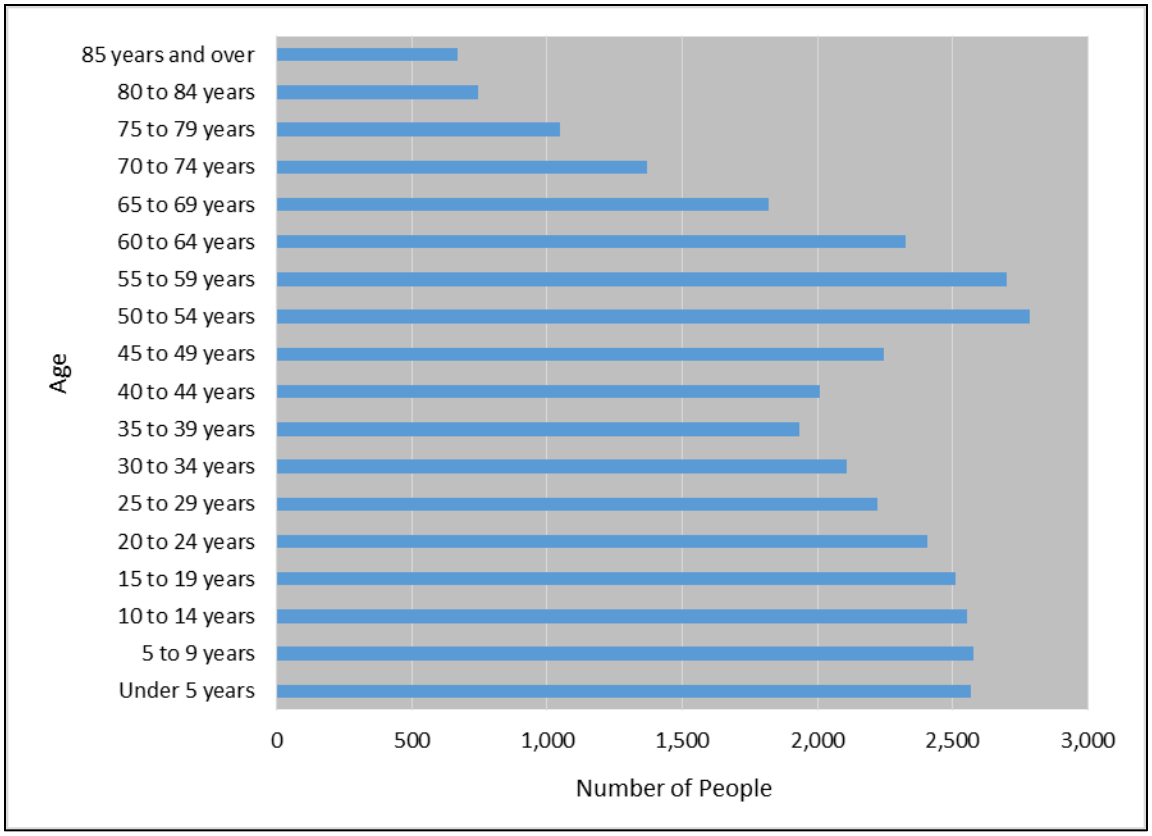


Figure 6-15. Matagorda County Age Distribution

6.6.3 Disabled Populations

The 2010 U.S. Census estimated that 57 million non-institutionalized Americans with disabilities live in the U.S. This equates to about one-in-five persons. People with disabilities are more likely to have difficulty responding to a hazard event than the general population. Local government is the first level of response to assist these individuals, and coordination of efforts to meet their access and functional needs is paramount to life safety efforts. It is important for emergency managers to distinguish between functional and medical needs in order to plan for incidents that require evacuation and sheltering. Knowing the percentage of population with a disability will allow emergency management personnel and first responders to have personnel available who can provide services needed by those with access and functional needs. According to the 2010 U.S. Census, 10.3% of the population in the planning area lives with some form of disability.

6.6.4 Ethnic Population

Research shows that minorities are less likely to be involved in pre-disaster planning and experience higher mortality rates during a disaster event. Post-disaster recovery can be less effective for ethnic populations and is often characterized by cultural insensitivity. Since higher proportions of ethnic minorities live below the poverty line than the majority white population, poverty can compound vulnerability. According to the U.S. Census, the ethnic composition of the planning area is predominantly white, at about 80.6%. The largest minority population is Hispanic or Latino at 39%. Figure 6-16 shows the population distribution by race and ethnicity in the planning area. The values shown on Figure 6-16 exceed 100% because according to the U.S. Census, Hispanic or Latino is listed as an ethnicity, not a race. Therefore, the Hispanic or Latino designation encompasses several races.

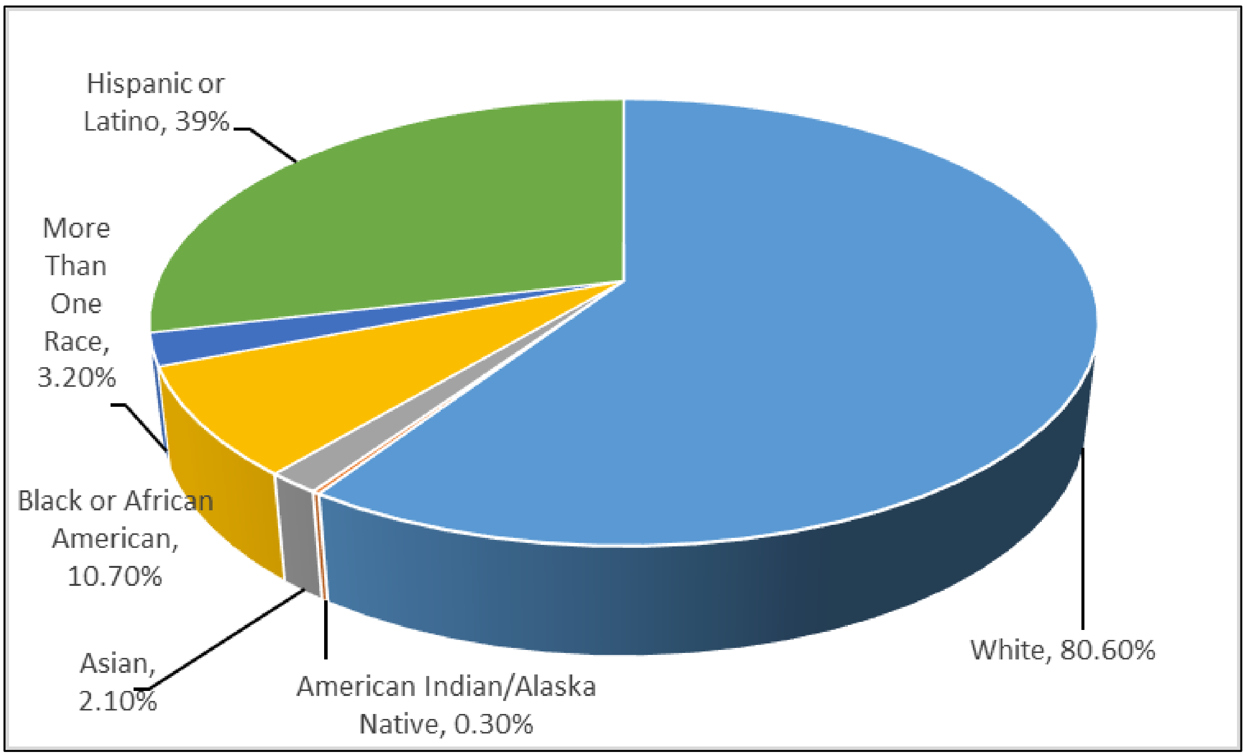


Figure 6-16. Matagorda County Ethnic Distribution

The planning area has a 10.7% foreign-born population. Other than English, the most commonly spoken language in the planning area is Spanish. The census estimates 12.6% of the residents speak English "less than very well."

6.7 ECONOMY

Select 2013 economic characteristics estimated for Matagorda County and the participating communities by the U.S. Census Bureau are shown in Table 6-7.

**TABLE 6-7.
MATAGORDA COUNTY ECONOMIC CHARACTERISTICS**

	Matagorda County	City of Bay City	City of Palacios
Families Below Poverty Level	16.9%	20.7%	23.6%
Individuals Below Poverty Level	21.1%	25.8%	24.1%
Median Home Value	$92,000	$89,500	$65,900
Median Household Income	$43,096	$40,250	$46,477
Per Capita Income	$23,389	$22,212	$17,098
Population >16 Years Old in Labor Force	60.6%	62.5%	60.3%
Population Employed	55.9%	62.5%	58.1%

Source: factfinder.census.gov; www.city-data.com

6.7.1 Income

In the United States, individual households are expected to use private resources to some extent to prepare for, respond to, and recover from disasters. This means that households living in poverty are automatically disadvantaged when confronting hazards. Additionally, the poor typically occupy more poorly built and inadequately maintained housing. Mobile or modular homes, for example, are more susceptible to damage in earthquakes and floods than other types of housing. In urban areas, the poor often live in older houses and apartment complexes, which are more likely to be made of un-reinforced masonry, a building type that is particularly susceptible to damage during earthquakes. Furthermore, residents below the poverty level are less likely to have insurance to compensate for losses incurred from natural disasters. This means that residents below the poverty level have a great deal to lose during an event and are the least prepared to deal with potential losses. The events following Hurricane Katrina in 2005 illustrated that personal household economics significantly impact people’s decisions on evacuation. Individuals who cannot afford gas for their cars will likely decide not to evacuate.

Based on U.S. Census Bureau estimates, per capita income in the planning area in 2012 was $23,389 and the median household income was $43,096. It is estimated that about 14% of households have an annual income between $100,000 and $149,999 and 4% have an annual income above $150,000. Families with incomes below the poverty level in 2012 made up 16.9% of all families and 21.1% of the total county population.

6.7.2 Employment Trends

According to the U.S. Bureau of Labor Statistics, Matagorda County’s unemployment rate as of March 1, 2015, was 6.5%, compared to a statewide rate of 4.2%. Figure 6-17 compares the State of Texas’ and Matagorda County’s unemployment trends from 1990 through March 1, 2015. Matagorda County’s unemployment rate was lowest in 2007 at 5.0% and peaked in 1992 at 16.9%.

Source: U.S. Bureau of Labor Statistics, 2015, http://m.research.stlouisfed.org/fred/

Note: Shaded areas indicate U.S. recessions

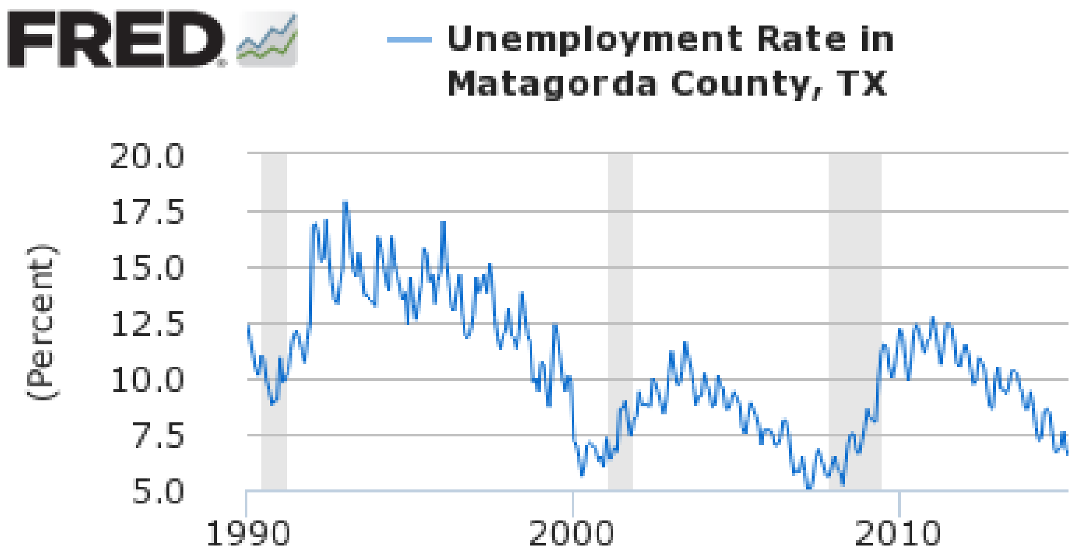


Figure 6-17. Matagorda County Unemployment Rate (1990-2015)

According to the 2013 Census data, 60.6% of Matagorda County's population 16 years and older is in the labor force, including 45.1% of women and 54.9% of men.

6.7.3 Occupations and Industries

According to 2013 Census data, the planning area's economy is strongly based in the education, health care and social assistance industries (21.6% of total employment), followed by the manufacturing (12.4%), retail trade (11.6%), and transportation and warehousing (10.5%). Figure 6-18 shows the distribution of industry types in Matagorda County, based on share of total employment.

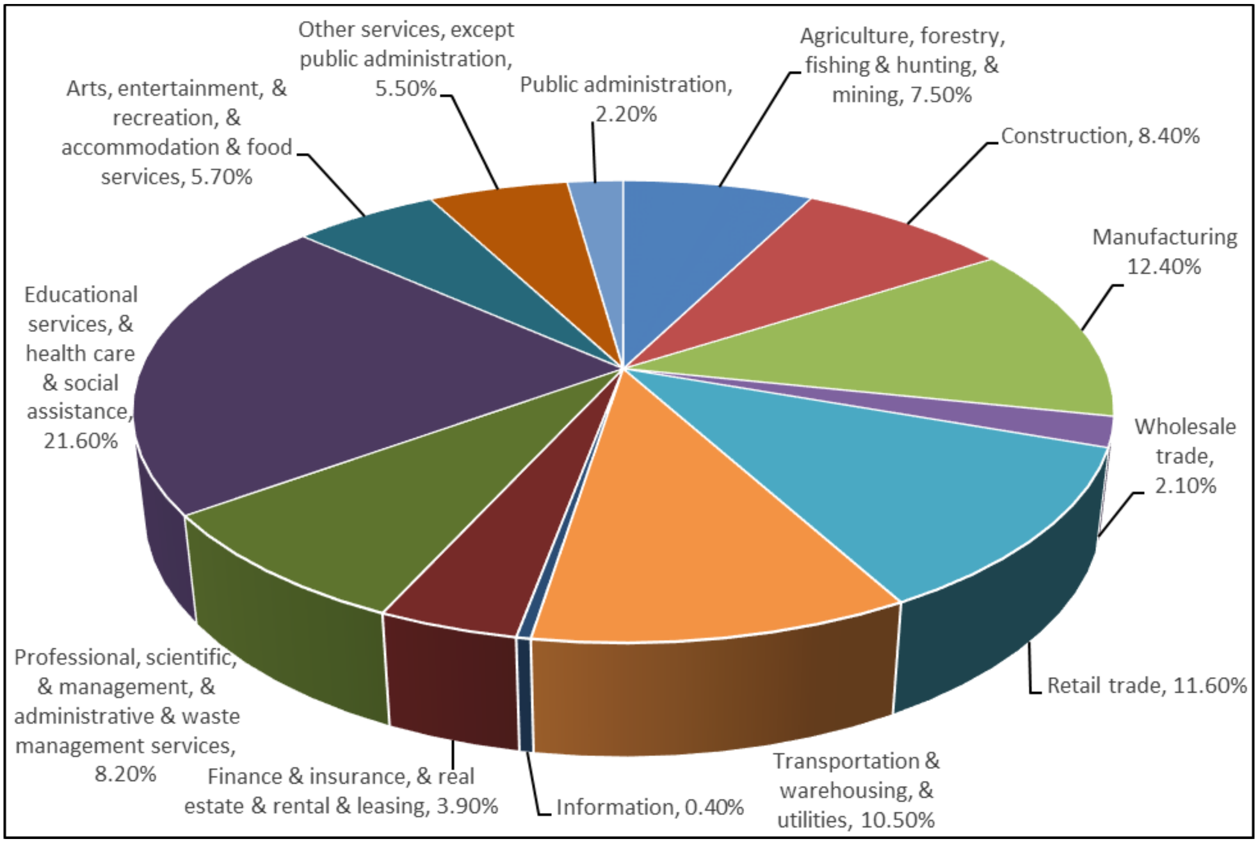


Figure 6-18. Percent of Total Employment by Industry in Matagorda County

6.8 TRENDS IN DEVELOPMENT

The municipal planning partners have adopted plans that govern land use decision and policy making in their jurisdictions. Decisions on land use will be governed by these programs. This plan will work together with these programs to support wise land use in the future by providing vital information on the risk associated with natural hazards in the planning area.

It is the goal that all municipal planning partners will incorporate this hazard mitigation plan update in their comprehensive plans (if applicable) by reference. This will help ensure that future development trends can be established with the benefits of the information on risk and vulnerability to natural hazards identified in this plan. The participating communities have not formally tracked the impacts of changes in development over the last five years and how these changes in development were influenced by the risk associated with natural hazards in the county or the communities. As part of this hazard mitigation plan update, Matagorda County and the participating cities are now equipped with the knowledge and the tools to track and implement changes to the plan during their annual reviews and 5-year updates to reflect development changes. However, it should be noted that the mitigation actions developed and prioritized through the mitigation action ranking process reflect the current development conditions and applicable policies.

6.8.1 Matagorda County

Matagorda County consists primarily of agricultural land and water/wetland. Developed land accounts for only 4.9% of the county. Table 6-8 lists the present land use in Matagorda County.

TABLE 6-8.
PRESENT LAND USE IN PLANNING AREA

Present Use Classification	Area (acres)	% of Total Land Area
Agriculture	393,469	52.3
Developed, Open Space	25,672	3.4
Developed, High Intensity	742	<0.1
Developed, Medium Intensity	2,134	0.3
Developed, Low Intensity	7,913	1.1
Forest Land	61,677	8.2
Grassland/Prairie	86,166	11.5
Water/Wetland	173,759	23.1
Total	**751,532**	**100**

Note: Acreage covers only mapped parcels and thus excludes many rights of way and major water features, such as East Matagorda Bay, Matagorda Bay, or the Gulf of Mexico.

As described in Chapter 6.6.1, the population of Matagorda County decreased by 3.5% from 1990 to 2013. Most of the population in the county lives in the City of Bay City.

Housing units in unincorporated Matagorda County are mainly single-family detached homes; however, there are approximately 1,850 mobile homes in the unincorporated areas of the county. According to the U.S. Census Bureau, the number of residential building permits reported in Matagorda County decreased from 18 in 2010 to 12 in 2012 (the most recent available data). Unincorporated Matagorda County would be impacted by an increase in vulnerability since additional residential building permits have been issued since 2011. Figure 6-19 shows the reported residential building permits in Matagorda County. All of the permits reflected in this graph are from the City of Bay City and the City of Palacios.

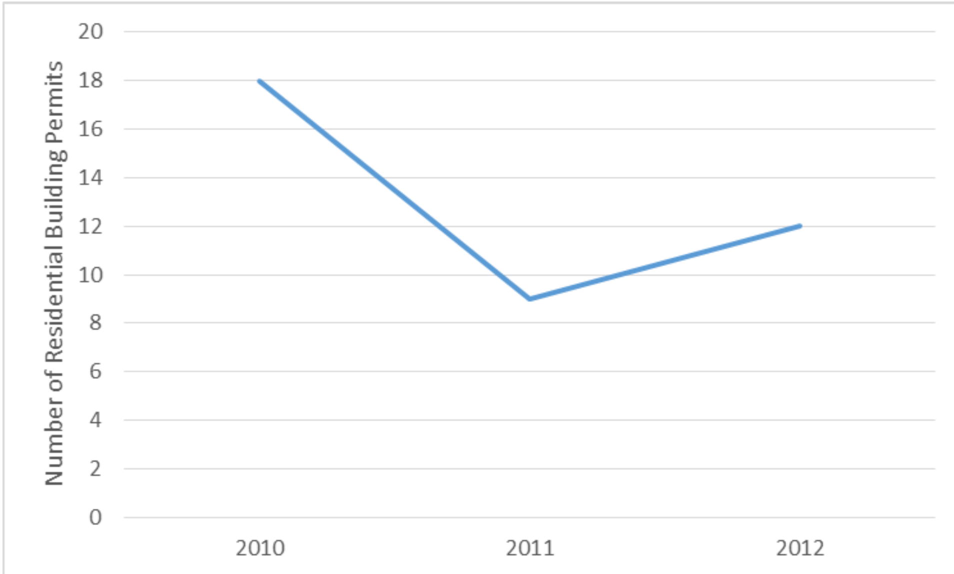


Figure 6-19. Residential Building Permits in Matagorda County

6.8.2 City of Bay City

According to 2013 U.S. Census data, the population of the City of Bay City decreased approximately 4% from 1990 to 2013, as shown on Figure 6-20. The number of residential building permits reported in the City of Bay City decreased during the last 10 years, from a high of 32 permits in 2007 to a low of 9 in 2012, as shown on Figure 6-21. Even with the decrease in building permits over the past decade, the City of Bay City would be impacted by an increase in vulnerability since additional residential building permits have been issued since 2011. According to the 2010-2014 American Community Survey, 5,026 homes in the City of Bay City are single-family homes and 564 are mobile homes.

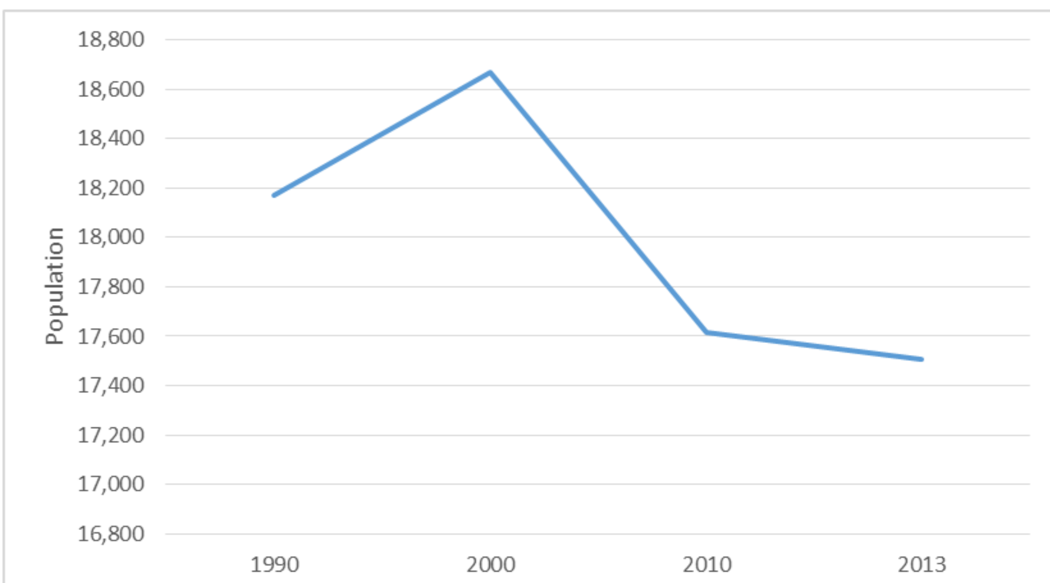


Figure 6-20. Population of City of Bay City

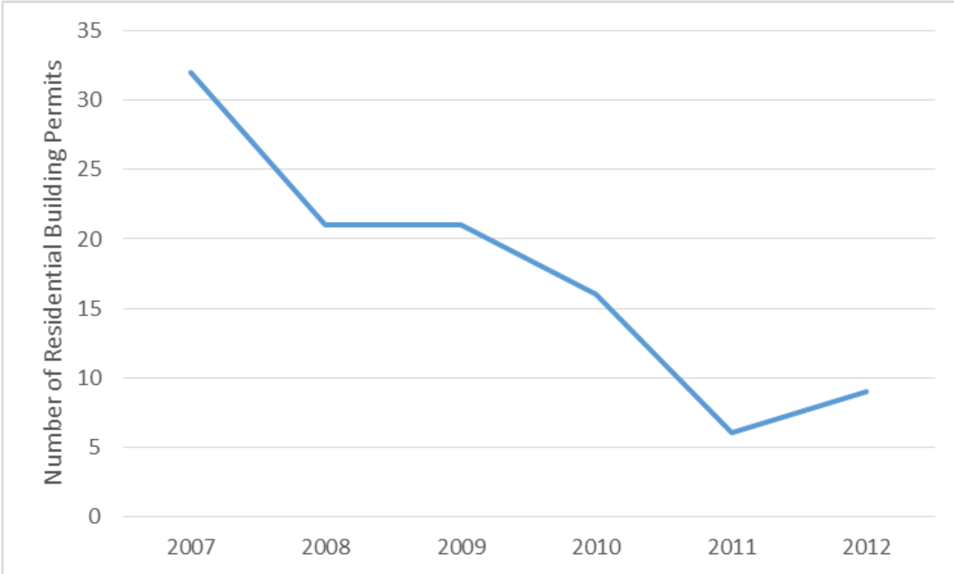


Figure 6-21. Residential Building Permits in the City of Bay City

6.8.3 City of Palacios

According to 2013 U.S. Census data, the population of the City of Palacios increased approximately 6% from 1990 to 2013, as shown on Figure 6-22. The number of residential building permits reported in the City of Palacios remained steady in recent years; there were 2 in 2010 and 3 in 2011 and 2012 (the most recent data available), as shown on Figure 6-23. The City of Palacios would be impacted minimally and vulnerability would not be significantly increased by the small number of residential building permits issued since 2011. According to the 2010-2014 American Community Survey, 1,223 homes in the City of Palacios are single-family homes and 489 are mobile homes.

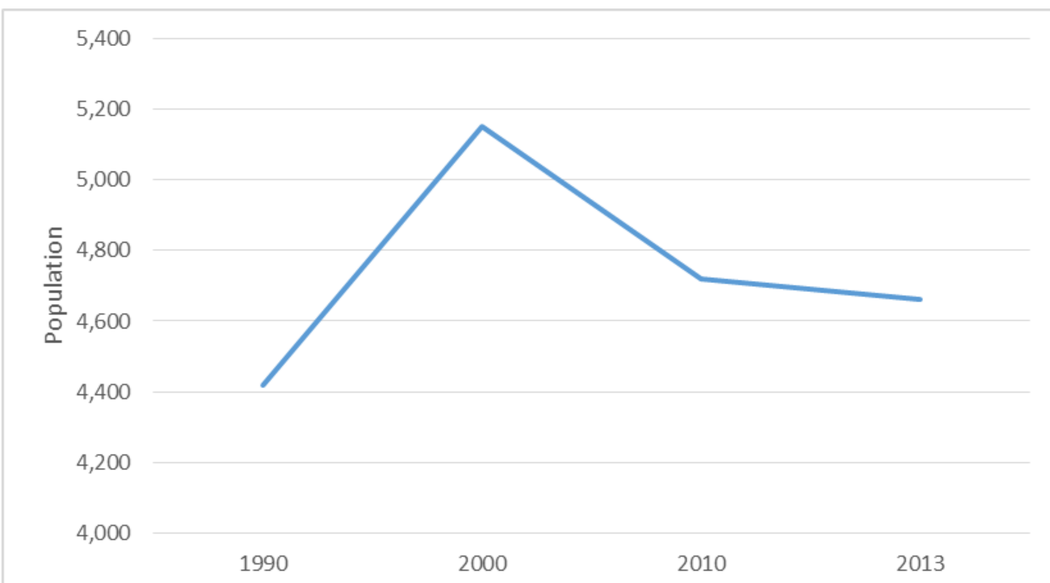


Figure 6-22. Population of City of Palacios

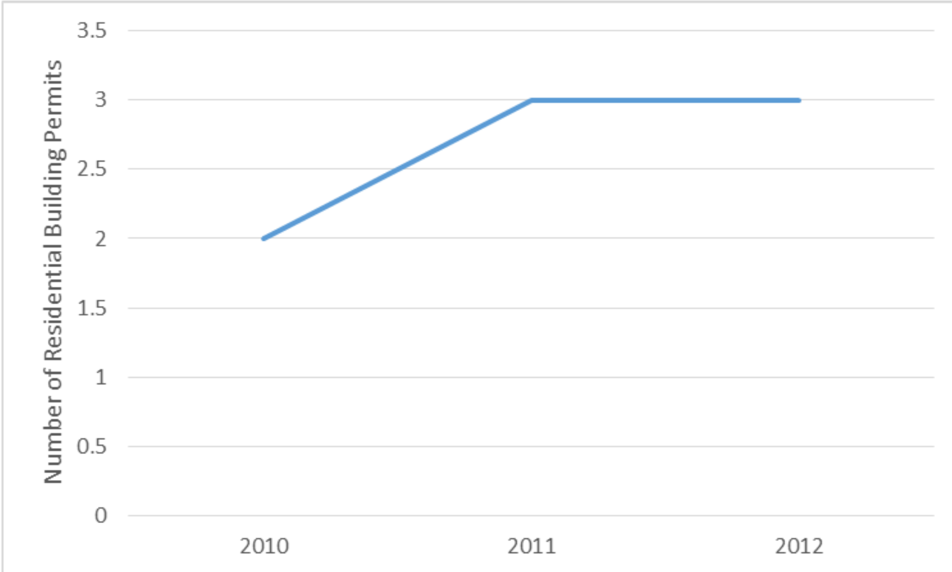


Figure 6-23. Residential Building Permits in the City of Palacios

6.9 LAWS AND ORDINANCES

Existing laws, ordinances, and plans at the federal, state, and local level can support or impact hazard mitigation actions identified in this plan. Hazard mitigation plans are required to include review and incorporation, if appropriate, of existing plans, studies, reports, and technical information as part of the planning process (44 CFR, Section 201.6(b)(3)). Pertinent federal, state, and local laws are described below. These laws, programs, documents, and departments were reviewed to identify the plans, regulations, personnel, and funding mechanisms available to the county and planning partners to impact and mitigate the effects of natural hazards. The county and the cities have the capacity to expand their hazard mitigation capabilities through the training of existing staff, cross-training staff across program areas, and hiring of additional staff, as well as acquiring additional funding through the attainment of grant funds, raising of taxes, and levying of new taxes.

6.9.1 Federal

Disaster Mitigation Act

The DMA is the current federal legislation addressing hazard mitigation planning. It emphasizes planning for disasters before they occur. It specifically addresses planning at the local level, requiring plans to be in place before Hazard Mitigation Grant Program (HMGP) funds are available to communities. This plan is designed to meet the requirements of DMA, improving the planning partners' eligibility for future hazard mitigation funds.

Endangered Species Act

The federal Endangered Species Act (ESA) was enacted in 1973 to conserve species facing depletion or extinction and the ecosystems that support them. The act sets forth a process for determining which species are threatened and endangered and requires the conservation of the critical habitat in which those species live. The ESA provides broad protection for species of fish, wildlife, and plants that are listed as threatened or endangered. Provisions are made for listing species, as well as for recovery plans and the designation of critical habitat for listed species. The ESA outlines procedures for federal agencies to follow when taking actions that may jeopardize listed species and contains exceptions and exemptions. It is the enabling legislation for the Convention on International Trade in Endangered Species of Wild Fauna and Flora. Criminal and civil penalties are provided for violations of the ESA and the Convention.

Federal agencies must seek to conserve endangered and threatened species and use their authorities in furtherance of the ESA's purposes. The ESA defines three fundamental terms:

- **Endangered** means that a species of fish, animal, or plant is "in danger of extinction throughout all or a significant portion of its range." (For salmon and other vertebrate species, this may include subspecies and distinct population segments.)
- **Threatened** means that a species "is likely to become endangered within the foreseeable future." Regulations may be less restrictive for threatened species than for endangered species.
- **Critical habitat** means "specific geographical areas that are…essential for the conservation and management of a listed species, whether occupied by the species or not."

Five sections of the ESA are of critical importance to understanding the act:

- **Section 4: Listing of a Species**—NOAA's Fisheries Service is responsible for listing marine species; the U.S. Fish and Wildlife Service is responsible for listing terrestrial and freshwater aquatic species. The agencies may initiate reviews for listings, or citizens may petition for them. A listing must be made "solely on the basis of the best scientific and commercial data available." After a listing has been proposed, agencies receive comment and conduct further scientific reviews for 12 to 18 months, after which they must decide if the listing is warranted. Economic impacts cannot be considered in this decision, but it may include an evaluation of the adequacy of local and state protections. Critical habitat for the species may be designated at the time of listing.
- **Section 7: Consultation**—Federal agencies must ensure that any action they authorize, fund, or carry out is not likely to jeopardize the continued existence of a listed or proposed species or adversely modify its critical habitat. This includes private and public actions that require a federal permit. Once a final listing is made, non-federal actions are subject to the same review, termed a "consultation." If the listing agency finds that an action will "take" a species, it must propose mitigations or "reasonable and prudent" alternatives to the action; if the proponent rejects these, the action cannot proceed.
- **Section 9: Prohibition of Take—**It is unlawful to "take" an endangered species, including killing or injuring it or modifying its habitat in a way that interferes with essential behavioral patterns, including breeding, feeding, or sheltering.
- **Section 10: Permitted Take**—Through voluntary agreements with the federal government that provide protections to an endangered species, a non-federal applicant may commit a take that would otherwise be prohibited as long as it is incidental to an otherwise lawful activity (such as developing land or building a road). These agreements often take the form of a "Habitat Conservation Plan."
- **Section 11: Citizen Lawsuits**—Civil actions initiated by any citizen can require the listing agency to enforce the ESA's prohibition of taking or to meet the requirements of the consultation process.

Clean Water Act

The federal Clean Water Act (CWA) employs regulatory and non-regulatory tools to reduce direct pollutant discharges into waterways, finance municipal wastewater treatment facilities, and manage polluted runoff. These tools are employed to achieve the broader goal of restoring and maintaining the chemical, physical, and biological integrity of the nation's surface waters so that they can support "the protection and propagation of fish, shellfish, and wildlife and recreation in and on the water."

Evolution of CWA programs over the last decade has included a shift from a program-by-program, source-by-source, and pollutant-by-pollutant approach to more holistic watershed-based strategies. Under the watershed approach, equal emphasis is placed on protecting healthy waters and restoring impaired ones. A full array of issues are addressed, not just those subject to CWA regulatory authority. Involvement of stakeholder groups in the development and implementation of strategies for achieving and maintaining water quality and other environmental goals is a hallmark of this approach.

National Flood Insurance Program

The National Flood Insurance Program (NFIP) provides federally backed flood insurance in exchange for communities enacting floodplain regulations. Participation and good standing under NFIP are prerequisites to grant funding eligibility under the Robert T. Stafford Act. Matagorda County and the Cities of Bay City and Palacios participate in the NFIP and have adopted regulations that meet the NFIP requirements. At the time of the preparation of this plan, the county, and the Cities of Bay City and Palacios were in good standing with NFIP requirements.

6.9.2 State and Regional

Texas Division of Emergency Management

The TDEM is a division within the Texas Department of Public Safety and has its roots in the civil defense programs established during World War II. It became a separate organization through the Texas Civil Protection Act of 1951, which established the Division of Defense and Disaster Relief in the Governor's Office to handle civil defense and disaster response programs. The division was collocated with the Department of Public Safety (DPS) in 1963. The division was renamed the Division of Disaster Emergency Services in 1973. After several more name changes, it was designated an operating division of the Texas Department of Public Safety in 2005. Legislation passed during the 81st session of the Texas Legislature in 2009 formally changed the name to TDEM. TDEM operates according to the Texas Disaster Act of 1975 (Chapter 418 of the Texas Government Code).

TDEM's is "charged with carrying out a comprehensive all-hazard emergency management program for the state and for assisting cities, counties, and state agencies in planning and implementing their emergency management programs. A comprehensive emergency management program includes pre- and post-disaster mitigation of known hazards to reduce their impact; preparedness activities, such as emergency planning, training, and exercises; provisions for effective response to emergency situations; and recovery programs for major disasters."

Texas Water Development Board

The Texas Water Development Board (TWDB) was created in 1957 but its history dates back to a 1904 constitutional amendment authorizing the first public development of water resources. The TWDB mission is "to provide leadership, information, education, and support for planning, financial assistance, and outreach for the conservation and responsible development of water for Texas." TWDB provides water planning, data collection and dissemination, financial assistance, and technical assistance services.

TWDB financial assistance programs are funded through state-backed bonds, a combination of state bond proceeds and federal grant funds, or limited appropriated funds. Since 1957, the Texas State Legislature and voters approved constitutional amendments authorizing TWDB to issue up to $10.93 billion in Texas Water Development Bonds. To date, TWDB has sold nearly $3.95 billion of these bonds to finance the construction of water- and wastewater-related projects. In 1987, TWDB added the Clean Water State Revolving Fund (CWSRF) to its portfolio of financial assistance programs. Low-interest loans from the CWSRF finance costs associated with the planning, design, construction, expansion, or improvement of wastewater treatment facilities, wastewater recycling and reuse facilities, collection systems, stormwater pollution control projects, and nonpoint source pollution control projects. Funded in part by federal grant money, CWSRF provides loans at interest rates lower than the market can offer to any eligible applicant. CWSRF offers 20-year loans using either a traditional long-term, fixed-rate or a short-term, variable-rate construction period loan that converts to a long-term, fixed-rate loan on project completion.

Texas Soil and Water Conservation Board

The Texas State Soil and Water Conservation Board (TSSWCB) is the state agency that administers Texas' soil and water conservation law and coordinates conservation and nonpoint source water pollution abatement programs. The TSSWCB was created in 1939 by the Texas Legislature to organize the state into 216 soil and water conservation districts (SWCD) and to serve as a centralized agency for communicating with the Texas Legislature as well as other state and federal entities. The TSSWCB is the lead state agency for the planning, management, and abatement of agricultural and silvicultural (forestry) nonpoint source water pollution, and administers the Water Supply Enhancement Program. Each SWCD is an independent political subdivision of state government. Local SWCDs are actively involved throughout the state in soil and water conservation activities such as operation and maintenance of flood control structures.

Texas Bureau of Economic Geology

The University of Texas at Austin, Bureau of Economic Geology serves as the State Geological Survey of Texas. The bureau conducts research focusing on the intersection of energy, environment, and economy. The bureau partners with federal, state, and local agencies, academic institutions, industry, nonprofit organizations, and foundations to conduct high-quality research and to disseminate the results to the scientific and engineering communities as well as to the broad public. The Geophysical Log Facility (GLF) is the official well log repository for the Railroad Commission of Texas, which by law receives a copy of geophysical logs from every new, deepened, or plugged well drilled in Texas since September 1985.

Texas Forest Service

Texas Forest Service (TFS) was created in 1915 by the 34th Legislature as an integral part of the Texas A&M University System. It is mandated by law to assume direction of all forest interests and all matters pertaining to forestry within the jurisdiction of the state. TFS administers the Community Wildfire Protection Plan (CWPP) to reduce related risks to life, property, and the environment. Its Fire Control Department provides leadership in wildland fire protection for state and private lands in Texas and reduces wildfire-related loss of life, property, and critical resources.

The intention of the TFS CWPP is to reduce the risk of wildfire and promote ecosystem health. The plan also is intended to reduce home losses and provide for the safety of residents and firefighters during wildfires. It has the following goals and objectives.

Goals:

- Provide for the safety of residents and emergency personnel
- Limit the number of homes destroyed by wildfire
- Promote and maintain healthy ecosystems
- Educate citizens about wildfire prevention

Objectives:

- Complete wildfire risk assessments
- Identify strategic fuels reduction projects
- Address treatment of structural ignitability
- Identify local capacity building and training needs
- Promote wildfire awareness programs

CWPPs are developed to mitigate losses from wildfires. By developing a CWPP, a community is outlining a strategic plan to mitigate, prepare, respond, and recover.

Texas Department of State Health Services

The mission of the Department of Public Health is to protect and preserve the health of the citizens of Texas. Public health nurses provide a variety of services including immunizations, preventive assessments of children and the elderly, and a full range of services designed to assist individuals and groups to attain and maintain good health and to cope with illnesses.

Texas Colorado River Floodplain Coalition

The TCRFC is a partnership of cities and counties in the Colorado River Basin and surrounding areas seeking better ways to reduce and mitigate flood damage. The coalition was formed in response to a combination of rapid growth, a greatly expanded number of homes and businesses in the floodplain, and devastating floods that have reoccurred in the basin. TCRFC’s mission statement is to “Encourage comprehensive consistent management of the floodplain along the Colorado River and its tributaries; provide a forum for data exchange; and facilitate a structured approach to managing the complex issues related to floodplain management.” TCRFC is the sponsoring agency for the development of this HMP to address all natural hazards that could potentially affect communities.

Houston-Galveston Area Council of Governments

The Houston-Galveston Area Council of Governments (H-GAC) is the regional organization through which local governments consider issues and cooperate in solving area-wide problems. Through H-GAC, local governments also initiate efforts in anticipating and preventing problems, and saving public funds. The 13 counties in H-GAC's service region are: Austin, Brazoria, Chambers, Colorado, Fort Bend, Galveston, Harris, Liberty, Matagorda, Montgomery, Walker, Waller, and Wharton. There are more than 100 member cities in the region.

H-GAC's mission is to serve as the instrument of local government cooperation, promoting the region's orderly development and the safety and welfare of its citizens. H-GAC provides planning programs in most areas of shared governmental concern. All H-GAC programs are carried out under the policy direction of H-GAC’s local elected official Board of Directors. H-GAC is made up of the region's local governments and their elected officials, and works together with public and private sector organizations and a host of volunteers.

H-GAC provides regional 911 and emergency communications planning. The regional 911 system represents the cooperative efforts of 8 counties (Brazoria, Chambers, Colorado, Liberty, Matagorda, Walker, Waller and Wharton), 23 public safety answering points, some 224 emergency service providers, and numerous telephone companies. H-GAC also provides hurricane evacuation planning; provides information on disaster debris management; and includes several committees and councils relating to natural hazard mitigation, planning, and recovery, including the Regional Flood Management Council.

6.9.3 Matagorda County

County government is made up of the following offices and departments:

- County Judge
- Commissioner Court
- County Attorney
- County Clerk
- County Treasurer
- District Attorney
- District Judge
- District Clerk
- Juvenile Probation
- Emergency Management

- County Tax Assessor/Collector
- Constable
- Sherriff
- Justice of the Peace
- County Surveyor
- County Auditor
- Adult Probation
- Extension Office
- Human Resources
- 911 Addressing
- Information Systems
- Veterans Services

Excerpts from applicable policies, regulations, and plans and program descriptions follow to provide more detail on existing mitigation capabilities.

Matagorda County Subdivision Regulations, 2008 (as amended)

The Matagorda County Subdivision Regulations, dated August 11, 2008, established rules, regulations, and standards governing the subdivision of land within the unincorporated areas of Matagorda County. It established standards and specifications for platting, bond requirements, utilities, construction of roads and drainage. The Subdivision Regulations were designed and enacted for the purpose of promoting the health, safety, and general welfare of the public and to establish standards of subdivision design, which will encourage the development of sound, economical, stable neighborhoods, and create a healthy environment for present and future inhabitants of Matagorda County by:

1. Detailing preliminary and final platting requirements, lot sizes, and setbacks
2. Detailing requirements and design standards, for water, wastewater, street design and maintenance, and utilities
3. Detailing acceptable impacts and drainage requirements
4. Detailing administrative responsibilities including enforcement and variances

Matagorda County's Floodplain Management Plan

The Matagorda County's Floodplain Management Plan established the County Building Official as the Floodplain Administrator to administer the National Flood Insurance Act and Texas Flood Control and Insurance Act. The purpose of the order and attached regulations is "to promote the public health, safety, and general welfare and to minimize public and private losses due to flood conditions in specific areas by regulations designed to: (1) protect human life and health; (2) minimize the expenditure of public money for costly flood control projects; (3) minimize the need for rescue and relief efforts associated with flooding and usually undertaken at public expense; (4) minimize prolonged business interruptions; (5) minimize damage to public facilities and utilities such as water and gas mains, electric, telephone, and sewer lines, and streets and bridges located in or near floodplains; (6) help maintain a stable tax base by providing for the sound use and development of flood-prone areas in such a manner as to minimize future flood blight areas; and (7) ensure that potential buyers are notified that property is in a flood area."

The order will be implemented through methods authorized by federal and state law to: (1) restrict or prohibit uses that are dangerous to health, safety, or property in times of flood, or uses that cause excessive increases in flood heights or velocities; (2) require that uses vulnerable to floods, including facilities which serve such uses, be protected against flood damage at the time of initial construction; (3) control the alteration of natural floodplains, stream channels, watercourses, and natural protective barriers which are involved in the accommodation of flood waters; (4) control filling, grading, dredging, and other development which may increase flood damage; and (5) prevent or regulate the construction of flood barriers which will unnaturally divert flood waters or which may increase flood hazards to other lands."

The ordinance will be administered by the County Building Official whose responsibilities include reviewing and approving permit applications in according with the ordinance and required permitting practices. The ordinance also addressed development requirements, variances procedures, planning requirements for subdivisions, shallow areas, and severity.

Matagorda County Floodplain Map

The current floodplain maps date back to 1984. New floodplain maps from FEMA will be made available in late 2015.

Matagorda County Commissioners Court

The Commissioners Court and Drainage Districts are responsible for the maintenance and construction of those roadway and drainage structure assets maintained through the direct and indirect efforts of Matagorda County.

Matagorda Economic Development Corporation

The Matagorda County Economic Development Corporation (MCEDC) is focused on growing Matagorda County through recruitment of new industries, commercial businesses, tourism infrastructure and through expansion of existing businesses. It seeks to expand our agriculture and aquaculture sectors through new crops for renewable fuel production and value-added opportunities.

The MCEDC Board represents all of Matagorda County. Its 11 appointed members represent five public funding entities–Matagorda County, Bay City Community Development, Palacios Economic Development, Matagorda County Navigation District #1, the Port of Bay City Authority, and the four Chambers of Commerce from Bay City, Matagorda, Palacios, and Sargent. An Executive Director and a Director of Communications implement board directives.

6.9.4 City of Bay City

The City of Bay City government is made up of the following offices and departments:

- Airport
- City Secretary
- Emergency Preparedness
- Fire Department (all volunteer)
- Finance
- Information Technology
- Municipal Court
- Parks and Recreation
- Police
- Library
- Public Works

The City of Bay City has multiple plans and functions in place that guide growth and development within the community. The City also has a Planning Commission. Excerpts from applicable policies, regulations, and plans and program descriptions follow to provide more detail on existing mitigation capabilities.

City of Bay City Comprehensive Plan, 2015

The City of Bay City Comprehensive Plan is currently being developed to help guide city development through 2040. The final drafts of the Vision Bay City 2040 Plan and Implementation Guide have been released. These documents are based on numerous opportunities for public input, stakeholder interviews, and interviews with city staff. The revisions will occur prior to the council adopting the plan in 2015. This plan has five major sections. The introduction provides background on the plan, discusses plan implementation, and provides a summary of the public input. It also has the Vision Statement created to guide planning efforts. The second section is the Demographic Analysis, which provides information related to Bay City's current and projected populations, housing, education, income, employment, and taxes. The third section includes the various topical chapters addressing the range of issues in the plan. These include the following:

- Land Use
- Housing
- Parks and Recreation
- Downtown Revitalization and Historic Preservation
- Livability and Quality of Life
- Transportation
- Infrastructure and City Facilities
- Economic Development
- Tourism Development

Within these chapters, a series of goals and objectives are identified based on an assessment of Bay City and intensive public engagement. These goals address key challenges and provide background information, best practices, and analysis of the issues. The fourth section is the Implementation Guide for potential partners and stakeholders, as well as potential funding sources. This guide is intended to be used regularly by City staff, the City Council, the Planning Commission, and others as they make decisions to ensure they are following the plan guidelines. The fifth section is an appendix with resources to help with plan implementation.

City of Bay City Code of Ordinances

Some of the chapters in the Bay City, Texas Code of Ordinances have provisions related, directly or indirectly, to hazard mitigation. These provisions are discussed below:

- **Chapter 1 - General Provisions**

  Provisions under this chapter include:

  - Establishes the Planning Commission (Ord. No. 1445, § 1, 11-8-2012; Ord. No. 1449, § 1, 12-13-2012; Ord. No. 1488, § 1, 1-9-2014)

- **Chapter 22 – Buildings and Building Regulations**

  Provisions under this chapter include:

  - Adoption of the International Building Code, 2009 edition (Code 1985, § 6-16; Code 2000, § 22-31; Ord. No. 1372, 8-13-2009; Ord. No. 1401, 3-24-2011)
  - Building permit requirements (Code 1985, § 27-7; Code 2000, § 98-7; Ord. of 4-26-2001)

- **Chapter 30 - Civil Emergencies**

  Provisions under this chapter include:

  - Establishment of the Bay City Emergency Management Organization (Code 1985, § 8-4; Code 2000, §§ 2-136(a), 30-34(a); Ord. No. 1304, § 1, 6-12-2003)
  - Identification of the powers, duties, and responsibilities of the Emergency Management Director (Code 1985, § 8-4; Code 2000, §§ 2-136(b), 30-34(b); Ord. No. 1304, § 2, 6-12-2003

- Appointment of an emergency management coordinator and formation of the emergency management council (Code 1985, § 8-4; Code 2000, § 2-136(c); Ord. No. 1304, § 3, 6-12-2003)

- **Chapter 34 - Emergency Services**

  Provisions under this chapter include:

  - Establishment of ambulance services for Bay City (Code 2000, § 34-2; Ord. No. 1261, 8-24-2000

- **Chapter 42 – Fire Prevention and Protection**

  Provisions under this chapter include:

  - Creation of the Office of Fire Marshal (Code 1985, § 9-16; Code 2000, § 42-36)
  - Adoption of the International Fire Code, 2000 edition (Code 1985, § 9-36; Code 2000, § 42-76; Ord. No. 1260, § 1, 8-24-2000; Ord. No. 1384, § 1, 3-25-2010; Ord. No. 1401, 3-24-2011)

- **Chapter 46 – Floods**

  Provisions under this chapter include:

  - Adoption of the Standard for Floodplain Management (Code 1985, § 10-2; Code 2000, § 46-33)
  - Description of enforcement, authorization, and purpose of the Standard for Floodplain Management in Bay City (Code 1985, § 10-7; Code 2000, § 46-34)
  - Methods of reducing flood losses (Code 1985, § 10-4; Code 2000, § 46-35)
  - Basis for establishing the areas of special flood hazard and permitting requirements (Code 1985, § 10-8; Code 2000, § 46-38)
  - Designation, duties, and responsibilities of the floodplain administrator (Code 1985, § 10-26; Code 2000, § 46-66)
  - Permit and variance procedures for a floodplain development permit (Code 1985, § 10-27; Code 2000, § 46-67 and 68)
  - Construction standards for new construction and substantial improvements to minimize flood damage (Code 1985, § 10-46; Code 2000, § 46-91)
  - Review of proposed subdivisions and land use areas to minimize flood damage (Code 1985, § 10-47; Code 2000, § 46-92)

- **Chapter 98 – Subdivisions**

  Provisions under this chapter include:

  - Manage the orderly, safe and healthful development to promote the health, safety and general welfare of the community (Code 1985, § 27-2; Code 2000, § 98-2; Ord. of 4-26-2001)
  - Land development and division restrictions (Code 1985, § 27-4; Code 2000, § 98-4; Ord. of 4-26-2001)
  - Permit and variance procedures for subdivisions (Code 1985, § 27-6; Code 2000, § 98-6; Ord. of 4-26-2001; Ord. No. 1477, § 4, 10-24-2013; 1985, § 27-7; Code 2000, § 98-7; Ord. of 4-26-2001)

- **Chapter 110 – Planning and Development**

  Provisions under this chapter include:

  - Established building requirements (Code 1985, § 23-18; Code 2000, § 78-33)
  - Created the City of Bay City Downtown Historical District and Southside Historic District (Code 1985, § 23-31; Code 2000, § 78-66)
  - Duties and powers of the historic commission, support staff and historic preservation officer (Code 2000, § 78-103; Ord. No. 1332, § 3, 3-23-2006; Ord. No. 1400, § 1, 3-24-2011)

City of Bay City Planning Commission

The Bay City Planning Commission is charged with the review, investigation, and recommendation of land use within Bay City. The planning commission shall have the power and it shall be its duty to:

- Make and/or amend a Master Plan for the physical development of the city
- Review plats for subdividing land within the city's corporate limits and extra territorial jurisdiction
- Submit to the Mayor a list of recommended capital improvements by priority which in the opinion of the Commission are necessary or desirable
- Consult with department heads and the Chief Administrative Officer concerning planning for their areas
- Consider the wisdom of, and make recommendations to council regarding the adoption of development regulations within the city
- Perform such additional duties and powers as may be prescribed by ordinance

6.9.5 City of Palacios

The Palacios government is made up of the following offices and departments:

- City Administration
- Airport
- Building and Inspections Department
- Finance Department
- Municipal Court
- Police Department
- Fire Department
- Public Works

The city also has a Parks and Recreation Committee, Airport Committee, Pavilion Committee, Planning and Zoning Commission, Zoning Board of Adjustments, and Charter Review Commission. Excerpts from applicable policies, regulations, and plans and program descriptions follow to provide more detail on existing mitigation capabilities.

City of Palacios Comprehensive Planning and Capacity Study 2009-2029, 2009

The Comprehensive Plan guides city staff and civic leaders in making sound planning decisions regarding the long-term growth and development of Palacios. The text, tables, charts, and figures contained in these Planning Studies provide an inventory, description, and analysis of Palacios' current physical, economic, and social conditions. The primary purposes of these Planning Studies are to:

- Guide routine engineering, financial, and planning decisions
- Publicly acknowledge the future intentions of the city government with respect to the growth and nature of the community

- Allow for increased coordination between the city, other governmental organizations, the citizens, private industry and developers, and other interested parties.

Palacios identified goals to manage infrastructure (water, sewer, streets, drainage), housing, recreation, tourism, economic development, and regulatory/leadership.

City of Palacios Emergency Management

Palacios has adopted resolutions and ordinances that created an Office of Emergency Management and identified the Mayor as the Director. The city has elected to use the Matagorda County Emergency Operation Plan to guide response and recovery operations.

City of Palacios Code of Ordinances

Some of the chapters in the Palacios, Texas Code of Ordinances have provisions related, directly or indirectly, to hazard mitigation. These provisions are discussed below:

- **Chapter 1 - General Provisions including Emergency Management**

  Provisions under this chapter include:

  - Adopts the National Incident Management System dated March 1, 2004, as the standard for incident management by the city (Ordinance 09-07-2005 adopted 08/01/05)
  - Establishment of the City of Palacios Emergency Management Organization (Ordinance 669, sec. 1, adopted 02/03/03)
  - Identification of the powers, duties, and responsibilities of the Emergency Management Director (Ordinances 669, sec. 2, adopted 02/03/03; 669, sec. 4, adopted 02/03/03)

- **Chapter 3 - Buildings and Building Regulations**

  Provisions under this chapter include:

  - Adoption of the International Building Code, 2003 edition (Ordinance 02-01-2006, sec. 1, adopted 02/06/06)
  - Building permit requirements, including the application requirements, authority, and process (1996 Code, sec. 3.504(a), 1996 Code, sec. 3.504(b)).
  - Designation of the Building and Inspections Department processes (1996 Code, sec. 3.504(d), 1996 Code, sec. 3.507(c))
  - Description of enforcement, authorization, and purpose of the Standard for Floodplain Management (1996 Code, sec. 3.803)
  - Methods of reducing flood losses (1996 Code, sec. 3.804)
  - Basis for establishing the areas of special flood hazard and permitting requirements (1996 Code, sec. 3.806)
  - Designation, duties, and responsibilities of the floodplain administrator (Ordinance 25-11-2007, sec. 3, adopted 11/19/07)
  - Permit and variance procedures for a floodplain development permit (Ordinances 25-11-2007, sec. 4, adopted 11/19/07, 25-11-2007, sec. 5, adopted 11/19/07)
  - Construction standards for new construction and substantial improvements to minimize flood damage (Ordinance 25-11-2007, sec. 7, adopted 11/19/07)
  - Standards for subdivision (1996 Code, sec. 3.808)

  - Permit required for development activities increasing flooding or drainage problems (1996 Code, sec. 3.810)

- **Chapter 5 – Fire Prevention and Protection**

  Provisions under this chapter include:

  - Creation of the Office of the Fire Marshall including authorities and responsibilities (1996 Code, sec. 5.401)
  - Adoption of the Standard Fire Prevention Code, 1997 edition (1996 Code, sec. 5.101)
  - Regulations on the use, possession, and sale of fireworks (Ordinance 2011-O-6, sec. 2, adopted 6/14/11)

- **Chapter 10 – Subdivision**

  Provisions under this chapter include:

  - Manage the orderly, safe and healthful development to promote the health, safety and general welfare of the community (1996 Code, sec. 9.203)
  - Minimum Construction Standards (1996 Code, sec. 9.502)
  - Land development and division restrictions (1996 Code, sec. 9.403)

- **Chapter 13 – Utilities**

  Provisions under this chapter include:

  - Authority to implement drought restrictions as warranted (1996 Code, art. 11.1300)

- **Chapter 14 – Zoning**

  Provisions under this chapter include:

  - Establishes zoning regulations and establishes zoning types within the City of Palacios. Ordinance 27-11-2007
  - Restrictions on the types of businesses that can operate with the City Ordinance 27-11-2007
  - Creates the Board of Adjustments procedures, variances, and review process for approval of construction projects within the city Ordinance 27-11-2007

City of Palacios Planning and Zoning Commission

The Planning and Zoning Commission is charged with the review, investigation, and recommendation of land use within the City of Palacios. The planning and zoning commission shall have the power and it shall be its duty to:

- Inspect property and premises.
- Recommend to the City Council approval or disapproval of proposed changes in the zoning plan.
- Formulate and recommend to the City Council, for its adoption, a comprehensive plan for the orderly growth and development of the city and its environs and from time-to-time recommend such changes in the plan as it finds will facilitate the movement of people and goods, and the health, recreation, safety, and general welfare of the citizens of the city.
- Formulate a zoning plan as may be deemed best to carry out the goals of the City Plan; hold public hearings and make recommendations to the City Council relating to the creation, amendment, and implementation of zoning regulations and districts.

- Exercise all the powers of a commission as to approval or disapproval of plans, plats, or replats.
- Study and recommend the location, extension and planning of public rights-of-way, parks or other public places, and on the vacating or closing of same.
- Study and recommend on the general design and location of public buildings, bridges, viaducts, street fixtures and other structures appurtenances. Study and recommend on the design or alteration and on the location or relocation of works of art which are, or may become, the property of the city.
- Initiate in the name of the city, for consideration at public hearing, all proposals: (a) for the opening, vacating or closing of public rights-of-way, parks or other public places; or closing of public rights-of-way, parks or other public places; (b) for the change of zoning district boundaries on an area-wide basis. No fee shall be required for the filing of any such proposal in the name of the city.
- Formulate and recommend to the City Council for its adoption policies and regulations consistent with the adopted City Plan governing the location and/or operation of utilities, public facilities, and services owned or under city control.

Palacios Parks and Recreation Committee

The Palacios Parks and Recreation Committee is established to look after, care for, promote, manage, and foster public parks.

Palacios Seawall Commission

The Palacios Seawall Commission is established to maintain the city's seawall. The Commission has its own taxing authority to make improvements to protect the shoreline.

Palacios Airport Committee

The Palacios Airport Committee is established to advise the city council on all matters relating to the governance of the municipal airport and any other municipal airport facilities as may be proposed and/or developed in the future.

Palacios Zoning Board of Adjustments

The Palacios Board of Adjustment was created to hear and decide appeals, hear and decide special exceptions, and hear and decide specific variances.

City of Palacios Consolidated Zoning Ordinance

Palacios has adopted resolutions and ordinances that directly or indirectly mitigate hazards identified in this plan. The comprehensive zoning ordinance, Ordinance 27-11-2007, was adopted by the city on December 11, 2007, as amended.

CHAPTER 7.
HAZARD MITIGATION CAPABILITIES ASSESSMENT

The planning team performed an inventory and analysis of existing authorities and capabilities called a "capability assessment." A capability assessment creates an inventory of an agency's mission, programs and policies, and evaluates its capacity to carry them out. The county and the planning partners used this capabilities assessment to identify mitigation actions to strengthen their ability to mitigate the effects of a natural hazard.

7.1 MATAGORDA COUNTY

7.1.1 Legal and Regulatory Capabilities

Table 7-1 lists planning and land management tools typically used by local jurisdictions to implement hazard mitigation activities and indicates those that are in place in Matagorda County.

TABLE 7-1.
MATAGORDA COUNTY REGULATORY MITIGATION CAPABILITIES MATRIX

Regulatory Tool (ordinances, codes, plans)	Yes/No	Comments
General plan	No	
Zoning ordinance	No	
Subdivision ordinance	Yes	The Matagorda County Subdivision Regulations (2008, as amended) established rules, regulations and standards governing the subdivision of land within the unincorporated areas of Matagorda County.
Growth management	Yes	Growth management is accomplished through compliance with the Matagorda County Subdivision Ordinance and Economic Development.
Floodplain ordinance	Yes	Part of the Matagorda County Floodplain Management Plan.
Other special purpose ordinance (stormwater, steep slope, wildfire)	No	
Building code	No	
Erosion or sediment control program	No	
Stormwater management	No	
Site plan review requirements	Yes	The County Environmental Health Department administers a "Site Specific Development Plan" review process in accordance with the Subdivision Ordinance.
Capital improvement plan	No	
Economic development plan	No	
Local emergency operations plan	Yes	Matagorda County Basic Emergency Operations Plan

TABLE 7-1.
MATAGORDA COUNTY REGULATORY MITIGATION CAPABILITIES MATRIX

Regulatory Tool (ordinances, codes, plans)	Yes/No	Comments
Other special plans	No	
Flood insurance study or other engineering study for streams	Yes	The Floodplain Officer in the Environmental Health Department is the local repository for the FEMA FIRM for the unincorporated areas of the county and makes the maps available for public review. The department maintains FIRMs in conjunction with the NFIP. The old maps are from 1984 and 1992. New floodplain maps will go into effect in 2016.
Elevation certificates	Yes	The Matagorda County Environmental Health Department, Floodplain Department keeps records of Flood Elevation Certificates on file in its office.

Notes:
FEMA Federal Emergency Management Agency
FIRM Flood Insurance Rate Map

7.1.2 Administrative and Technical Capabilities

Table 7-2 identifies the county personnel responsible for activities related to mitigation and loss prevention in Matagorda County.

TABLE 7-2.
MATAGORDA COUNTY ADMINISTRATIVE/TECHNICAL MITIGATION CAPABILITIES MATRIX

Personnel Resources	Yes/No	Department/Position
Planner/engineer with knowledge of land development/land management practices	No	
Engineer/professional trained in construction practices related to buildings or infrastructure	Yes (limited)	
Planner/engineer/scientist with an understanding of natural hazards	No	
Personnel skilled in GIS	Yes	
Full-time building official	Yes	Environmental Health Department
Floodplain manager	Yes	Environmental Health Department, Floodplain Administrator
Emergency manager	Yes	Department of Emergency Management within the County Sherriff’s Department
Grant writer	No	County is supported by the Capitol Region of Council of Governments and Grant Works
Other personnel	No	
GIS data: Hazard areas	Yes	Floodplain only
GIS data: Critical facilities	No	
GIS data: Building footprints	No	

**TABLE 7-2.
MATAGORDA COUNTY ADMINISTRATIVE/TECHNICAL MITIGATION CAPABILITIES MATRIX**

Personnel Resources	Yes/No	Department/Position
GIS data: Land use	No	
GIS data: Links to Assessor's data	No	
Warning systems/services (Reverse callback, cable override, outdoor warning signals)	Yes	Rapid Notify and 32 sirens around the 10-mile EPZ
Other	No	

Notes:
EPZ Environmental Protection Zone
GIS Geographic Information System

7.1.3 Financial Capabilities

Table 7-3 identifies financial tools or resources that Matagorda County could use to help fund mitigation activities.

**TABLE 7-3.
MATAGORDA COUNTY FINANCIAL MITIGATION CAPABILITIES MATRIX**

Financial Resources	Accessible/Eligible to Use (Yes/No)
Community Development Block Grants	Yes
Capital improvements project funding	Yes
Authority to levy taxes for specific purposes	Yes
Fees for water, sewer, gas, or electric services	Yes
Impact fees for new development	Yes
Incur debt through general obligation bonds	Yes
Incur debt through special tax bonds	Yes
Incur debt through private activities	No
Withhold spending in hazard prone areas	No
Other	No

7.2 CITY OF BAY CITY

7.2.1 Legal and Regulatory Capabilities

Table 7-4 lists regulatory and planning tools typically used by local jurisdictions to implement hazard mitigation activities and indicates those that are in place in the City of Bay City.

**TABLE 7-4.
CITY OF BAY CITY REGULATORY MITIGATION CAPABILITIES MATRIX**

Regulatory Tool (ordinances, codes, plans)	Yes/No	Comments
General plan	Yes	Vision 2040
Zoning ordinance	No	
Subdivision ordinance	Yes	Chapter 98 of the City Ordinance
Growth management	Yes	Growth management is accomplished through compliance the Subdivision regulations. In 2015, an updated City of Bay City Subdivision Ordinance is being codified to manage platting and other development best practices.
Floodplain ordinance	Yes	Chapter 46 of the City Ordinance
Other special purpose ordinance (stormwater, steep slope, wildfire)	No	
Building code	Yes	Bay City adopted the International Building Code and International Residential Code (2009 editions)
Erosion or sediment control program	No	
Stormwater management	No	
Site plan review requirements	Yes	Site plan review requirements are conducted by the Construction Inspector and some building reviews are outsourced to Bureau Veritas
Capital improvements plan	Yes	The city maintains an ongoing 5-year Capital Improvement Plan for budgeting.
Economic development plan	Yes	Key policies and actions to guide economic development are managed by the Bay City Economic Development Corporation.
Local emergency operations plan	No	The City of Bay City works in conjunction with the Matagorda County Emergency Management. The city does have a checklist for Public Works personnel.
Other special plans	No	
Flood insurance study or other engineering study for streams	Yes	FEMA floodplain maps indicate flood insurance is necessary along the Cottonwood Creek.
Elevation certificates	Yes	The City of Bay City Public Works Department keeps records of Flood Elevation Certificates on file in its office.

7.2.2 Administrative and Technical Capabilities

Table 7-5 identifies the city personnel responsible for activities related to mitigation and loss prevention in the City of Bay City.

TABLE 7-5.
CITY OF BAY CITY ADMINISTRATIVE/TECHNICAL MITIGATION CAPABILITIES MATRIX

Personnel Resources	Yes/No	Department/Position
Planner/engineer with knowledge of land development/land management practices	Yes	Assistant Director of Public Works
Engineer/professional trained in construction practices related to buildings or infrastructure	Yes	Building Official
Planner/engineer/scientist with an understanding of natural hazards	Yes	Assistant Director of Public Works
Personnel skilled in GIS	Yes	Outsourced to Jones & Carter Engineering as needed.
Full-time building official	Yes	Public Works Department
Floodplain manager	Yes	Public Works Department
Emergency manager	Yes	The Mayor is the City's Emergency Management Director. The City of Bay City also works in conjunction with the Matagorda County Emergency Manager. The City is working to hire an Emergency Management Coordinator.
Grant writer	Yes	Outsourced to Grant Works and Jones & Carter Engineering or managed internally based on need
Other personnel	No	
GIS data: Hazard areas	No	
GIS data: Critical facilities	No	
GIS data: Building footprints	No	
GIS data: Land use	Yes	Matagorda County provided a GIS layer for the Planning Commission. Information can be obtained at JCMaps.com
GIS data: Links to Assessor's data	Yes	
Warning systems/services (Reverse callback, cable override, outdoor warning signals)	Yes	Reverse 911 based emergency phone notifications and outdoor warning sirens at the nuclear plant.
Other	No	

7.2.3 Financial Capabilities

Table 7-6 identifies financial tools or resources that the City of Bay City could use to help fund mitigation activities.

TABLE 7-6.
CITY OF BAY CITY FINANCIAL MITIGATION CAPABILITIES MATRIX

Financial Resources	Accessible/Eligible to Use (Yes/No)
Community Development Block Grants	Yes
Capital improvements project funding	Yes
Authority to levy taxes for specific purposes	Yes

TABLE 7-6. CITY OF BAY CITY FINANCIAL MITIGATION CAPABILITIES MATRIX	
Financial Resources	Accessible/Eligible to Use (Yes/No)
Fees for water, sewer, gas, or electric services	Yes (water and sewer)
Impact fees for new development	Yes
Incur debt through general obligation bonds	Yes
Incur debt through special tax bonds	Yes
Incur debt through private activities	No
Withhold spending in hazard prone areas	No
Other	No

7.3 CITY OF PALACIOS

7.3.1 Legal and Regulatory Capabilities

Table 7-7 lists planning and land management tools typically used by local jurisdictions to implement hazard mitigation activities and indicates those that are in place in the City of Palacios.

TABLE 7-7. CITY OF PALACIOS REGULATORY MITIGATION CAPABILITIES MATRIX		
Regulatory Tool (ordinances, codes, plans)	Yes/No	Comments
General plan	Yes	Palacios Comprehensive Planning and Capacity Study, 2009-2029
Zoning ordinance	Yes	Palacios Consolidated Zoning Ordinance, Ordinance 27-11-2007
Subdivision ordinance	Yes	Chapter 10, Municipal Code
Growth management	Yes	Growth management is accomplished through compliance the Subdivision and zoning regulations.
Floodplain ordinance	Yes	Part of Chapter 3, Building Code (2007 as codified)
Other special purpose ordinance (stormwater, steep slope, wildfire)	No	
Building code	Yes	The city adopted the 2003 editions of the International Building Code
Erosion or sediment control program	Yes	The city has a Seawall Commission with its own taxing authority. The city also works with LCRA regarding erosion and sediment control.
Stormwater management	No	The city works with LCRA regarding stormwater management
Site plan review requirements	Yes	The city building inspector reviews plan and relation to floodplain
Capital improvements plan	No	The city maintains an ongoing 5-year Capital Improvement Plan for budgeting.
Economic development plan	No	Key policies and actions to guide economic development are managed by the Palacios Economic Development Corporation.

**TABLE 7-7.
CITY OF PALACIOS REGULATORY MITIGATION CAPABILITIES MATRIX**

Regulatory Tool (ordinances, codes, plans)	Yes/No	Comments
Local emergency operations plan	No	The City of Palacios works in conjunction with the Matagorda County Emergency Management
Other special plans	No	
Flood insurance study or other engineering study for streams	No	
Elevation certificates	Yes	Palacios requires elevation certificates for development in floodplains.

7.3.2 Administrative and Technical Capabilities

Table 7-8 identifies the City of Palacios personnel responsible for activities related to mitigation and loss prevention.

**TABLE 7-8.
CITY OF PALACIOS ADMINISTRATIVE/TECHNICAL MITIGATION CAPABILITIES MATRIX**

Personnel Resources	Yes/No	Department/Position
Planner/engineer with knowledge of land development/land management practices	Yes	The Planning Commission manages the city's development/land management practices
Engineer/professional trained in construction practices related to buildings or infrastructure	Yes	Individuals serves as building inspector and code enforcement
Planner/engineer/scientist with an understanding of natural hazards	No	Texas Colorado Floodplain Coalition assist with the 5-year plan
Personnel skilled in GIS	No	Matagorda County manages the mapping
Full-time building official	Yes	Planning Commission
Floodplain manager	Yes	City Manager
Emergency manager	Yes	Palacios works in conjunction with the Matagorda County Emergency Manager. The city has an Emergency Management Coordinator.
Grant writer	No	Out sourced to Grant Works as needed
Other personnel	No	
GIS data: Hazard areas	No	
GIS data: Critical facilities	No	
GIS data: Building footprints	No	
GIS data: Land use	No	
GIS data: Links to Assessor's data	No	
Warning systems/services (Reverse callback, cable override, outdoor warning signals)	No	

TABLE 7-8. CITY OF PALACIOS ADMINISTRATIVE/TECHNICAL MITIGATION CAPABILITIES MATRIX		
Personnel Resources	Yes/No	Department/Position
Other	No	The closest available stations are in Bay City and El Campo.

7.3.3 Financial Capabilities

Table 7-9 identifies financial tools or resources that City of Palacios could use to help fund mitigation activities.

TABLE 7-9. CITY OF PALACIOS FINANCIAL MITIGATION CAPABILITIES MATRIX	
Financial Resources	Accessible/Eligible to Use (Yes/No)
Community Development Block Grants	Yes
Capital improvements project funding	Yes
Authority to levy taxes for specific purposes	Yes
Fees for water, sewer, gas, or electric services	Yes (water and sewer only)
Impact fees for new development	No
Incur debt through general obligation bonds	Yes
Incur debt through special tax bonds	No
Incur debt through private activities	No
Withhold spending in hazard prone areas	No
Other	No

PART 2
RISK ASSESSMENT

CHAPTER 8.
EXPANSIVE SOILS

EXPANSIVE SOILS RANKING	
Jurisdiction	Expansive Soils
Matagorda County	Low
City of Bay City	Low
City of Palacios	Low

DEFINITIONS

Expansive Soils — Expansive soils are soils that expand when water is added, and shrink when they dry out. They usually undergo significant volume change with the addition or depletion of pore water. Generally, the result of the chemical structure of certain types of clay soils.

8.1 GENERAL BACKGROUND

Expansive and collapsible soils are some of the most widely distributed and costly geologic hazards. Collapsible soils are a group of soils that can rapidly settle or collapse the ground. They are also known as metastable soils and are unsaturated soils that undergo changes in volume and settlement in response to wetting and drying, often resulting in severe damage to structures. The sudden and usually large volume change could cause considerable structural damage. Expansive soil and rock are characterized by clayey material that shrinks as it dries or swells as it becomes wet. In addition, trees and shrubs placed closely to a structure can lead to soil drying and subsequent shrinkage. The parent (source) rock most associated with expansive soils is shale Figure 8-1 shows expansive soil distribution in the U.S. Collapsible soils consist of loose, dry, low-density materials that collapse and compact under the addition of water or excessive loading. Soil collapse occurs when the land surface is saturated at depths greater than those reached by typical rain events. This saturation eliminates the clay bonds holding the soil grains together. Similar to expansive soils, collapsible soils result in structural damage such as cracking of the foundation, floors, and walls in response to settlement. Swelling soils cause cracked foundations, as well as damage to upper floors of a building when the motion in the structure is significant. Shrinkage as result of dried soils can remove support from buildings or other structures and result in damaging subsidence. Fissures in the soil can also develop. These fissures can facilitate the deep penetration of water when moist conditions or runoff occurs.

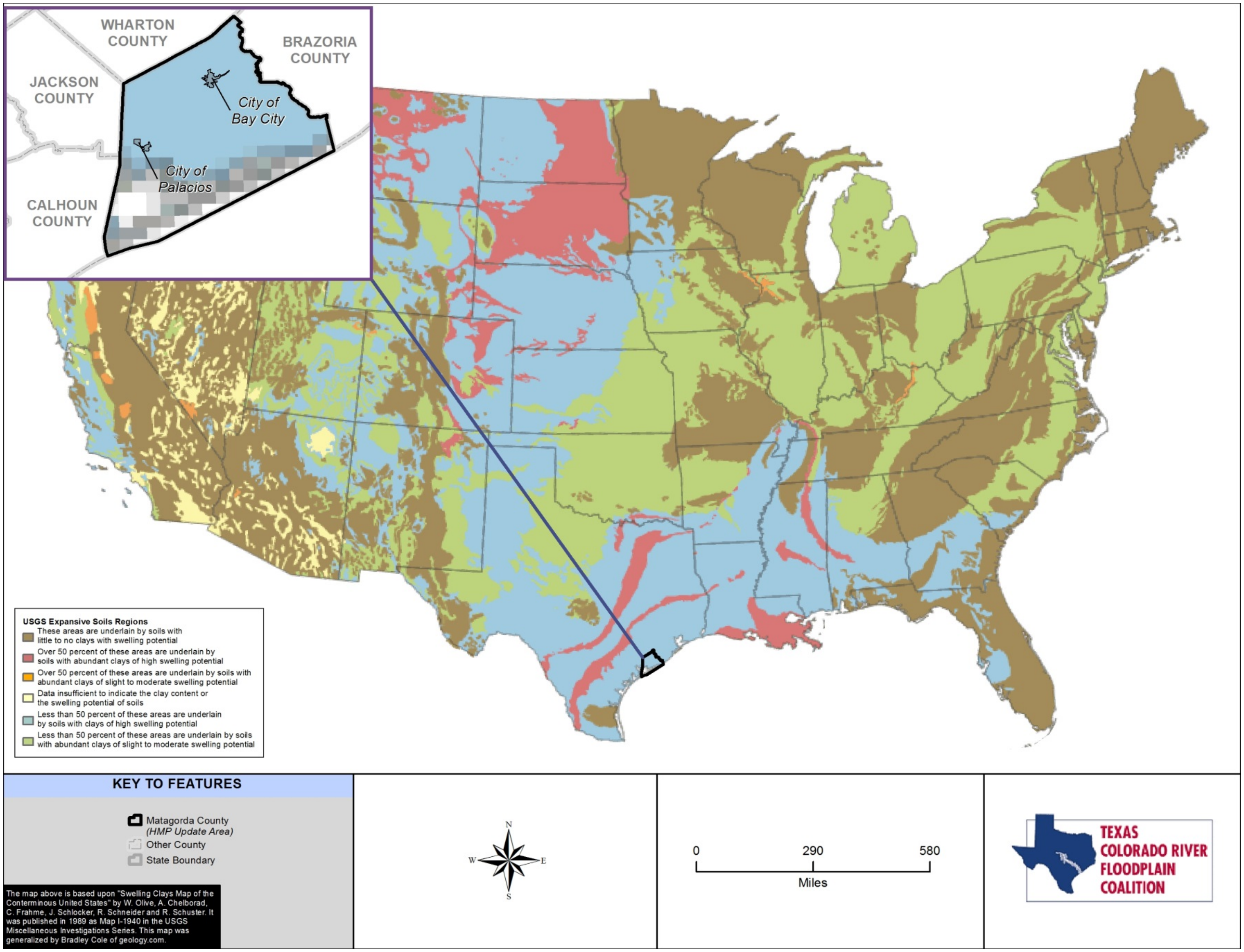


Figure 8-1. Expansive Soil Regions

8.2 HAZARD PROFILE

8.2.1 Past Events

Matagorda County's soils are mostly underlain by soils with clayey textures and have high shrink-swell properties. Expansive soils can cause structural damage, and even though structural foundation issues occur in the HMP update area there is little documentation of site-specific past events from local, state, or national datasets.

Expansive soil is a condition that is native to Matagorda County and participating communities because of the clay composition of the soils in this region. Expansive soils cannot be documented as a time-specific event, except when it leads to structural and infrastructure damage. There are no specific damage reports or historical records of events in Matagorda County and participating communities, (via NCDC and local records) however future events can occur. See Chapter 8.2.3 below for more information on future events.

8.2.2 Location

Structural foundation issues are a known occurrence through this region of South Texas, including Matagorda County and participating communities. The potential vertical rise of the clay soil in the area can be as high as several inches over a drought cycle. Structural foundations in the participating communities are thus subject to cyclical perimeter lifting and lowering from seasonal changes in soil moisture content because of the semi-arid conditions that persist in the area. Figure 8-1 shows the location of expansive soils areas for the participating communities.

8.2.3 Frequency

Expansive soil is a condition that is native to Matagorda County and participating communities. In Texas, it can take five or more years for an initial moisture dome to stabilize in a foundation. The establishment of the initial moisture dome usually causes the worst of the damage from foundation deflection. Afterward, the foundation is subject to cyclic perimeter lifting and lowering from seasonal changes in soil moisture content. For example, most homeowners with moving foundations find that cracks widen in the summer and close in the winter because Matagorda County and participating communities normally get most of their annual rainfall in May and October, summers can be quite dry, and evapotranspiration is less in the winter. Due to the minimal of swelling potential, an event is rare or unlikely (event possible in next 10 years). This applies to Matagorda County and all participating communities.

Future Events

The large increase in development in the Texas Gulf Coast region could Matagorda County area could lead to an increase in expansive soil events. More structures, residents, and people could cause a strain on previously undeveloped areas of land and resources. This could increase the probability of an event occurring in Matagorda County and the participating communities. Future events are considered rare (event possible in next 10 years) for Matagorda County and participating communities.

8.2.4 Severity

The severity of expansive soils are largely related to the extent and location of areas that are impacted. Such events can cause property damage as well as loss of life; however, events may also occur in remote areas of the HMP update area where there is little to no impact to people or property.

Expansive soil is the hidden force behind basement and foundation problems. The U.S. Dept. of Agriculture claims that expansive soils are responsible for more home damage every year than floods, tornadoes and hurricanes combined. The U.S. Dept. of Agriculture estimates 50% of all homes in the U.S. are built on expansive soils. Each year in the U.S., expansive soils cause $2.3 billion in structural damage. Structures may be condemned as a result of this damage resulting in large losses. Shrink-swell problems are the second most likely problem a homeowner would encounter, after insects.

The *State of Texas Hazard Mitigation Plan* defines soil expansion measurements in terms of its swelling potential or volumetric swell. The State uses the American Society for Testing and Materials (ASTM) soil expansion index adopted by ASTM in 1988.This expansion index has been determined to have a greater range and better sensitivity of expansion than other indexes. The following ratings define expansive soil extent 'per the ASTM D4729-11 Expansive Soils Index:

0-20%	Very Low
21-50%	Low
51-90%	Medium
91-130%	High
130%+	Very High

As seen by Figure 8-1, less than 50% of the areas within Matagorda County and participating communities are underlain by soils with abundant clays of high swelling potential, and therefore fall under the 'Low' Extent. Most Unified Building Codes (UBC) mandates that special foundation design consideration be employed if the Expansion Index is 20 or greater.

8.2.5 Warning Time

Soil expansion generally occurs gradually over time; however, these processes may be intensified as a result of natural or human-induced activities.

8.3 SECONDARY HAZARDS

Events that cause damage to improved areas can result in secondary hazards, such as explosions from natural gas lines, loss of utilities such as water and sewer due to shifting infrastructure, and potential failures of reservoir dams. Additionally, these events may occur simultaneously with other natural hazards such as flooding. Erosion can cause undercutting that can result in an increase in landslide or rockfall hazards. Additionally erosion can result in the loss of topsoil, which can affect agricultural production in the area. Deposition can have impacts that aggravate flooding, bury crops, or reduce capacities of water reservoirs.

8.4 CLIMATE CHANGE IMPACTS

In areas where climate change results in less precipitation and reduced surface-water supplies, communities will pump more groundwater. Changes in precipitation events and the hydrological cycle may result in changes in the rate of subsidence and soil erosion. According to a 2003 paper published by the Soil and Water Conservation Society (Soil and Water Conservation 2003):

> *The potential for climate change – as expressed in changed precipitation regimes – to increase the risk of soil erosion, surface runoff, and related environmental consequences is clear. The actual damage that would result from such a change is unclear. Regional, seasonal, and temporal variability in precipitation is large both in simulated climate regimes and in the existing climate record. Different landscapes vary greatly in their vulnerability to soil erosion and runoff. Timing of agricultural production practices creates even greater vulnerabilities to soil erosion and runoff during certain seasons. The effect of a particular storm event depends on the moisture content of the soil before the storm starts. These interactions between precipitation, landscape, and management mean the actual outcomes of any particular change in precipitation regime will be complex.*

8.5 EXPOSURE

While all structures and foundations are exposed to expansive soils, Matagorda County and participating communities' significant clay soil composition increases the likelihood and severity of the seasonal swelling and contraction of soils. Each participating community's structures and population are potentially exposed and equally at risk by expansive soils. Table 8-1 lists the exposed population and structure count for each participating jurisdiction.

8.5.1 Population

It can be assumed that the entire planning area is exposed equally to some extent to expansive soils events. Certain areas are more exposed due to geographic location and local weather patterns. Current growth trends could cause more area residents to be exposed to expansive soils. Increased population will increase demands on structure development, as well as surface and sub-surface soil activities, and may introduce new expansive soils in areas where soil expansion activities have not yet occurred.

8.5.2 Property

According to the Matagorda County HAZUS 2.2 inventory data (updated with 2010 U.S. Census Data and 2014 RS Means Square Foot Costs), there are 16,635 buildings within the census blocks that define the planning area with an asset replaceable value of over $4 million (excluding contents). About 98.5% of these buildings (and 83.4% of the building value) are associated with residential housing. Within the participating communities in the HMP update area, there are an estimated 14,544 buildings (residential, commercial, and other) with a total asset inventory (excluding contents) value of over $3.6 million. Other types of buildings in this report include agricultural, education, religious, and governmental structures. See hazard loss tables for community-specific total assessed numbers (e.g. Table 15-6). Table 8-1 lists the exposed structures and population for the participating communities.

TABLE 8-1
EXPOSED STRUCTURES AND POPULATION

Jurisdiction	Residential	Commercial	Other *	**Total Structures**	**Total Population**
Unincorporated Area	5,744	121	35	5,900	17,631
City of Bay City	1,785	17	10	1,812	4,718
City of Palacios	6,787	29	16	6,832	10,028
Matagorda County Total	14,316	167	61	14,544	32,377

*Other includes industrial, agricultural, religious, governmental, and educational classifications.

8.5.3 Critical Facilities and Infrastructure

Any critical facilities or infrastructure that are located in the participating communities on or near areas prone to expansive soils and are equally exposed to risk from this hazard. Bare ground or lack of tree cover may result in additional exposure.

8.5.4 Environment

Expansive soils are naturally occurring processes, but can still cause damage to the natural environment. These processes and events can alter the natural environment where they occur.

8.6 VULNERABILITY

Matagorda County and participating communities have low to limited risk from expansive soils because of the amounts of clay with swelling potential of the soils in these communities. All jurisdictions classified their risk as ‘low’. Because expansive soils cannot be directly modeled in HAZUS, annualized losses were estimated using GIS-based analysis, historical data analysis, and statistical risk assessment methodology. Event frequency, severity indicators, expert opinions, and historical local knowledge of the region were used for this assessment.

8.6.1 Population

The risk of injury or fatalities as a result of this hazard is limited, but possible. The most vulnerable demographics will be the economically disadvantaged population areas, children under 16 years, and the elderly. Economically disadvantaged families and those living on a fixed income may not have the financial means to adequately deal with the effects of an event and make the necessary structurally improvements. The youth and elderly population may require further assistance as dependents if an event were to occur. Table 8-2 show vulnerable populations per participating community.

TABLE 8-2
MOST VULNERABLE POPULATION

Jurisdiction	Youth Population (< 16)	% of Total Population	Elderly Population (> 65)	% of Total Population	Economically Disadvantage (Income < $20,000)	% of Total Population
Unincorporated Area	4,912	27.86	2,146	12.17	1,749	9.92
City of Bay City	1,441	30.54	623	13.20	549	11.64
City of Palacios	2,192	21.86	1,829	18.24	527	5.26
Matagorda County Total	8,545	26.39	4,598	14.20	2,825	8.73

8.6.2 Property

All properties are equally at risk from expansive soils, but properties in poor condition or in particularly vulnerable locations (economically disadvantaged communities and areas with low tree cover) may risk the most damage. Generally, damage is minimal and goes unreported.

Loss estimations for expansive soil hazards are not based on damage functions, because no such damage functions have been generated. Instead, loss estimates were developed representing projected damages (annualized loss) on exposed values. Historical events, statistical analysis and probability factors were applied to the county's and communities exposed values to create an annualized loss. Table 8-3 lists the property loss estimates for each participating community. Annualized losses of 'negligible' are less than $50 annually. Negligible loss hazards are still included despite minimal annualized losses because of the potential for a high value damaging event.

**TABLE 8-3.
LOSS ESTIMATES FOR EXPANSIVE SOILS**

Jurisdiction	Exposed Value	Annualized Loss	Annualized Loss Percentage
Unincorporated Area	$2,558,729,176	$2,117	<0.01%
City of Bay City	$2,649,736,203	Negligible	<0.01%
City of Palacios	$669,865,421	Negligible	<0.01%
Matagorda County Total	**$5,878,330,801**	**$2,117**	<0.01%

Vulnerability Narrative

All participating communities are equally at risk to expansive soils. Table 8-2 lists the vulnerable population per community. Table 8-3 lists the estimated annualized losses in dollars for each participating community.

- **City of Bay City -** The effects of expansive soils are more likely to be felt in the more developed areas of the City, such as along TX 35. Property owners can face additional property maintenance costs because of structure foundation issues caused by the swelling of soils. Owners unaware of the areas of higher risk at the time the property was purchased are more at risk to not be prepared for its effects. If an event were to occur near a critical facility, such as a police station or government building, one of these facilities could be shut down resulting in increased response times to residents. Community leaders who are unaware of their risks and the hazards associated with expansive soils increase vulnerability as they will not be able to effectively plan mitigation actions or respond in emergency events.
- **City of Palacios -** Recent weather events of greater disparity (such as short intense periods of rainfall to prolonged drought conditions) cause more stress on areas affected by expansive soils. As the soil expands, cracks in foundations can occur as well as other structural damages. This can cause damages to critical facilities and infrastructure (such as emergency response facilities, government buildings and water supply facilities). Structures built without the benefit of building requirements designed to minimize the risk of property damage are more vulnerable as well. Residents and builders unaware of the risks and hazards associated with expansive soils increase vulnerability as they may be unaware of mitigation actions to protect against the negative impacts of expansive soils.
- **Matagorda County (Unincorporated Area) -** Less than 50% of the areas within Matagorda County are underlain by soils with abundant clays of high swelling potential. Critical facilities and structures that have not been inspected for expansive soils may have a greater risk. Residents and business owners who are unaware of the dangers of expansive soils are more vulnerable also as they may be unaware of how to mitigate negative impacts. Those who do not take measures to minimize the water exposed to clays around vulnerable building foundations increase risk as well.

Community Perception of Vulnerability

See front page of current chapter for a summary of hazard rankings for Matagorda County and participating communities in this HMP update. Chapter 19 gives a detailed description of this rankings and Chapter 20 addresses mitigations actions for this hazard vulnerability.

8.6.3 Critical Facilities and Infrastructure

Even though expansive soils cause enormous amounts of damage, the effects can occur slowly and may not be attributed to a specific event. The damage done by expansive soils is then attributed to poor construction practices or a misconception that all buildings experience this type of damage as they age. Cracked foundations, floors, and basement walls, as well damage to the upper floors of the building when the motion in the structure is significant are typical types of damage done by swelling soils. Shrinkage can remove support from buildings or other structures and result in damaging subsidence.

When critical facilities and infrastructure are affected and closed down for maintenance due to structure foundation problems as a result of soil expansion, critical response times and services to the affected communities will become limited.

8.6.4 Environment

Ecosystems that are exposed to increased soil expansion as a result of the clay content of their soil habitats. However, some soil swelling and contraction is required for healthful ecosystem functioning. Ecosystems that are already exposed to other pressures, such as encroaching development, may be more vulnerable to impacts from these hazards.

8.7 FUTURE TRENDS IN DEVELOPMENT

Jurisdictions in the planning area should ensure that known hazard areas are regulated under their planning and zoning programs. In areas where hazards may be present, permitting processes should require geotechnical investigations to access risk and vulnerability to hazard areas. Soil expansion issues generally do impact land use and structure development. Issues pertaining to land use in these areas are likely addressed through jurisdictional building codes, ordinances, and regulations.

8.8 SCENARIO

A worst case scenario would occur if a rapidly occurring soil swelling and contraction caused severe structure deformation or the subsurface soil to crack and open up beneath a structure where many individuals lived or worked. This situation could result in a number of injuries or fatalities and would cause extensive damage to the area directly impacted.

8.9 ISSUES

The major issues for soil expansion are the following:

- Onset of actual or observed soil expansion in many cases is related to changes in land use. Land uses permitted in known hazard areas should be carefully evaluated.
- Knowledge of hydrologic factors is critical for evaluating most types of soil swelling.
- Some land use and housing developments have had soil site investigations completed before development. This practice should be reviewed and expanded as needed.
- More detailed analysis should be conducted for critical facilities and infrastructure exposed to hazard areas. This analysis should address how potential structural issues were addressed in facility design and construction.

CHAPTER 9.
DAM/LEVEE FAILURE

DAM/LEVEE FAILURE RANKING	
Matagorda County	Medium
City of Bay City	Low
City of Palacios	No Exposure

DEFINITIONS

Breach — An opening through which floodwaters may pass after part of a levee has given way.

Dam Failure — An uncontrolled release of impounded water due to structural deficiencies in a dam.

Emergency Action Plan — A document that identifies potential emergency conditions at a dam and specifies actions to be followed to minimize property damage and loss of life. The plan specifies actions the dam owner should take to alleviate problems at a dam. It contains procedures and information to assist the dam owner in issuing early warning and notification messages to responsible downstream emergency management authorities of the emergency situation. It also contains inundation maps to show emergency management authorities the critical areas for action in case of an emergency. (FEMA 64)

High Hazard Dam — Dams where failure or operational error will probably cause loss of human life. (FEMA 333)

Significant Hazard Dam — Dams where failure or operational error will result in no probable loss of human life but can cause economic loss, environmental damage, or disruption of lifeline facilities, or can impact other concerns. Significant hazard dams are often located in rural or agricultural areas but could be located in areas with population and significant infrastructure. (FEMA 333)

Accredited Levee — A levee that is shown on a Flood Insurance Rate Map (FIRM) as providing protection from the 1% annual chance or greater flood. A **non-accredited or de-accredited levee** is a levee that is not shown on a FIRM as providing protection from the 1% annual chance or greater flood. A **provisionally accredited levee** is a previously accredited levee that has been de-accredited for which data and/or documentation is pending that will show the levee is compliant with National Flood Insurance Program (NFIP) regulations.

9.1 GENERAL BACKGROUND

9.1.1 Dams

Water is an essential natural resource and one of the most efficient ways to manage and control water resources is through dam construction. A dam is defined in the Texas Water Code as a barrier, including one for flood detention, designed to impound liquid volumes and which has a height of dam greater than six feet.” (Texas Administrative Code, Ch. 299, 1986).

The Texas Commission on Environmental Quality (TCEQ) has jurisdiction over rule changes to dams as 99% of dams are under state regulatory authority. Those regulations are implemented by the TCEQ Dam Safety Program, which monitors and regulates both private and public dams in Texas. The program periodically inspects dams that pose a high or significant hazard and makes recommendations and reports to dam owners to help them maintain safe facilities. The primary goal of the state’s Dam Safety Program is to reduce the risk to lives and property from the consequences of dam failure.

In 2008, TCEQ proposed several rule changes including the definition of dams and dam classifications. According to the new definition, a dam in Texas is a barrier with a “height greater than or equal to 25 feet and a maximum storage (top of dam) capacity of 15 acre-feet; a height greater than 6 feet and a maximum storage capacity greater than or equal to 50 acre-feet; or one that poses a threat to human life or property in the event of failure, regardless of height or maximum storage capacity.” Figure 9-1 shows the specifications required for a dam to be regulated by TCEQ.

Source: DamSafetyAction.Org, Texas

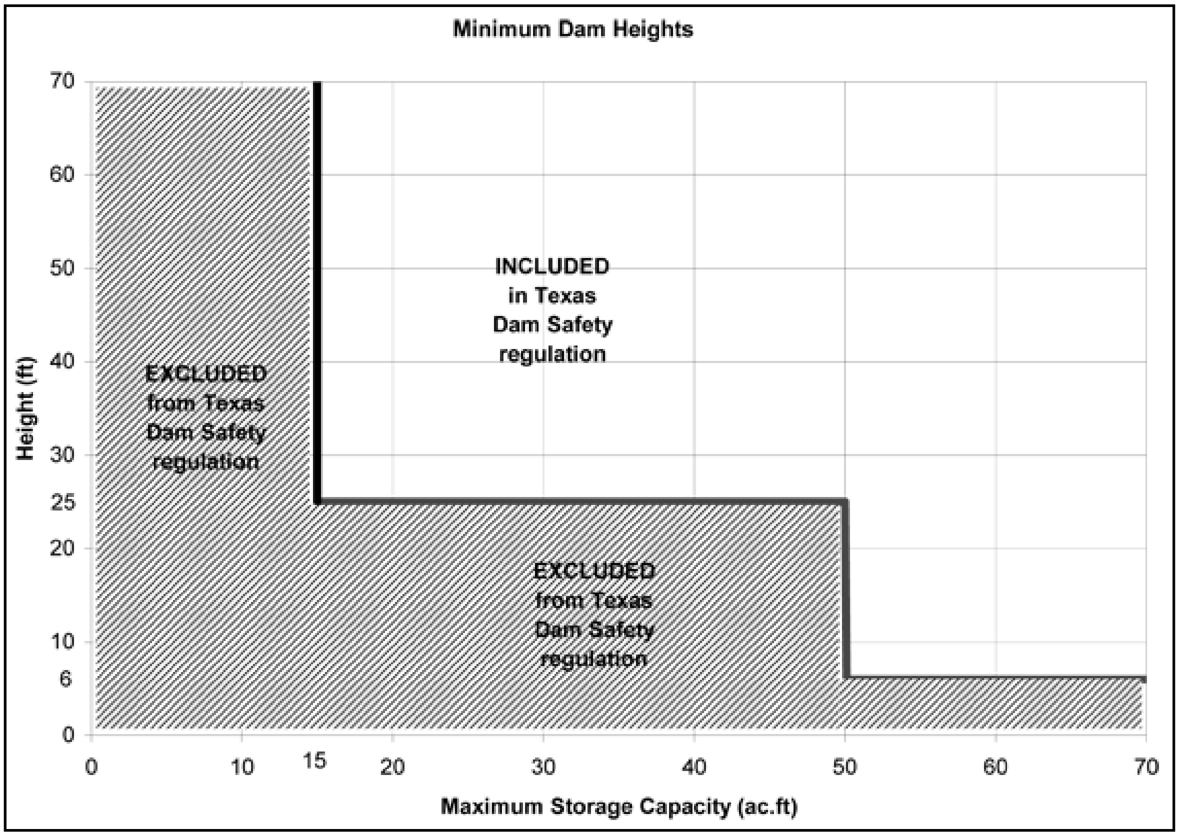


Figure 9-1. TCEQ Dam Definition

The majority of dams and lakes in Texas are used for water supply. Dams also provide benefits such as irrigation for agriculture, hydropower, flood control, maintenance of lake levels, and recreation. The primary purposes and benefits of dams are shown on Figure 9-2. However, despite the benefits and importance of dams to our public works infrastructure, many safety issues exist for dams as with any complex infrastructure; the most serious threat is dam failure.

Source: FEMA, Dams

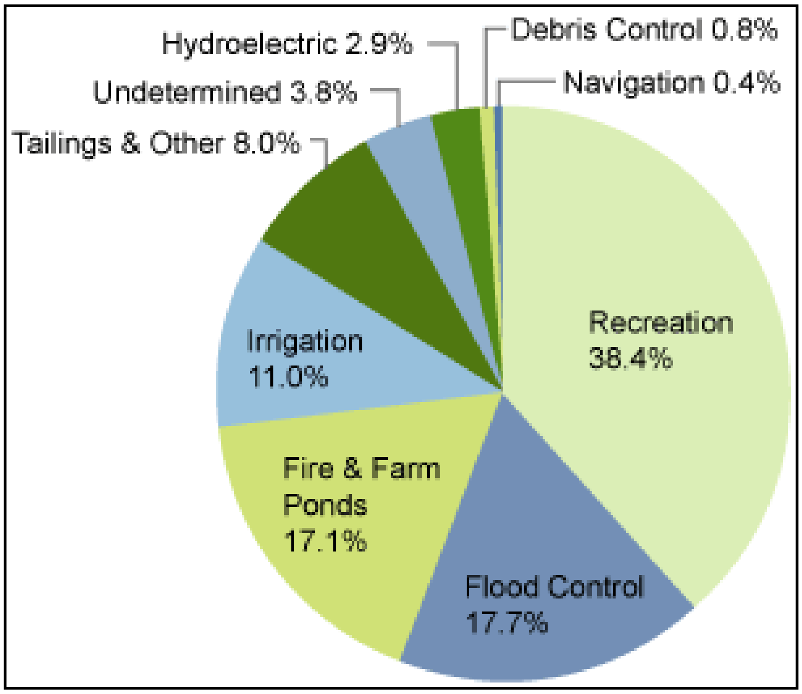


Figure 9-2. Primary Purpose/Benefit of U.S. Dams

Approximately 10% of the dams in Matagorda County and participating communities are owned by either the local government or local government agency. The remaining 90% are privately owned. See Figure 9-3 for location of dams in the participating communities.

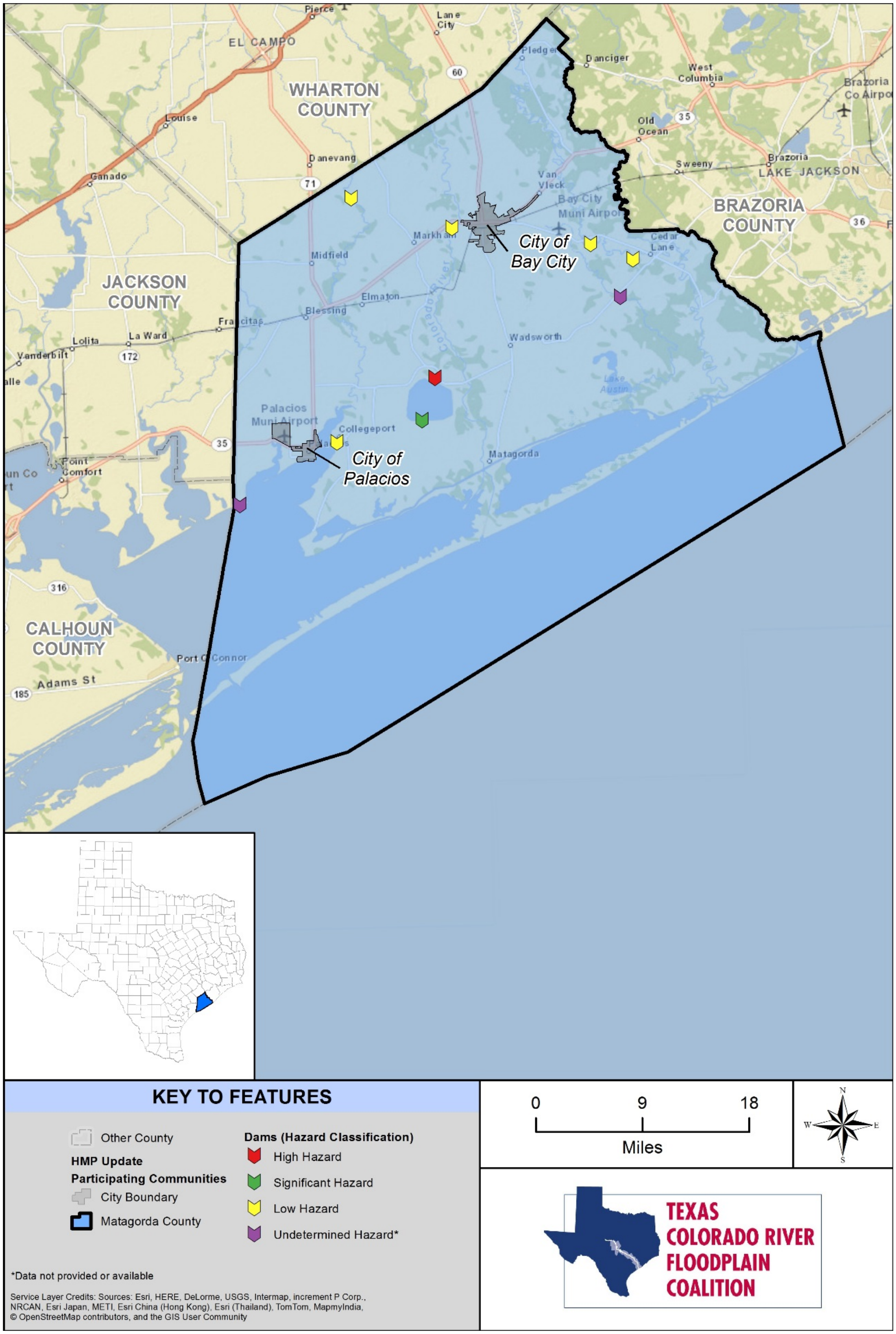


Figure 9-3. High and Significant Hazard Dams in Matagorda County and Participating Communities

9.1.2 Levees

The Federal Emergency Management Agency (FEMA) defines a levee as a "man-made structure, usually an earthen embankment, designed and constructed in accordance with sound engineering practices to contain, control, or divert the flow of water so as to provide protection from temporary flooding." The terms dike and levee are sometimes used interchangeably. A few examples of levee systems are the Texas City Hurricane Protection Structure, Freeport Hurricane Protection Structure, the Port Arthur Hurricane Protection Structure in the Houston area, and the Trinity Floodway Levees in the Dallas area. Levees reduce the risk of flooding but no levee system can eliminate all flood risk. There is always a chance that a flood will exceed the capacity of a levee, no matter how well built. Levees can work to provide critical time for local emergency management officials to safely evacuate residents during flooding events. The possibility exists that levees can be overtopped or breached by large floods; however, levees sometimes fail even when a flood is small.

Although there are levees in all 50 states, there is no single agency responsible for levee construction and maintenance. It is a common misperception that U.S. Army Corps of Engineers (USACE) manages all levees in the nation. In reality, the levees included in the USACE Levee Safety Program represent only about 10% of the nation's levees (as estimated by the National Committee on Levee Safety). Some estimates indicate that over 100,000 miles of levees exist across the nation. Of that number, the USACE designed and constructed over 14,000 miles of levees with another 14,000 to 16,000 miles operated by other federal agencies, such as the U.S. Bureau of Reclamation. The majority of the nation's levees were constructed by private and non-federal interests and are not federally operated or maintained. However, more than 10 million people live or work behind USACE program levees. For this reason, USACE considers its role in assessing, communicating, and managing risk to be a top priority. Figure 9-4 shows USACE program levees versus other levee programs. Figure 9-5 shows the counties in Texas with levees. Matagorda County and participating communities do have known levees (See Figure 9-5). This includes the Colorado River East and West Levee, and the Matagorda Ring Levee. All three of these levees are located in the Matagorda County Unincorporated area. Additionally, the Colorado River East Levee intersects the western extent of the City of Bay City. Additional small private levees may exist.

Flooding can happen anywhere, but certain areas are especially prone to serious flooding. To help communities understand their risk behind levee structures, FEMA uses levee accreditation on flood insurance rate maps (FIRM) to show the locations with reduced risks from the base flood. Conditions in, near, or under levees can change due to environmental factors. The FIRMs take these factors into consideration. If the risk level for a property changes, so may the requirement to carry flood insurance.

Levee accreditation is FEMA's recognition that a levee is reasonably certain to contain the base (1% annual chance exceedance, sometimes referred to as the 100-year flood) regulatory flood. In order to be accredited, levee owners must certify to FEMA that the levee will provide protection from the base flood. Certification is a technical finding by a professional engineer based on data, drawings, and analyses that the levee system meets the minimum acceptable standards. FEMA's accreditation is not a guarantee of performance; it is intended to provide updated information for insurance and floodplain development.

Source: USACE

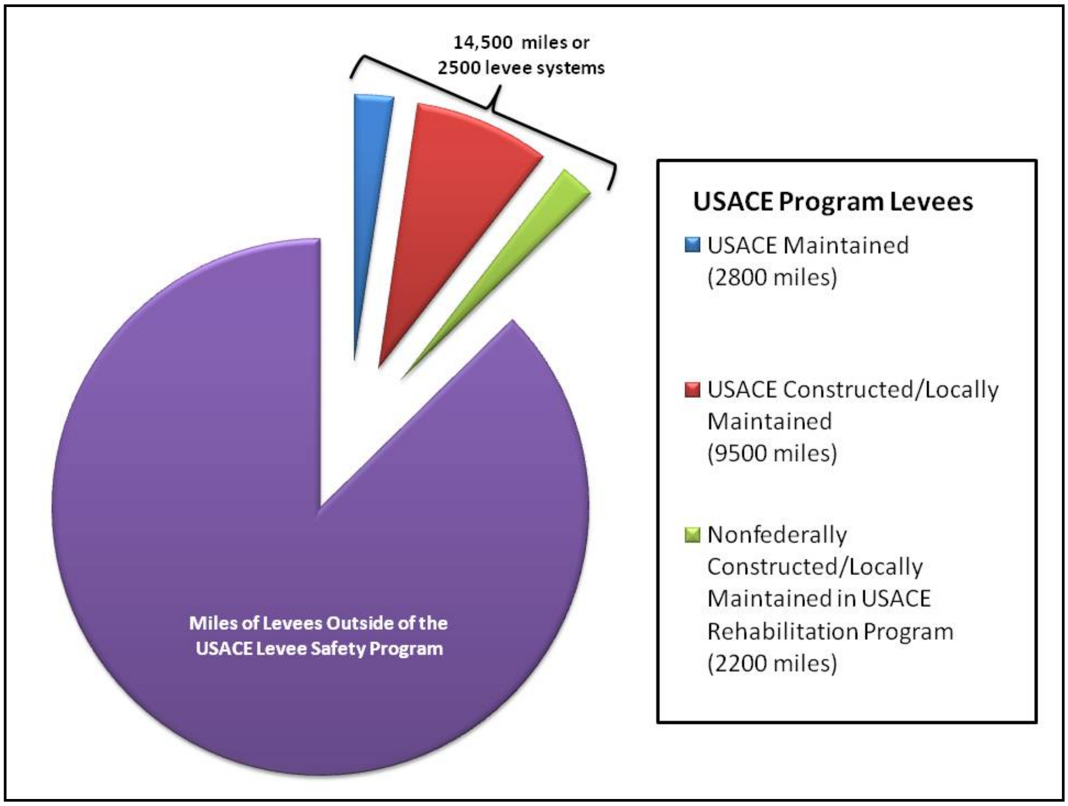


Figure 9-4. U.S. Levee Systems

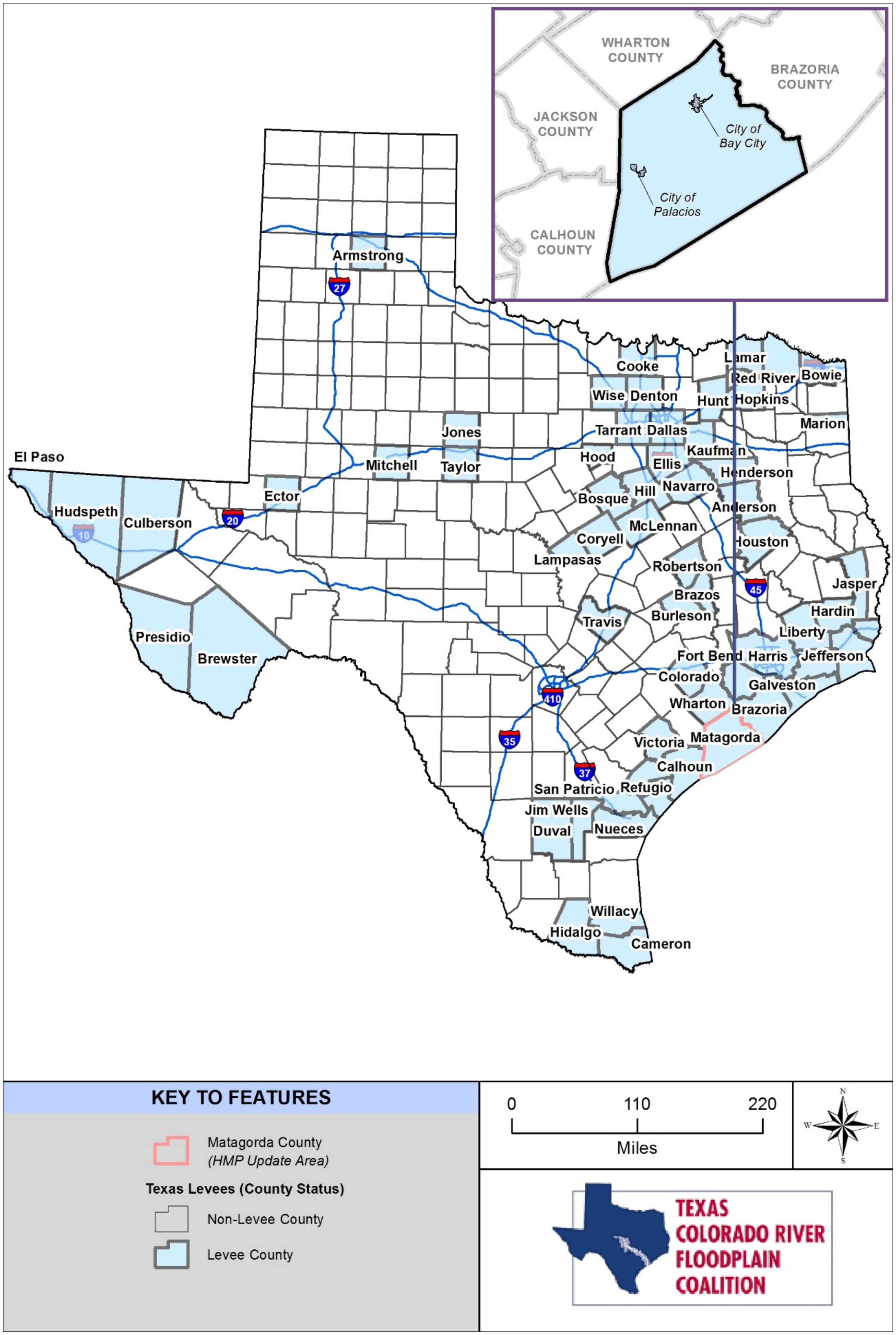


Figure 9-5. Texas Counties with Levees

9.1.3 Causes of Dam Failure

Dam failure is a collapse or breach in a dam. While most dams have storage volumes small enough that failures have little or no repercussions, dams with large storage amounts can cause significant downstream flooding. Dam failures in the United States typically occur from any one or combination of the following:

- Overtopping of the primary dam structure, which accounts for 34% of all dam failures, can occur due to inadequate spillway design, settlement of the dam crest, blockage of spillways, and other factors.
- Foundation defects due to differential settlement, slides, slope instability, uplift pressures, and foundation seepage can also cause dam failure. These account for 30% of all dam failures.
- Failure due to piping and seepage accounts for 20% of all failures. These are caused by internal erosion due to piping and seepage, erosion along hydraulic structures such as spillways, erosion due to animal burrows, and cracks in the dam structure.
- Failure due to problems with conduits and valves, typically caused by the piping of embankment material into conduits through joints or cracks, constitutes 10% of all failures.

The remaining 6% of U.S. dam failures are due to miscellaneous causes. Many dam failures in the United States have been secondary results from other disasters. The prominent causes are earthquakes, landslides, extreme storms, massive snowmelt, equipment malfunction, structural damage, foundation failures, and sabotage.

Poor construction, lack of maintenance and repair, and deficient operational procedures are preventable or correctable by a program of regular inspections. Terrorism and vandalism are serious concerns that all operators of public facilities must plan for; these threats are under continuous review by public safety agencies.

9.1.4 Causes of Levee Failure

Levee data used in this report is from the FEMA Midterm Levee Inventory (MLI) and the Hazards, United States-Multi Hazard (HAZUS-MH) database. The FEMA MLI captures all levee data (USACE and non-USACE), with a primary focus on levees that provide protection from the base (1%-annual chance) flood. Levees providing less than base flood protection will also be included, but only for those levees with data readily available. The FEMA MLI and HAZUS-MH database (as well as local knowledge from the Steering Committee) were used to identify known levees in the planning area. The HAZUS-MH database did not list any levees in Matagorda County. The FEMA MLI database however did contain levees for Matagorda County. It is possible that there are additional private levees located within the county that are not listed in these databases.

A levee breach occurs when part of a levee gives way, creating an opening through which floodwaters may pass. A breach may occur gradually or suddenly. The most dangerous breaches happen quickly during periods of high water. The resulting torrent can quickly swamp a large area behind the failed levee with little or no warning.

Earthen levees can be damaged in several ways. For instance, strong river currents and waves can erode the surface. Debris and ice carried by floodwaters—and even large objects such as boats or barges—can collide with and gouge the levee. Trees growing on a levee can blow over, leaving a hole where the root wad and soil used to be. Burrowing animals can create holes that enable water to pass through a levee. If severe enough, any of these situations can lead to a zone of weakness that could cause a levee breach. In seismically active areas, earthquakes and ground shaking can cause a loss of soil strength, weakening a levee and possibly resulting in failure. Seismic activity can also cause levees to slide or slump, both of which can lead to failure. Unfortunately, in the rare occurrence when a levee system fails or is overtopped, severe flooding can occur due to increased elevation differences associated with levees and the increased water velocity that is created.

It is also important to remember that no levee provides protection from events for which it was not designed, and proper operation and maintenance are necessary to reduce the probability of failure. In some cases, flooding may not be directly attributable to a river, stream, or lake overflowing its banks. Rather, it may simply be the combination of excessive rainfall or snowmelt, saturated ground, and inadequate drainage. With no place to go, the water will find the lowest elevations—areas that are often not in a floodplain. This type of flooding, often referred to as sheet flooding, is becoming increasingly prevalent as development outstrips the ability of the drainage infrastructure to properly carry and disburse the water flow. Flooding also occurs due to combined storm and sanitary sewers that cannot handle the amount of water.

The complicated nature of levee protection was made evident by events such as Hurricane Katrina. Flooding can be exacerbated by levees that are breached or overtopped. As a result, FEMA and USACE are re-evaluating their policies regarding enforcement of levee maintenance and post-flood rebuilding. Both agencies are also conducting stricter inspections to determine how much protection individual levees actually provide. The Texas Water Development Board's (TWDB) mission is to provide leadership, information, education, and support for planning, financial assistance, and outreach for the conservation and responsible development of water for Texas. TWDB will assist qualifying entities who are in good standing with the National Flood Insurance Program (NFIP) through technical and financial assistance. TWDB assistance may include grant funding, participation in levee inspections, assistance in developing Maintenance Deficiency Correction Plans, site visits, and participation in public hearings. In addition, the TWDB will also discourage the construction of new levees to protect new developments, and instead encourage other types of flood mitigation projects.

9.1.5 Regulatory Oversight

The potential for catastrophic flooding due to dam failures led to passage of the National Dam Safety Act (Public Law 92-367). The National Dam Safety Program requires a periodic engineering analysis of every major dam in the country. The goal of this FEMA-monitored effort is to identify and mitigate the risk of dam failure so as to protect the lives and property of the public.

Texas Rules and Regulations for Dam Safety and Dam Construction

Effective September 1, 2013, dams are exempt from safety requirements if they are located on private property, have a maximum impoundment capacity of less than 500 acre-feet, are classified as low or significant hazard, are located in a county with a population of less than 350,000 (as per 2010 U.S. Census), and are not located within the corporate limits of a municipality. Dam owners will still have to comply with maintenance and operation requirements. There is no exemption expiration date. Figure 9-6 shows counties in Texas that fall under this exemption criteria. Five of the dams in Matagorda County are non-exempt while the others are exempt per 30 TAC 299.

To help the State Dam Safety Program achieve its goal, the state's dam safety regulations now include the requirement for Emergency Action Plans on all non-exempt Significant-Hazard and High-Hazard Potential dams (Title 30, Texas Administrative Code, Ch. 299, 299.61b). Dam count and exemptions 30 TAC 299 are detailed below by jurisdiction in Table 9-1.

TABLE 9-1.
DAM COUNTS AND EXEMPTIONS

Jurisdiction	Dam Count	Exemptions
Unincorporated Area	9	7
City of Bay City	0	0
City of Palacios	0	0
Matagorda County Total	**9**	**7**

*Dams data provided by Texas Water Development Board (TWDB) in 2015.

U.S. Army Corps of Engineers Dam Safety Program

USACE is responsible for safety inspections of some federal and non-federal dams in the United States that meet the size and storage limitations specified in the National Dam Safety Act. USACE has inventoried dams; surveyed each state and federal agency's capabilities, practices, and regulations regarding design, construction, operation and maintenance of the dams; and developed guidelines for inspection and evaluation of dam safety (USACE 1997).

Federal Energy Regulatory Commission Dam Safety Program

The Federal Energy Regulatory Commission (FERC) cooperates with a large number of federal and state agencies to ensure and promote dam safety. More than 3,000 dams are part of regulated hydroelectric projects in the FERC program. Two-thirds of these are more than 50 years old. As dams age, concern about their safety and integrity grows, so oversight and regular inspection are important. FERC inspects hydroelectric projects on an unscheduled basis to investigate the following:

- Potential dam safety problems
- Complaints about constructing and operating a project
- Safety concerns related to natural disasters
- Issues concerning compliance with the terms and conditions of a license.

Every 5 years, an independent engineer approved by the FERC must inspect and evaluate projects with dams higher than 32.8 feet (10 meters) or with a total storage capacity of more than 2,000 acre-feet.

FERC monitors and evaluates seismic research and applies it in investigating and performing structural analyses of hydroelectric projects. FERC also evaluates the effects of potential and actual large floods on the safety of dams. During and following floods, FERC visits dams and licensed projects, determines the extent of damage, if any, and directs any necessary studies or remedial measures the licensee must undertake. The FERC publication *Engineering Guidelines for the Evaluation of Hydropower Projects* guides the FERC engineering staff and licensees in evaluating dam safety. The publication is frequently revised to reflect current information and methodologies.

FERC requires licensees to prepare Emergency Action Plans and conducts training sessions on how to develop and test these plans. The plans outline an early warning system if there is an actual or potential sudden release of water from a dam due to failure. The plans include operational procedures that may be used, such as reducing reservoir levels and reducing downstream flows, as well as procedures for notifying affected residents and agencies responsible for emergency management. These plans are frequently updated and tested to ensure that everyone knows what to do in emergency situations.

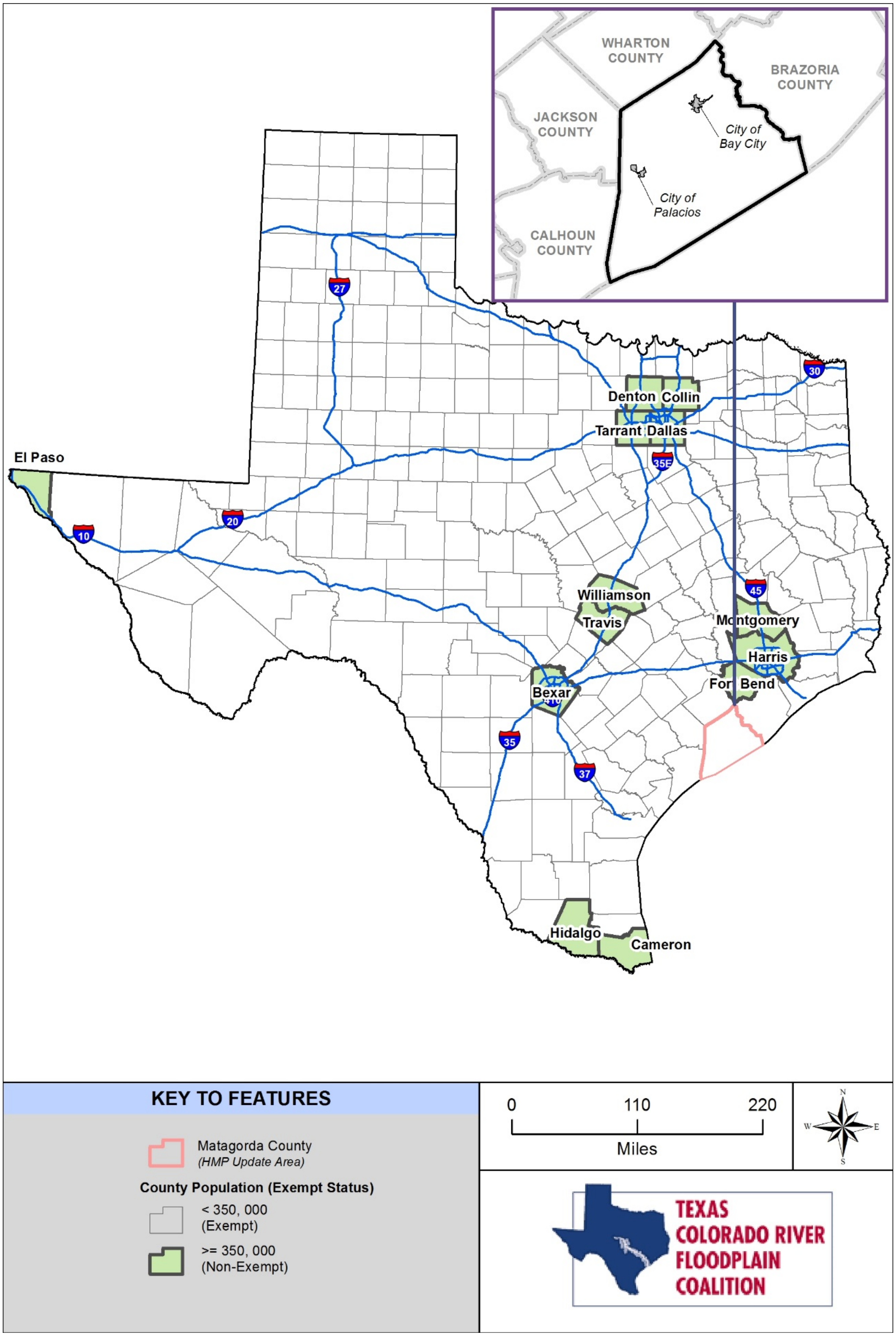


Figure 9-6. Texas County Population Exemptions for Dams

9.2 HAZARD PROFILE

9.2.1 Past Events

There are approximately 7,290 dams in the inventory of dams in Texas. Only two major dam failures have occurred in the entire Texas Colorado River Floodplain Coalition (TCRFC) planning region. Both occurred in the City of Austin, which is not a participating jurisdiction in this effort. The last failure for the city was in 1915. There have been no previous dam or levee failure events in Matagorda County and the participating communities.

After a series of high-profile failures throughout the United States during the 1960s and early 1970s, the U.S. Congress enacted legislation mandating inspections and strict safety requirements for all governmental and privately operated dams. Stricter state and federal dam safety regulations were adopted in the 1970s and 1980s as a direct response to numerous dam failures across the country. These standards require that dams be able to withstand the most severe flood imaginable, the Probable Maximum Flood (PMF). This flood is so severe and statistically remote that its probability of occurrence in any given year cannot be measured. Since that time the number of failures and deaths has dramatically decreased.

The Lower Colorado River Authority (LCRA) conducted a Dam Modernization Program between 1994 and 2004 to strengthen the dams in its jurisdiction and ensure their safety for years to come. This program addressed a common problem with the stability of the "gravity" sections of the dams. Since gravity sections derive strength from their size and weight, post-tensioned anchors were added to improve stability. The dam modernization program helps ensure that LCRA's dams meet required design safety standards to resist the water load and pressure of the PMF.

An extreme precipitation event occurred May 23 through 25, 2015 (this event is further outlined in Chapter 12, Flood) causing a rise in Lake Travis (Mansfield Dam, Figure 9-7) however no releases occurred from LCRA.

Source: LCRA

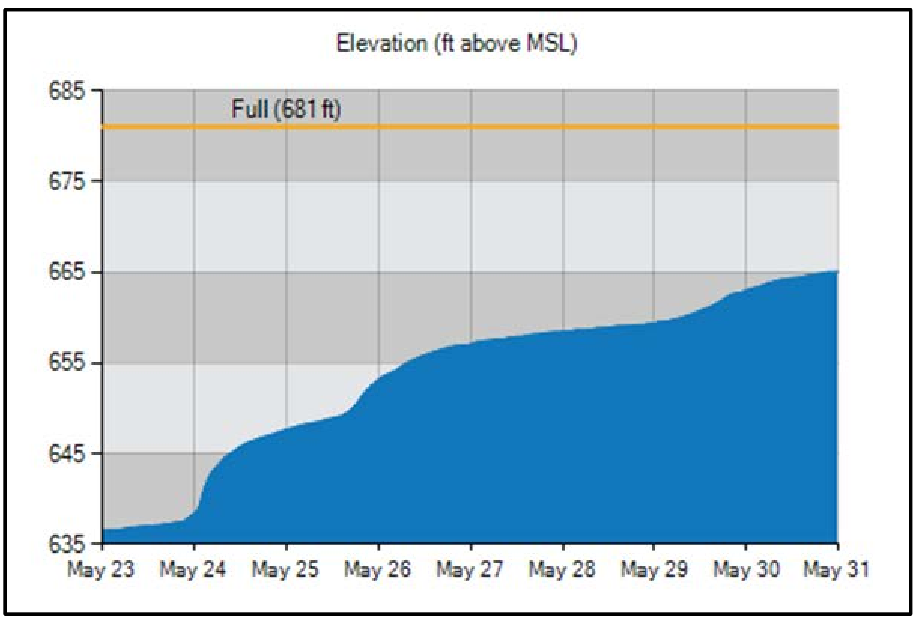


Figure 9-7. Lake Travis Water Surface Elevation During the May 2015 Precipitation Event

9.2.2 Location

TWDB provided a database of dams based on the National Inventory of Dams. Table 9-2 shows the number documented high and significant hazard dams in each participating community. This database lists 9 dams in Matagorda County and participating communities and classifies dams based on the potential hazard to the downstream area resulting from failure or mis-operation of the dam or facilities:

- High-Hazard Potential—Probable loss of life (one or more persons)
- Significant-Hazard Potential—No probable loss of human life but can cause economic loss, environment damage, disruption of lifeline facilities, or impact other concerns; often located in predominantly rural or agricultural areas but could be located in areas with population and significant infrastructure
- Low-Hazard Potential—No probable loss of human life and low economic or environmental losses; losses are principally limited to the owner's property

Based on these classifications, there is one high-hazard dam and one significant-hazard dam in Matagorda County. These dams are listed in Table 9-2. Figure 9-3 shows locations of the dams in the participating communities. Figure 9-8 shows the estimated potential dam inundation extents and population vulnerability. All of the levees in Matagorda County are located in the unincorporated area of the county and around the City of Bay City. There are not any known levees in or near the City of Palacios. All of the levees in Matagorda County are located in the unincorporated area of the county and around the City of Bay City. There are not any known levees in or near the City of Palacios.

TABLE 9-2.
HIGH- AND SIGNIFICANT-HAZARD DAMS IN MATAGORDA COUNTY

Name	Near City[a]	Max Storage (Acre-Feet)	Hazard Class
STP Essential Cooling Pond Dam	Unincorporated Area	687	High
STP Main Cooling Reservoir Dam	Unincorporated Area	250,000	Significant

[a] Data shown in this table is for dams in participating communities only.
Source: Texas Water Development Board

The FEMA MLI data provided a listing of levee locations in Texas. Figure 9-9 shows levee locations in Matagorda County. The levees in the planning area are The Colorado River East & West Levees, and the Matagorda Ring Levee. These levees have been certified as proving protection from the 100-year floodplain.

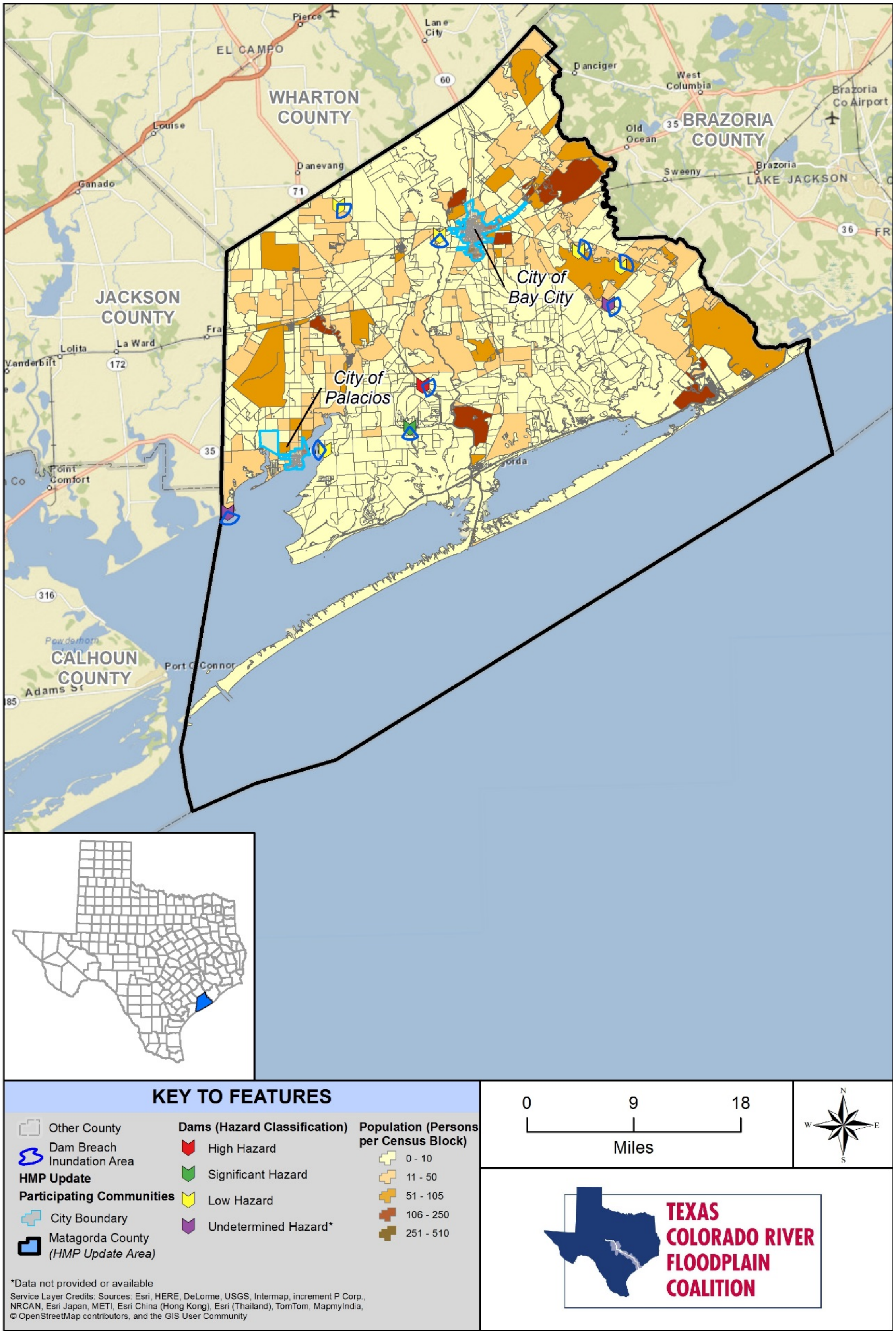


Figure 9-8. Matagorda County and Participating Communities Dam Potential Inundation Areas and Population

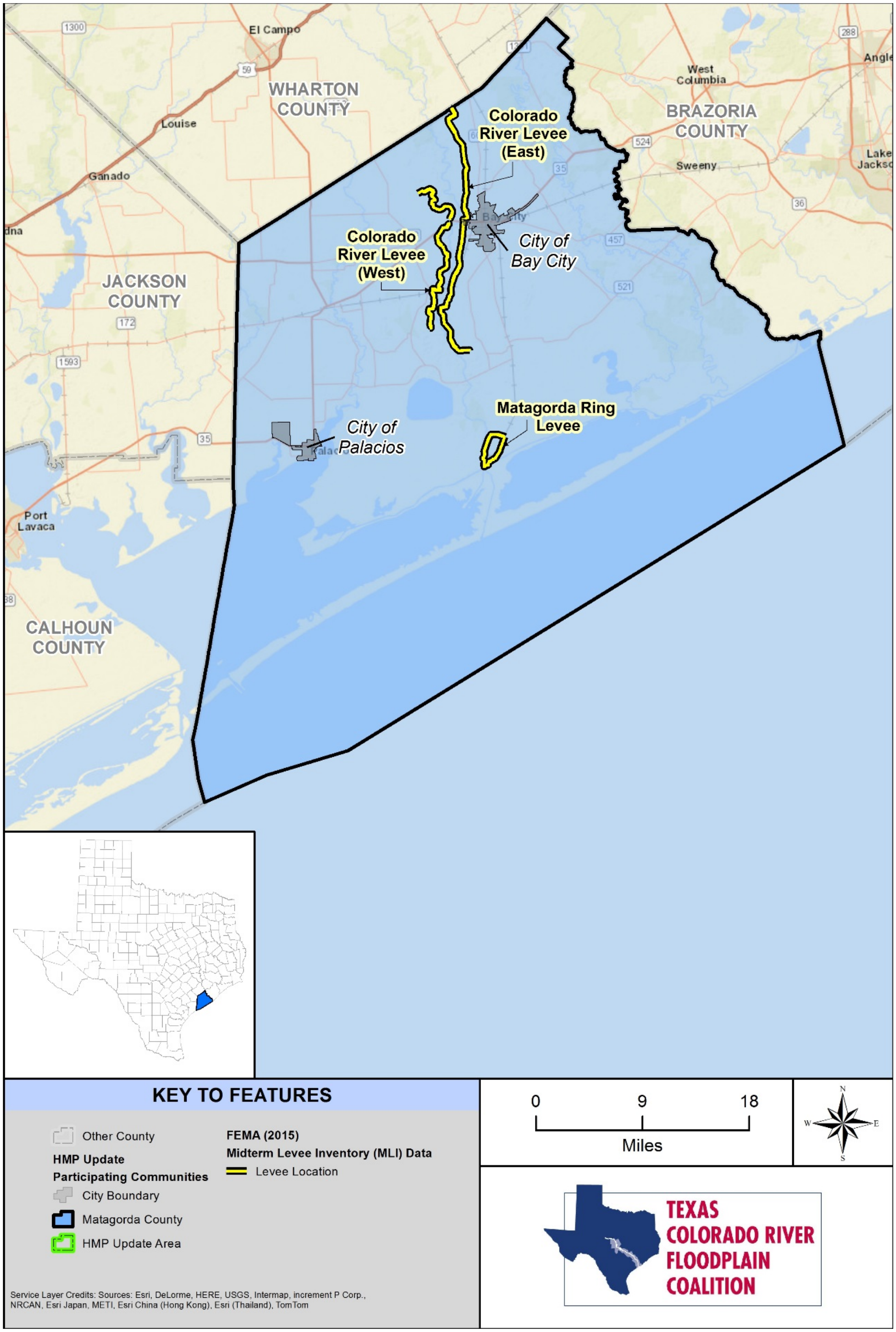


Figure 9-9. Levees in Matagorda County

There are an uncounted number of 'non-jurisdictional' dams on public and private lands in the planning area. These are small dams that normally do not store water but may impound water during heavy precipitation events. Because they are not monitored or maintained, there is potential for them to overtop or fail and cause flooding and property damage during a significant rainfall event. The extent and risk associated with these dams is not known.

The risks of a dam failure is spread throughout the planning area while that of a levee failure is limited to the City of Matagorda, Bay City, and the north central portions of the county. Matagorda County could be impacted by several high-hazard dams that are located outside of the county. If a failure of one of these high-hazard dams occurred, it could result in loss of life. Other high-hazard dams are located outside of the county. Their drainages enter Matagorda County either by direct drainage through parts of the county or by inflow into the Tres Palacio River, Caney Creek, or Colorado River upstream from Wharton County.

Major dams located outside of the planning area that could affect the participating communities, including Carlson Fancies Reservoir located along the Tres Palacios River in Wharton County (~10 miles upstream of Matagorda County). The Tom Miller Dam is located along the Colorado River in Travis County, approximately 225 miles upstream of Matagorda County. Because of these two dam's upstream location, any major dam breach will minimally effect Matagorda County unincorporated area and the City of Bay City. The City of Palacios does not have dams located within or upstream its jurisdiction.

9.2.3 Frequency

There has been no occurrence of dam failure in the past 100 years in the HMP update area. Overall, the probability of a dam failure somewhere in Matagorda County and the participating communities is considered rare or unlikely (event not possible in the next 10 years). This same probability applies to future events (event not possible in the next 10 years).

9.2.4 Severity

USACE and TCEQ developed the classification system shown in Table 9-3 and Table 9-4 for the hazard potential of dam failures. The hazard rating systems are both based only on the potential consequences of a dam failure; neither system takes into account the probability of such failures. Table 9-4 shows the specifications required for a dam to be regulated by TCEQ.

**TABLE 9-3.
USACE HAZARD POTENTIAL CLASSIFICATION**

Hazard Category [a]	Direct Loss of Life [b]	Lifeline Losses [c]	Property Losses [d]	Environmental Losses [e]
Low	None (rural location, no permanent structures for human habitation)	No disruption of services (cosmetic or rapidly repairable damage)	Private agricultural lands, equipment, and isolated buildings	Minimal incremental damage
Significant	Possible (rural location, only transient or day-use facilities)	Disruption of essential facilities and access	Major public and private facilities	Major mitigation required
High	Certain (one or more persons; extensive residential, commercial, or industrial development)	Disruption of essential facilities and access	Extensive public and private facilities	Extensive mitigation cost or impossible to mitigate

a. Categories are assigned to overall projects, not individual structures at a project.

b. Loss of life potential based on inundation mapping of area downstream of the project. Analyses of loss of life potential should take into account the population at risk, time of flood wave travel, and warning time.

c. Indirect threats to life caused by the interruption of lifeline services due to project failure or operational disruption; for example, loss of critical medical facilities or access to them.

d. Damage to project facilities and downstream property and indirect impact due to loss of project services, such as impact due to loss of a dam and navigation pool, or impact due to loss of water or power supply.

e. Environmental impact downstream caused by the incremental flood wave produced by the project failure, beyond what would normally be expected for the magnitude flood event under which the failure occurs.

Source: U.S. Army Corps of Engineers, 1995

TABLE 9-4.
TCEQ HAZARD POTENTIAL CLASSIFICATION

Hazard Category	Human Impact	Economic Impact
Low	No loss of life expected (no lives or permanent habitable structures in the inundation area)	Minimal economic loss (failure may cause damage to occasional farms, agricultural improvements, and minor highways)
Significant	Loss of life is possible (1 to 6 lives or 1 to 2 permanent habitable structures in the inundation area)	Appreciable economic loss (failure may cause damage to isolated homes, secondary highways, minor railroads, or cause interruption of public services)
High	Loss of life is expected (7 or more lives or 3 or more permanent habitable structures in the inundation area)	Excessive economic losses (failure may cause damage to public, agricultural, industrial, or commercial facilities or utilities, and main highways or railroads)

Source: Texas Commission on Environmental Quality, http://www.tceq.texas.gov/field/damsafetyprog.html

9.2.5 Warning Time

Warning time for dam failure varies depending on the cause of the failure. In events of extreme precipitation or massive snowmelt, evacuations can be planned with sufficient time. In the event of a structural failure due to earthquake, there may be no warning time. A dam’s structural type also affects warning time. Earthen dams do not tend to fail completely or instantaneously. Once a breach is initiated, discharging water erodes the breach until either the reservoir water is depleted or the breach resists further erosion. Concrete gravity dams also tend to have a partial breach as one or more monolith sections are forced apart by escaping water. The time of breach formation ranges from a few minutes to a few hours (USACE 1997).

Emergency Action Plans for all high-hazard dams that would affect Matagorda County are on file with TCEQ. Additionally, possible evacuation routes in the event of a failure have been identified.

9.3 SECONDARY HAZARDS

Dam failure can cause severe downstream flooding, depending on the magnitude of the failure. Other potential secondary hazards of dam failure are landslides around the reservoir perimeter, bank erosion on the rivers, and destruction of downstream habitat.

9.4 CLIMATE CHANGE IMPACTS

Dams are designed partly based on assumptions about a river’s flow behavior, expressed as hydrographs. Changes in weather patterns can have significant effects on the hydrograph used for the design of a dam. If the hygrograph changes, it is conceivable that the dam can lose some or all of its designed margin of safety, also known as freeboard. If freeboard is reduced, dam operators may be forced to release increased volumes earlier in a storm cycle in order to maintain the required margins of safety. Such early releases of increased volumes can increase flood potential downstream.

Dams are constructed with safety features known as “spillways.” Spillways are put in place on dams as a safety measure in the event of the reservoir filling too quickly. Spillway overflow events, often referred to as “design failures,” result in increased discharges downstream and increased flooding potential. Although climate change will not increase the probability of catastrophic dam failure, it may increase the probability of design failures.

9.5 EXPOSURE

Dam data records and exposures are described in general in this section. Figure 9-8 shows potential estimated areas of impact by a dam breach and population vulnerability by census block.

Table 9-5 below list the dams in each jurisdiction, as well as dam height, maximum discharge, and storage. A higher discharge and storage area corresponds with a greater extent of damage from a dam failure. High hazard dams (Table 9-2) are susceptible to human, economic, and environmental impact from a failure (Table 9-3 and Table 9-4). This table includes major upstream dams outside of the planning area that may affect the planning area. However, due to their distant location from the planning area, the effects of a dam breach are minimized, and would not significantly contribute to damages.

Overall, dam failure impacts would likely be rare and limited in Matagorda County, largely affecting the downstream areas during a failure event. Roads closed due to dam failure floods could result in serious transportation disruptions due to the limited number of roads in the county. The maximum inundation depth for a dam breach would be in line to the height of the dam, as listed in the table below. The maximum inundation depth for a levee breach would be in line to the height of the levee, as described in the text below. Small dams and levees in the rural parts of unincorporated area of the county do not have the data available to predict breach analysis inundation effects on local road crossing. Existing road closure policies and emergency management practices will be used.

For the City of Bay City, the Colorado River at the Bay City has a bank full stage of 23 feet and a Flood Stage of 44 feet. The Tres Palacios River at Midfield has an action stage of 15’, and a flood stage of 24’. Participating communities use gauges for measurements, monitoring of conditions, road closures, and emergency conditions during events.

For the unincorporated area of the county, the Tres Palacios River at Midfield has an action stage of 15’, and a flood stage of 24’. The Colorado River East Levee has an height of 16-18 feet near the City of Bay City. The main transportation routes on the west side of the city include 7th Street, Avenue F, and Nile Valley Road, with an average estimated elevation of 55 feet, 50 feet and 48 feet respectively. The City of Bay City uses gauges for measurements, monitoring of conditions, road closures, and emergency conditions during events.

TABLE 9-5.
MATAGORDA COUNTY AND PARTICIPATING COMMUNITIES DAM EXTENTS

Dam Name	Community	Dam Height (feet)	Max Discharge (cubic feet/second)	Max Storage (acre feet)
AH JOHNSON RESERVOIR LEVEE	Matagorda County Unincorporated Area	19	NA	562

TABLE 9-5. MATAGORDA COUNTY AND PARTICIPATING COMMUNITIES DAM EXTENTS				
Dam Name	**Community**	**Dam Height (feet)**	**Max Discharge (cubic feet/second)**	**Max Storage (acre feet)**
FAY RANCH DAM	Matagorda County Unincorporated Area	14	NA	84
HERFF CORNELIUS DAM 1	Matagorda County Unincorporated Area	8	NA	80
HUDGINS DAM	Matagorda County Unincorporated Area	12	NA	194
LCRA DAM BAY CITY	Matagorda County Unincorporated Area	13	NA	156
MATAGORDA BAY AQUACULTURE IMPOUNDMENT FACILITY	Matagorda County Unincorporated Area	5	NA	NA
REDFISH UNLIMITED RESERVOIR COMPLEX	Matagorda County Unincorporated Area	NA	NA	NA
STP ESSENTIAL COOLING POND DAM	Matagorda County Unincorporated Area	8	287	687
STP MAIN COOLING RESERVOIR DAM	Matagorda County Unincorporated Area	38	1,200	250,000
TOM MILLER DAM**	City of Austin	85	1,517,697	115,404
CARLSON FRANCIS RESERVOIRS**	Wharton County Unincorporated Area	7	NA	209
*No Dams within participating city limits				
**Dams located upstream of the planning area				

9.5.1 Population

Vulnerable populations are all populations downstream from dam failures or behind levees that are incapable of escaping the area within the allowable time frame. This population includes the elderly and young who may be unable to get themselves out of the inundation area. The vulnerable population also includes those who would not have adequate warning from a television or radio emergency warning system.

9.5.2 Property

According to the Matagorda County HAZUS 2.2 inventory data (updated with 2010 U.S. Census Data and 2014 RS Means Square Foot Costs), there are 16,635 buildings within the census blocks that define the planning area with an asset replaceable value of over $4 million (excluding contents). About 98.5% of these buildings (and 83.4% of the building value) are associated with residential housing. Within the participating communities in the HMP update area, there are an estimated 14,544 buildings (residential, commercial, and other) with a total asset inventory (excluding contents) value of over $3.6 million.. It is estimated that most of the residential structures were built without the influence of a structure building codes. Other types of buildings in this report include agricultural, education, religious, and governmental structures. See hazard loss tables for community-specific total assessed numbers (Table 9-8). Table 9-6 lists the exposed structures and population for the participating communities for dams and levees.

TABLE 9-6.
EXPOSED STRUCTURES AND POPULATION

Jurisdiction	Residential	Commercial	Other *	**Total Structures**	**Total Population**
Unincorporated Area	1,005	1	0	**1,006**	**1,400**
City of Bay City	81	1	0	**82**	**236**
City of Palacios	0	0	0	**0**	**0**
Matagorda County Total	**1,086**	**2**	**0**	**1,088**	**1,636**

*Other includes industrial, agricultural, religious, governmental, and educational classifications.

9.5.3 Critical Facilities and Infrastructure

Any critical facilities or infrastructure that are located within the dam inundation area are exposed to risk from the hazard. Dam or levee failure can result in serious structural damage to critical facilities and infrastructure, in particular roads, bridges, underground utilities, and pipelines.

9.5.4 Environment

Reservoirs held behind dams affect many ecological aspects of a river. River topography and dynamics depend on a wide range of flows, but rivers below dams often experience long periods of very stable flow conditions or saw-tooth flow patterns caused by releases followed by no releases. Water releases from dams usually contain very little suspended sediment; this can lead to scouring of river beds and banks.

The environment would be vulnerable to a number of risks in the event of dam failure. The inundation could introduce many foreign elements into local waterways. This could result in destruction of downstream habitat and could have detrimental effects on many species of animals.

9.6 VULNERABILITY

Dam failure inundation mapping for the planning area was not available to allow HAZUS loss estimations to be modeled. Due to this data deficiency annualized losses were estimated using GIS-based analysis, historical data analysis, and statistical risk assessment methodology. Event frequency, severity indicators, expert opinions, and historical local knowledge of the region were used for this assessment. Overall, dam failure impacts would likely be rare and limited in Matagorda County and the participating communities, with 10 to 25% of the planning area affected during a failure event. While parts of the county could be effected, the likelihood of this occurring (based on historical events, and local knowledge) is minimal. .Roads closed due to dam failure floods could result in serious transportation disruptions due to the limited number of roads in the HMP update area. After the Consultant team presented the dam and levee information profile and analyses (including general background, historical occurrences, extent, exposure and vulnerability), to the Committee, the risk analysis was discussed among the participating members.

Through these discussions and analysis, it was decided that while some communities have property and population that may be effected by an event due to the local knowledge, lack of previous events, no high hazard dams in the immediate or upstream area, and the overall probability of a minimal occurrence, the City of Palacios classified their respective jurisdictions as ‘No Exposure’.

9.6.1 Population

The risk of injury or fatalities as a result of this hazard is limited, but possible. The most vulnerable demographics will be the economically disadvantaged population areas, children under 16 year, and the elderly. See Table 9-7 for vulnerable populations per participating community in the inundation area.

**TABLE 9-7.
VULNERABLE POPULATION**

Jurisdiction	Youth Population (< 16)	% of Total Population	Elderly Population (> 65)	% of Total Population	Economically Disadvantage (Income < $20,000)	% of Total Population
Unincorporated Area	301	21.5	241	17.21	86	6.14
City of Bay City	87	36.86	27	11.44	10	4.24
City of Palacios	0	0.00	0	0.00	0	0.00
Matagorda County Total	388	23.71	268	16.38	96	5.87

9.6.2 Property

All downstream properties in the inundation area are equally at risk from a dam breach, but properties in poor condition or in particularly vulnerable locations (economically disadvantaged communities and areas nearest tom the dam breach) may risk the most damage. All properties protected by a levee in the planning area are equally at risk from a levee breach, but properties in poor condition or in particularly vulnerable locations (economically disadvantaged communities and areas nearest the levee breach) may risk the most damage.

Loss estimations for dam and levee hazards are not based on HAZUS modeled damage functions, because detailed dam and levee inundation mapping from hydrology and hydraulic modeling was unavailable. Annualized losses were estimated using GIS-based analysis, historical data analysis, and statistical risk assessment methodology. Event frequency, severity indicators, expert opinions, and historical local knowledge of the region were used for this assessment. Table 9-8 lists the property loss estimates for each participating community. Annualized losses of ‘negligible’ are less than $50 annually. Negligible loss hazards are still included despite minimal annualized losses because of the potential for a high value damaging event.

TABLE 9-8.
LOSS ESTIMATES FOR DAM BREACH

Jurisdiction	Exposed Value ($)	Annualized Loss ($)	Annualized Loss Percentage
Unincorporated Area	122,714,000	Negligible	<0.01
City of Bay City	9,050,000	Negligible	0
City of Palacios	0	0	0
Matagorda County Total	**131,764,000**	**Negligible**	**<0.01**

Vulnerability Narrative

All participating communities are equally at risk to a dam and levee breach. Communities with dams and levee inside as well as upstream of their jurisdictions are the most vulnerable. Table 9-7 lists the vulnerable population per community. Table 9-8 lists the estimated annualized losses in dollars for each participating community.

- **City of Bay City -** The City of Bay City has 0 dams within its city limits. However, there are known dams upstream of the City, and there may be additional unknown private dams in the area. The City of Bay City has 1 levee effecting its jurisdiction. The Colorado River East Levee runs along the part of the west side of the City of Bay City. A dam or levee breach at any of these could impact the entire community, especially the properties along the dammed waterbody. If a levee breach at the Colorado River East Levee occurred those nears the breach would be most vulnerable. The west side of the city is more vulnerable as it is located closer to the levee. A breach could cause unexpected flooding downstream, resulting in loss of life and great property damage. A devastating effect on water supply could be expected as well. People could be displaced from their homes as a result of unexpected flooding. Critical facilities are at an increased risk as damages causing operations to halt would cause harm to the entire community. This vulnerability increases in those that do not have an alternate source of power supply, such as a generator.
- **City of Palacios -** The City of Palacios does not have any documented dams within the city limits. With no known dams upstream of the City, no known previous events, and local knowledge, the City of Palacios is classified as 'No Exposure'.
- **Matagorda County (Unincorporated Area) -** There are 9 dams in the unincorporated parts of Matagorda County; including STP Essential Cooling Pond Dam, a high hazard dam 10 miles east of Palacios, and STP Main Cooling Reservoir Dam, a significant hazard dam located just to its south. Multiple dams upstream (both within Matagorda County and in further upstream counties) could impact the entire area. There are three levees in the unincorporated area of the county; the Colorado East & West Levees and the Matagorda Ring Levee. If a major thoroughfare such as the Union Pacific Railroad over the Colorado River, TX 71 or TX 35 were eroded and caved in as a result of flooding, many residents and businesses would be affected and emergency response times would increase. The Union Pacific RR has an approximate average elevation of 14.5' and 14' (East and West side of the Colorado River) and the average levee height is approximately 13.5' and 12.5' (East & West of the Colorado River). Dam and levee failures could impact critical facilities and infrastructure further increasing risk to residents. Facilities that are not equipped with an alternate power source, such as a generator, increase this vulnerability. Residents unable to

obtain warnings are at an increased risk as they will be unable to effectively prepare or respond in a dam failure.

Community Perception of Vulnerability

See front page of current chapter for a summary of hazard rankings for Matagorda County and participating communities in this plan update. Chapter 19 gives a detailed description of this rankings and Chapter 20 addresses mitigations actions for this hazard vulnerability.

9.7 FUTURE TRENDS IN DEVELOPMENT

Land use in the planning area will be directed by general plans. The safety elements of the general plans establish standards and plans for the protection of the community from hazards. Dam or levee failure is not typically addressed as a standalone hazard in the safety elements, but flooding is. The planning partners have established plans and policies regarding sound land use in identified flood hazard areas. Most of the areas vulnerable to the more severe impacts from dam failure are likely to intersect the mapped flood hazard areas. Flood-related policies in the general plans will help to reduce the risk associated with the dam failure hazard for all future development in the planning area.

9.8 SCENARIO

An earthquake in the region (although rare) could lead to liquefaction of soils around a dam or levee. This could occur without warning during any time of the day. A human-caused failure such as a terrorist attack also could trigger a catastrophic failure of a dam or levee that impacts the planning area. While the probability of dam or levee failure is very low, the probability of flooding associated with changes to dam operational parameters in response to climate change is higher. Dam and levee designs and operations are developed based on hydrographs with historical record. If these hydrographs experience significant changes over time due to the impacts of climate change, the design and operations may no longer be valid for the changed condition. This could have significant impacts on dams and levees that provide flood control. Specified release rates and impound thresholds may have to be changed. This would result in increased discharges downstream of these facilities, thus increasing the probability and severity of flooding.

9.9 ISSUES

The most significant issue associated with dam and levee failure involves the properties and populations in the inundation zones. Flooding as a result of a dam failure would significantly impact these areas. There is often limited warning time for dam failure. These events are frequently associated with other natural hazard events such as earthquakes, landslides, or severe weather, which limits their predictability and compounds the hazard. Important issues associated with dam failure hazards include the following:

- Federally regulated dams have an adequate level of oversight and sophistication in the development of Emergency Action Plans for public notification in the unlikely event of failure. However, the protocol for notification of downstream citizens of imminent failure needs to be tied to local emergency response planning.
- Mapping for federally regulated dams is already required and available; however, mapping for non-federally regulated dams that estimates inundation depths is needed to better assess the risk associated with dam failure from these facilities.
- Most dam failure mapping required at federal levels requires determination of the PMF. While the PMF represents a worst-case scenario, it is generally the event with the lowest probability of occurrence. For non-federally regulated dams, mapping of dam failure scenarios that are less extreme than the PMF but have a higher probability of occurrence can be valuable to emergency managers and community officials downstream of these facilities. This type of mapping can illustrate areas potentially impacted by more frequent events to support emergency response and preparedness.

- The concept of residual risk associated with structural flood control projects should be considered in the design of capital projects and the application of land use regulations.
- Security concerns should be addressed and the need to inform the public of the risk associated with dam failure is a challenge for public officials.
- Maintain accreditation of levees in the county.

CHAPTER 10.
DROUGHT AND EXTREME HEAT

DROUGHT AND EXTREME HEAT RANKING		
Jurisdiction	**Drought**	**Extreme Heat**
Matagorda County	Medium	Medium
City of Bay City	Low	Medium
City of Palacios	Low	Low

DEFINITIONS

Drought — The cumulative impacts of several dry years on water users. It can include deficiencies in surface and subsurface water supplies and generally impacts health, well-being, and quality of life.

Extreme Heat — Summertime weather that is substantially hotter or more humid than average for a location at that time of year.

10.1 GENERAL BACKGROUND

10.1.1 Drought

Drought is a normal phase in the climatic cycle of most geographical areas. According to the National Drought Mitigation Center, drought originates from a deficiency of precipitation over an extended period, usually a season or more. This results in a water shortage for some activity, group, or environmental sector. Drought is the result of a significant decrease in water supply relative to what is "normal" in a given location. Unlike most disasters, droughts normally occur slowly but last a long time. There are four generally accepted operational definitions of drought (Wilhite and Glantz 1985):

- **Meteorological drought** is an expression of precipitation's departure from normal over some period of time. Meteorological measurements are the first indicators of drought. Definitions are usually region-specific, and based on an understanding of regional climatology. A definition of drought developed in one part of the world may not apply to another, given the wide range of meteorological definitions.
- **Agricultural drought** occurs when there is not enough soil moisture to meet the needs of a particular crop at a particular time. Agricultural drought happens after meteorological drought but before hydrological drought. Agriculture is usually the first economic sector to be affected by drought.
- **Hydrological drought** refers to deficiencies in surface and subsurface water supplies. It is measured as stream flow and as lake, reservoir, and groundwater levels. There is a time lag between lack of rain and the volume of water in streams, rivers, lakes, and reservoirs, so hydrological measurements are not the earliest indicators of drought. After precipitation has been reduced or deficient over an extended period of time, this shortage is reflected in declining surface and subsurface water levels. Water supply is controlled not only by precipitation, but also by other factors, including evaporation (which is increased by higher than normal heat and winds), transpiration (the use of water by plants), and human use.
- **Socioeconomic drought** occurs when a physical water shortage starts to affect people, individually and collectively. Most socioeconomic definitions of drought associate it with the supply and demand of an economic good.

Defining when drought begins is a function of the impacts of drought on water users, and includes consideration of the supplies available to local water users as well as the stored water they may have available in surface reservoirs or groundwater basins. Different local water agencies have different criteria for defining drought conditions in their jurisdictions. Some agencies issue drought watch or drought warning announcements to their customers. Determinations of regional or statewide drought conditions are usually based on a combination of hydrologic and water supply factors.

10.1.2 Extreme Heat

Excessive heat events are defined by the U.S. Environmental Protection Agency (EPA) as “summertime weather that is substantially hotter or more humid than average for a location at that time of year” (EPA 2006). Criteria that define an excessive heat event may differ among jurisdictions and in the same jurisdiction depending on the time of year. Excessive heat events are often a result of more than just ambient air temperature. Heat index tables (see Figure 10-1) are commonly used to provide information about how hot it feels, which is based on the interactions between several meteorological conditions. Since heat index values were devised for shady, light wind conditions, exposure to full sunshine can increase heat index values by up to 15 degrees Fahrenheit (°F). Also, strong winds, particularly with very hot, dry air, can be extremely hazardous.

Source: NOAA National Weather Service

NOAA's National Weather Service

Heat Index

Temperature (°F)

Relative Humidity (%)	80	82	84	86	88	90	92	94	96	98	100	102	104	106	108	110
40	80	81	83	85	88	91	94	97	101	105	109	114	119	124	130	136
45	80	82	84	87	89	93	96	100	104	109	114	119	124	130	137	
50	81	83	85	88	91	95	99	103	108	113	118	124	131	137		
55	81	84	86	89	93	97	101	106	112	117	124	130	137			
60	82	84	88	91	95	100	105	110	116	123	129	137				
65	82	85	89	93	98	103	108	114	121	128	136					
70	83	86	90	95	100	105	112	119	126	134						
75	84	88	92	97	103	109	116	124	132							
80	84	89	94	100	106	113	121	129								
85	85	90	96	102	110	117	126	135								
90	86	91	98	105	113	122	131									
95	86	93	100	108	117	127										
100	87	95	103	112	121	132										

Likelihood of Heat Disorders with Prolonged Exposure or Strenuous Activity

Caution Extreme Caution Danger Extreme Danger

Classification	Heat Index	Effect on the body
Caution	80°F - 90°F	Fatigue possible with prolonged exposure and/or physical activity
Extreme Caution	90°F - 103°F	Heat stroke, heat cramps, or heat exhaustion possible with prolonged exposure and/or physical activity
Danger	103°F - 124°F	Heat cramps or heat exhaustion likely, and heat stroke possible with prolonged exposure and/or physical activity
Extreme Danger	125°F or higher	Heat stroke highly likely

Figure 10-1. Heat Index Table

10.2 HAZARD PROFILE

Droughts originate from a deficiency of precipitation resulting from an unusual weather pattern. If the weather pattern lasts a short time (a few weeks or a couple months), the drought is considered short-term. If the weather pattern becomes entrenched and the precipitation deficits last for several months or years, the drought is considered to be long-term. It is possible for a region to experience a long-term circulation pattern that produces drought, and to have short-term changes in this long-term pattern that result in short-term wet spells. Likewise, it is possible for a long-term wet circulation pattern to be interrupted by short-term weather spells that result in short-term drought.

Precipitation into the area lakes and dams is the main source of Texas' water supply. Precipitation is the only naturally reoccurring/renewable water supply for Matagorda County. Annual precipitation in the populated areas of the planning area is approximately 46 to 48 inches per year. There are various streams and tributaries contributing to water supply in the area. This supply is stored in four forms throughout the state: streamflow, reservoir water, soil moisture, and groundwater.

The summer months in Texas are frequently affected by severe heat hazards. Persistent domes of high pressure establish themselves, which set up hot and dry conditions. This high pressure prevents other weather features such as cool fronts or rain events from moving into the area and providing necessary relief. Daily high temperatures range into the upper 90s and low 100s. When combined with moderate to high relative humidity levels, the heat index moves into dangerous levels, and a heat index of 105°F is considered the level where many people begin to experience extreme discomfort or physical distress.

10.2.1 Past Events

Drought

Texas officially experienced the driest nine-month period in the state's history between October 2010 and June 2011 according to the National Weather Service (NWS) in Fort Worth. This beat the previous record of June 1917 to February 1918. The substantial dry period has led to widespread extreme to exceptional drought conditions throughout the state. The 2010-2011 drought neared record levels, ranking as the third worst in Texas history. The worst of the 2010-2011 drought was found in central and western Texas where precipitation deficits during the 10 months exceeded 20 inches in some areas.

Based on previous occurrences, drought conditions in South Texas counties, such as Matagorda County(and participating communities), are usually limited, typically with periods of dryness and moderate drought. These drought conditions are shown as D0 and D1 drought intensity in Figure 10-2 and Figure 10-3. These figures show the severity of drought conditions in Texas in spring 2012 and spring 2015. As of March 2015, portions of Matagorda County(and participating communities) were still experiencing D0 and D1 drought conditions. However, the drought conditions changed in May 2015 with heavy spring rains falling over the Texas region. Matagorda County(and participating communities), like much of Texas, saw its wettest May on record. Texas received a statewide average of 8.81 inches of rain in May 2015, exceeding the previous record wet month of June 2004 during which a statewide average of 6.66 inches of rain fell, according to the Office of the State Climatologist at Texas A&M University. The Texas region received more rain in the first 5 months of 2015 than in all of 2011.

Figure 10-4 shows the drought conditions as of June 2015. For the first time in 3 years, none of the state falls within the U.S. Drought Monitor's most severe classification. Almost all of Matagorda County (and participating communities) are now no longer experiencing drought and area reservoirs are 100% full or experienced large capacity gains during the spring and early summer of 2015.

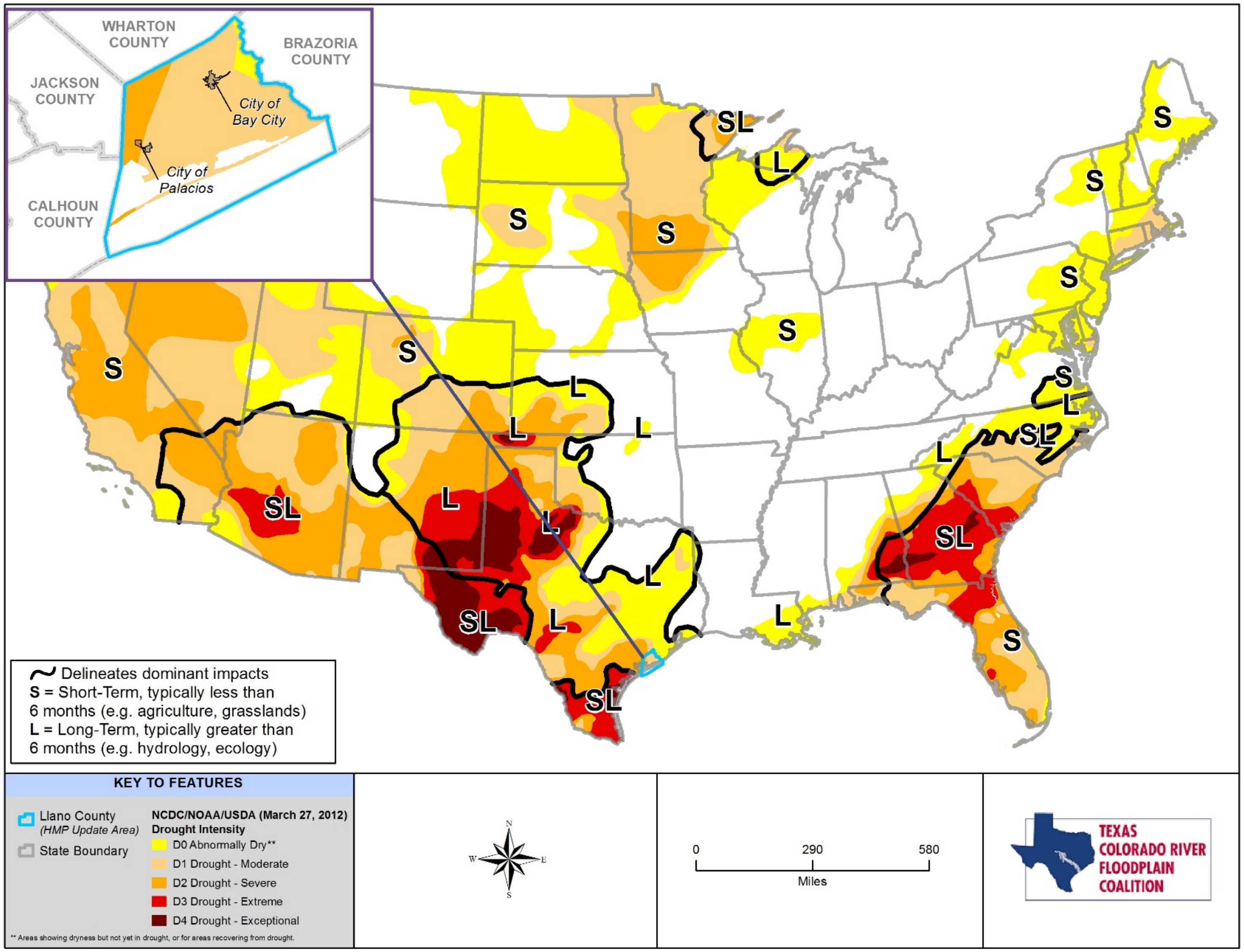


Figure 10-2. U.S. Drought Monitor, March 27, 2012

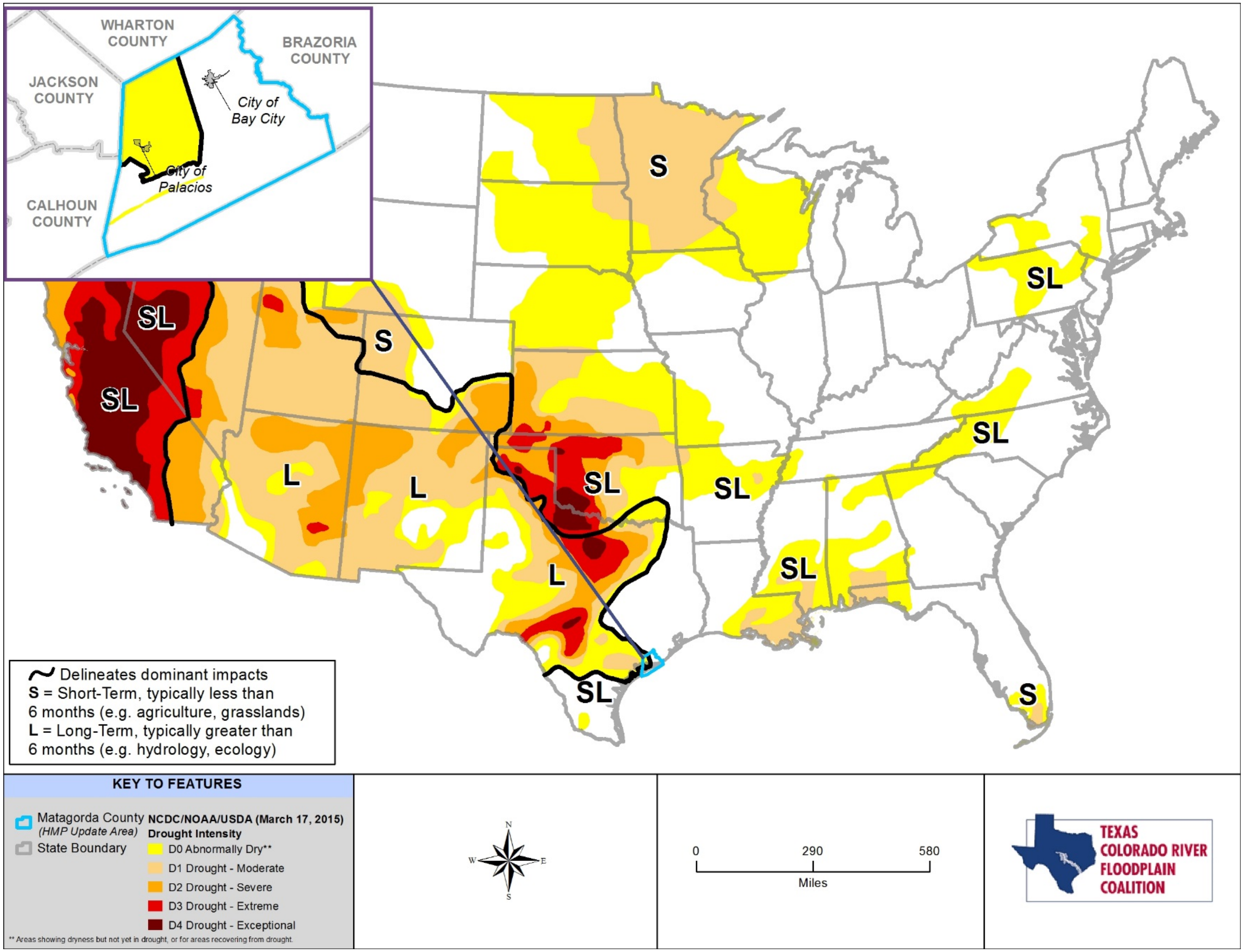


Figure 10-3. U.S. Drought Monitor, March 17, 2015

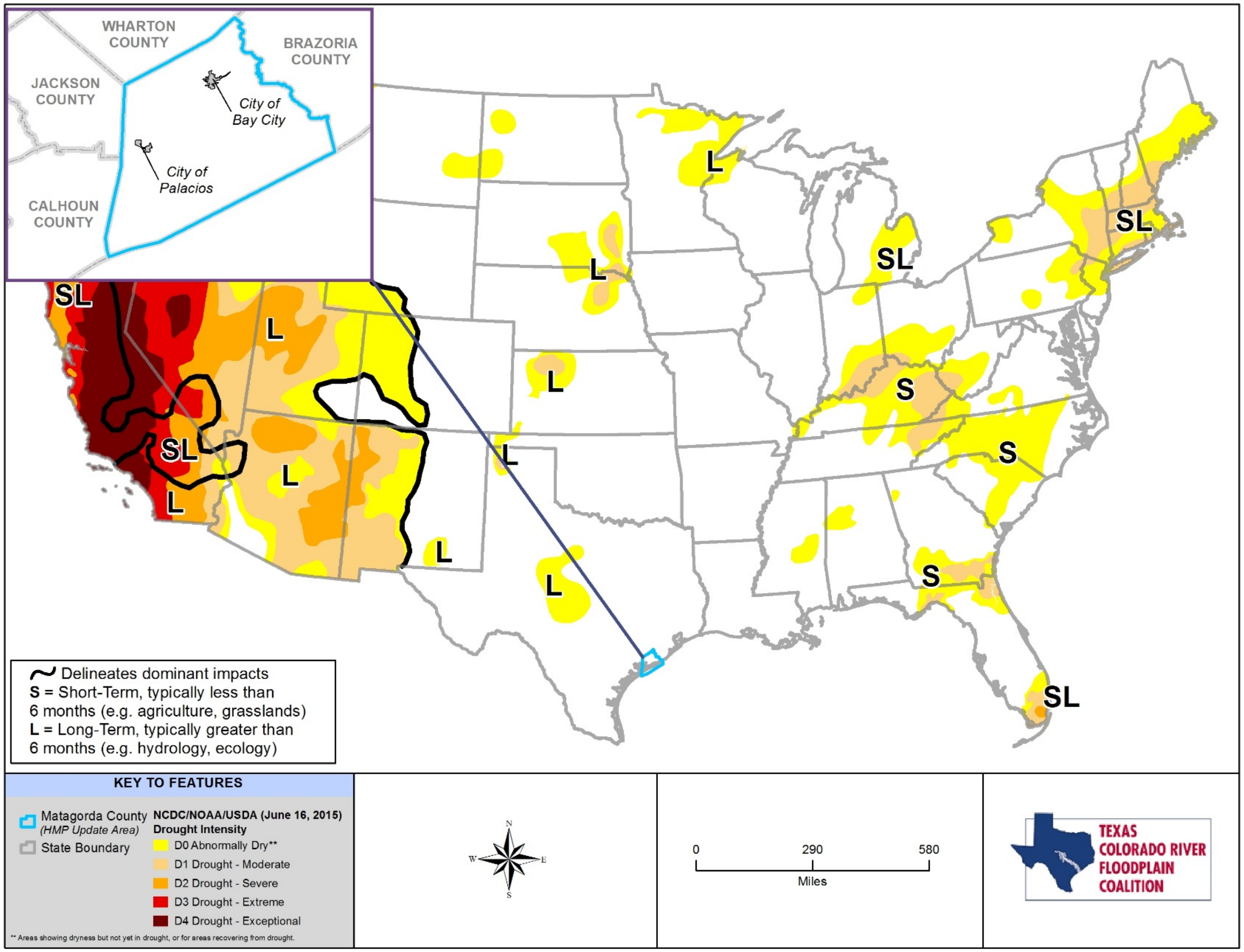


Figure 10-4. U.S. Drought Monitor, June 16, 2015

The National Drought Mitigation Center developed the Drought Impact Reporter in response to the need for a national drought impact database for the United States. Information comes from a variety of sources: on-line drought-related news stories and scientific publications, members of the public who visit the website and submit a drought-related impact for their region, members of the media and members of relevant government agencies. The database is being populated beginning with the most recent impacts and working backward in time. Since drought impacts affect large areas across multiple counties, the impacts affects Matagorda County and participating communities equally.

The Drought Impact Reporter

The Drought Impact Reporter contains information on impacts from droughts that affected Matagorda County and participating communities between January 2005 and April 2015. Most of the impacts were classified as "agriculture" (267). Other impacts include "society and public health" (76), "fire" (121), "tourism and recreation" (8), "water supply and quality" (89), "energy" (11), "business and industry" (34), "plants and wildlife" (81), and "relief, response, and restrictions" (146). These categories are described as follows:

- **Agriculture -** Drought effects associated with agriculture, farming, aquaculture, horticulture, forestry, or ranching. Examples of drought-induced agricultural impacts include damage to crop quality; income loss for farmers due to reduced crop yields; reduced productivity of cropland; insect infestation; plant disease; increased irrigation costs; cost of new or supplemental water resource development (wells, dams, pipelines) for agriculture; reduced productivity of rangeland; forced reduction of foundation stock; closure/limitation of public lands to grazing; high cost or unavailability of water for livestock, Christmas tree farms, forestry, raising domesticated horses, bees, fish, shellfish, or horticulture.
- **Society and Public Health -** Drought effects associated with human, public, and social health include health-related problems related to reduced water quantity or quality, such as increased concentration of contaminants; loss of human life (e.g., from heat stress, suicide); increased respiratory ailments; increased disease caused by wildlife concentrations; increased human disease caused by changes in insect carrier populations; population migration (rural to urban areas, migrants into the United States); loss of aesthetic values; change in daily activities (non-recreational, like putting a bucket in the shower to catch water); elevated stress levels; meetings to discuss drought; communities creating drought plans; lawmakers altering penalties for violation of water restrictions; demand for higher water rates; cultural/historical discoveries from low water levels; cancellation of fundraising events; cancellation/alteration of festivals or holiday traditions; stockpiling water; public service announcements and drought information websites; protests; and conflicts within the community due to competition for water.
- **Fire -** Drought often contributes to forest, range, rural, or urban fires, fire danger, and burning restrictions. Specific impacts include enacting or increasing burning restrictions; fireworks bans; increased fire risk; occurrence of fire (number of acres burned, number of wildfires compared to average, people displaced, etc.); state of emergency during periods of high fire danger; closure of roads or land due to fire occurrence or risk; and expenses to state and county governments of paying firefighters overtime and paying equipment (helicopter) costs.
- **Tourism and Recreation** - Drought effects associated with recreational activities and tourism include closure of state hiking trails and hunting areas due to fire danger; water access or navigation problems for recreation; bans on recreational activities; reduced license, permit, or ticket sales (e.g., hunting, fishing, ski lifts, etc.); losses related to curtailed activities (e.g., bird watching, hunting and fishing, boating, etc.); reduced park visitation; and cancellation or postponement of sporting events.
- **Water Supply and Quality -** Drought effects associated with water supply and water quality include dry wells; voluntary and mandatory water restrictions; changes in water rates; increasing

water restrictions; increases in requests for new well permits; changes in water use due to water restrictions; greater water demand; decreases in water allocation or allotments; installation or alteration of water pumps or water intakes; changes to allowable water contaminants; water line damage or repairs due to drought stress; drinking water turbidity; change in water color or odor; declaration of drought watches or warnings; and mitigation activities.

- **Energy -** Drought effects on power production, rates and revenue include production changes for both hydropower and non-hydropower providers; changes in electricity rates; revenue shortfalls and/or windfall profits; and purchase of electricity when hydropower generation is down.
- **Business and Industry -** Drought effects on non-agriculture and non-tourism businesses, such as lawn care; recreational vehicles or gear dealers; and plant nurseries. Typical impacts include reduction or loss of demand for goods or services; reduction in employment; variation in number of calls for service; late opening or early closure for the season; bankruptcy; permanent store closure; and other economic impacts.
- **Plants and Wildlife -** Drought effects associated with unmanaged plants and wildlife, both aquatic and terrestrial, include loss of biodiversity of plants or wildlife; loss of trees from rural or urban landscapes, shelterbelts, or wooded conservation areas; reduction and degradation of fish and wildlife habitat; lack of feed and drinking water; greater mortality due to increased contact with agricultural producers as animals seek food from farms and producers are less tolerant of the intrusion; disease; increased vulnerability to predation (from species concentrated near water); migration and concentration (loss of wildlife in some areas and too much wildlife in others); increased stress on endangered species; salinity levels affecting wildlife; wildlife encroaching into urban areas; and loss of wetlands.
- **Relief, Response, and Restrictions -** Drought effects associated with disaster declarations, aid programs, requests for disaster declaration or aid, water restrictions, or fire restrictions. Examples include disaster declarations; aid programs; USDA Secretarial disaster declarations; Small Business Association disaster declarations; government relief and response programs; state-level water shortage or water emergency declarations; county-level declarations; a declared "state of emergency;" requests for declarations or aid; non-profit organization-based relief; water restrictions; fire restrictions; NWS Red Flag warnings; and declaration of drought watches or warnings.

Extreme Heat

According a 2014 EPA study, a total of nearly 8,000 Americans suffered heat-related deaths between 1979 and 2010. The 2012 Natural Resource Defense Council study of 40 major U.S. cities showed that the historic average mortality per summer was 1,332 between 1975 and 2004. This reveals that annually more people in the U.S. die from severe summer heat than from hurricanes, lightning, tornadoes, floods, and earthquakes combined.

According to the National Climatic Data Center, a strong heat wave affected Texas in the summers of 1999, 2000, and 2011. During these heat waves, multiple counties suffered in terms of injuries and deaths, mostly to the elderly. During these periods, some Texas counties also experienced extreme heat events. Table 10-1 contains temperature summaries related to extreme heat for the Matagorda weather station.

Table 10-1 contains temperature summaries related to extreme heat for the Matagorda weather station. These temperatures are experienced throughout the entire planning area (City of Bay City, City of Palacios, and Matagorda County Unincorporated Areas).

TABLE 10-1.
TEMPERATURE DATA FROM MATAGORDA WEATHER STATION

Statistic	Years	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
High Annual Maximum	1928-2014	82	91	88	95	98	101	102	103	104	97	89	89
Low Annual Maximum	1928-2014	70	70	74	78	82	87	89	90	89	85	79	72
Average Annual Maximum	1928-2014	76.2	77.6	80.7	85.2	88.9	92.7	94.7	95.8	94.1	89.5	83.7	78.3
Average Days Annually with a Maximum Above 90	1943-2012	0	0	0	0.1	1.0	9.5	20.5	23.9	12.8	1.6	0	0

Source: www.wrcc.dri.edu
Temperatures are in degrees Fahrenheit

10.2.2 Location

Drought

The National Oceanic and Atmospheric Administration (NOAA) has developed several indices to measure drought impacts and severity and to map their extent and locations:

- The Palmer Crop Moisture Index measures short-term drought on a weekly scale and is used to quantify drought's impacts on agriculture during the growing season. Figure 10-5 shows this index for the week ending in March 28, 2015.
- The Palmer Z Index measures short-term drought on a monthly scale. Figure 10-6 shows this index for March 2015.
- The Palmer Drought Index (PDI) measures the duration and intensity of long-term drought-inducing circulation patterns. Long-term drought is cumulative, so the intensity of drought during a given month is dependent on the current weather patterns plus the cumulative patterns of previous months. Weather patterns can change quickly from a long-term drought pattern to a long-term wet pattern, and the PDI can respond fairly rapidly. Figure 10-7 and Figure 10-8 show this index for March 2015 and May 2015 to show the change in PDI after the May 2015 rain.
- The hydrological impacts of drought (e.g., reservoir levels, groundwater levels, etc.) take longer to develop and it takes longer to recover from them. The Palmer Hydrological Drought Index (PHDI), another long-term index, was developed to quantify hydrological effects. The PHDI responds more slowly to changing conditions than the PDI. Figure 10-9 shows this index for March 2015.
- While the Palmer indices consider precipitation, evapotranspiration and runoff, the Standardized Precipitation Index (SPI) considers only precipitation. In the SPI, an index of zero indicates the median precipitation amount; the index is negative for drought and positive for wet conditions. The SPI is computed for time scales ranging from 1 month to 24 months. Figure 10-10 shows the 24-month SPI map through the end of February 2015.

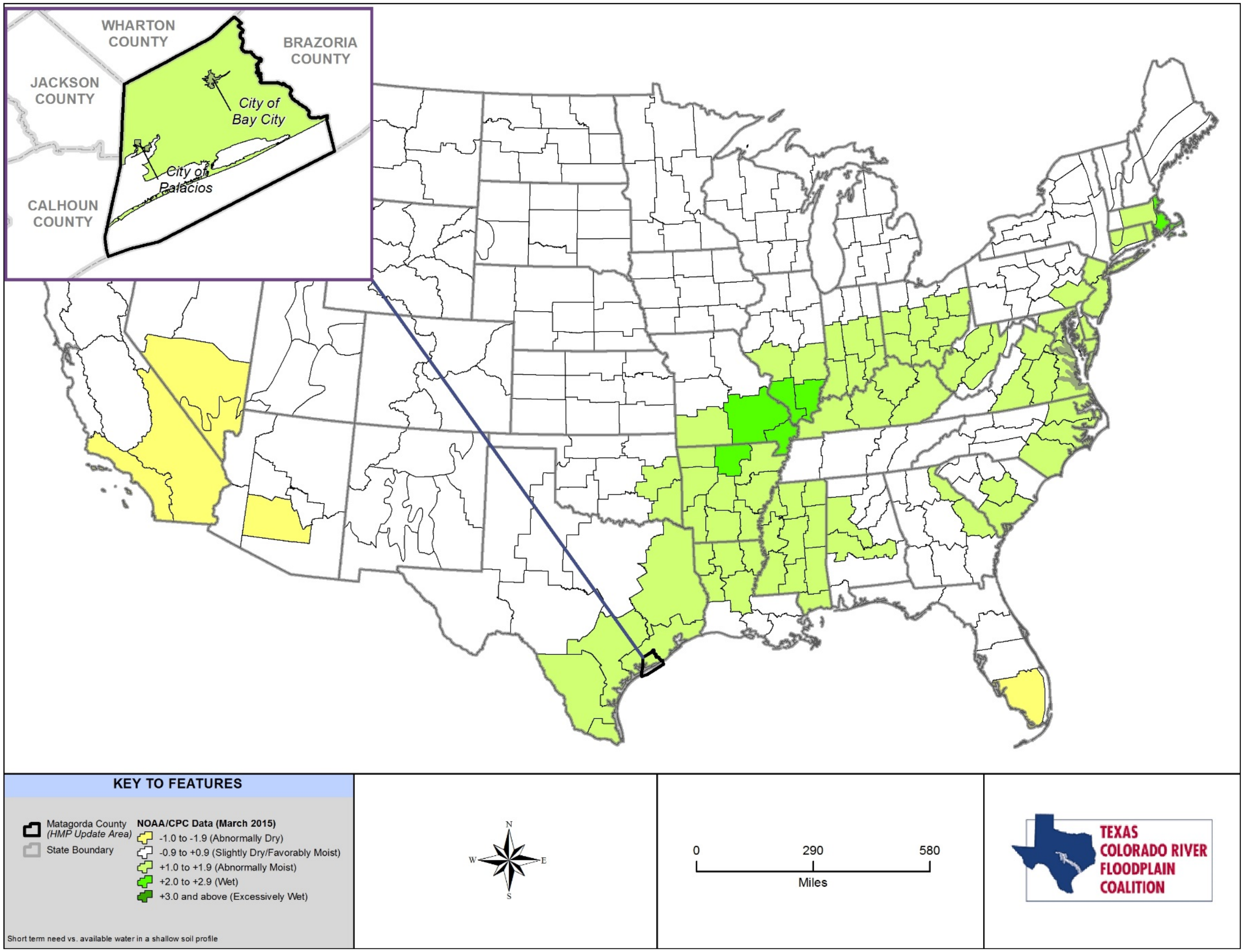


Figure 10-5. Crop Moisture Index (Week Ending March 28, 2015)

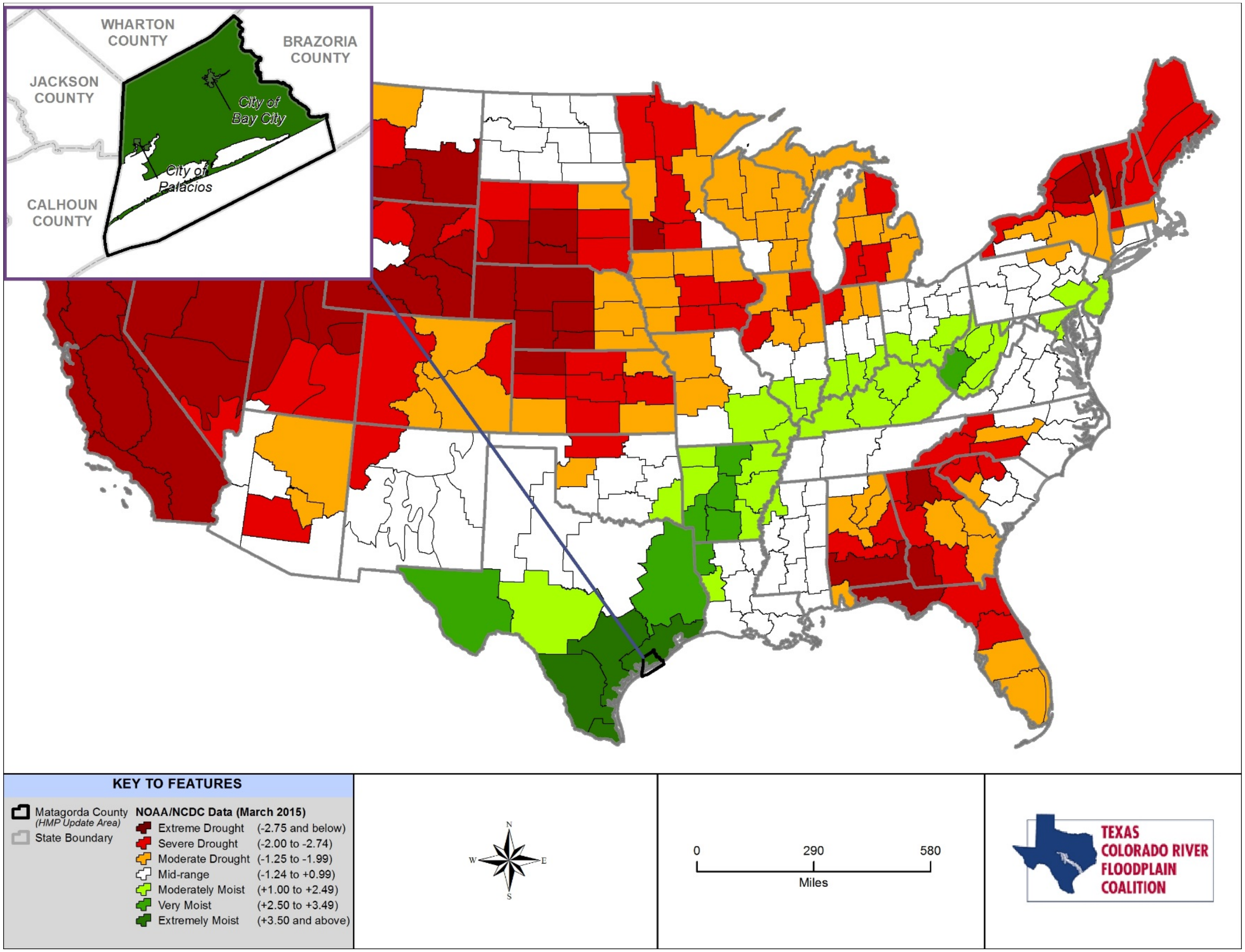


Figure 10-6. Palmer Z Index Short-Term Drought Conditions (March 2015)

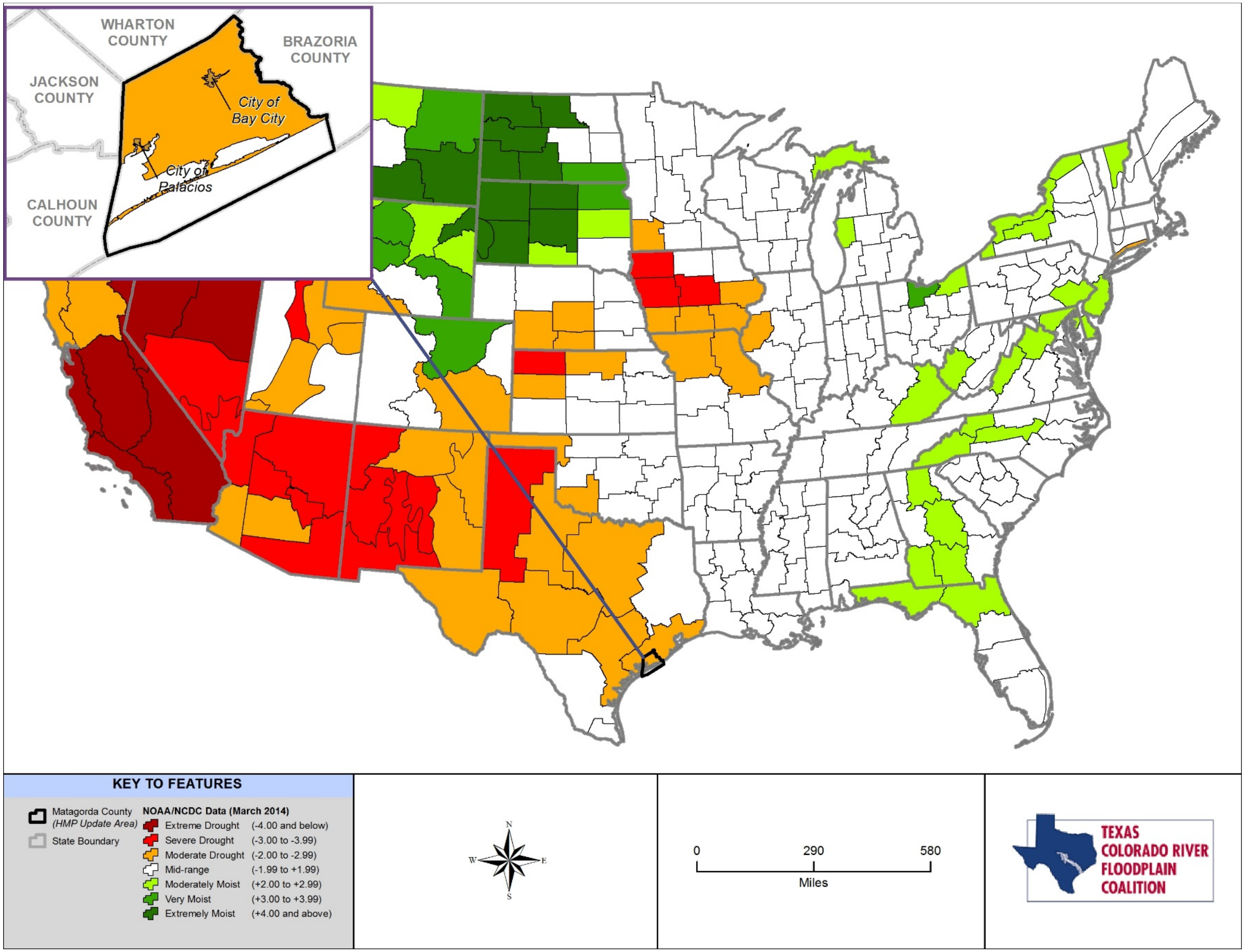


Figure 10-7. Palmer Drought Severity Index (March 2015)

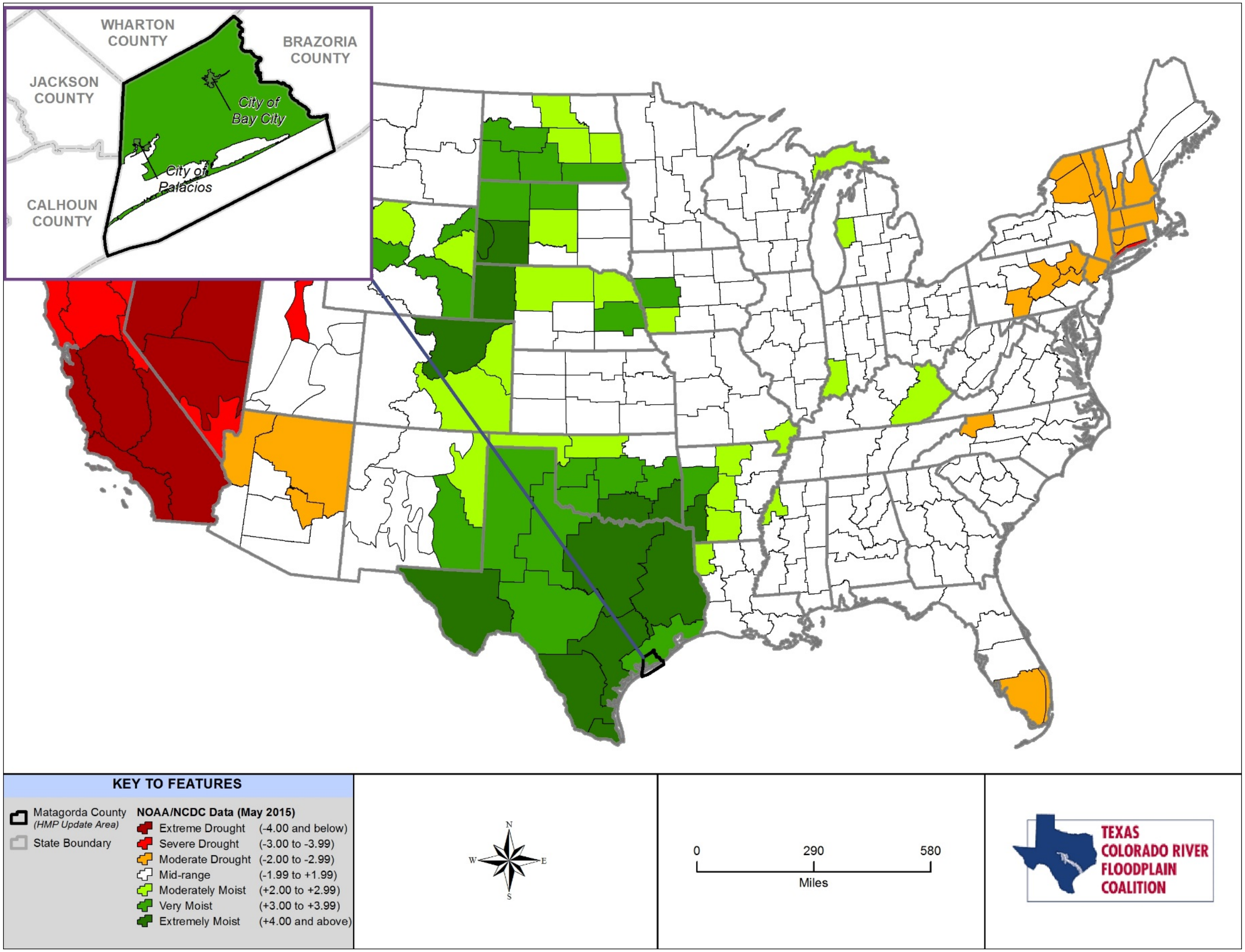


Figure 10-8. Palmer Drought Severity Index (May 2015)

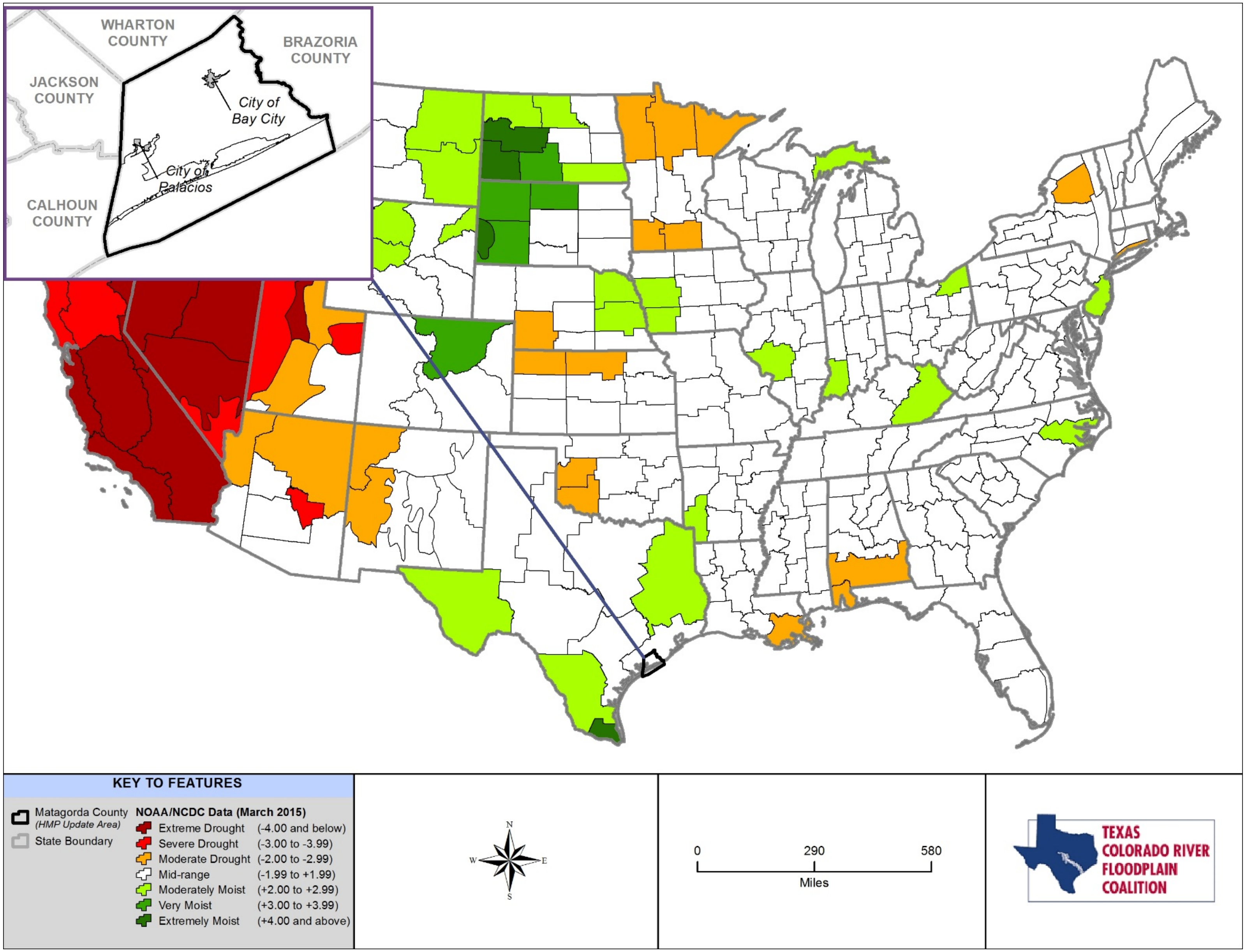


Figure 10-9. Palmer Hydrological Drought Index Long-Term Hydrologic Conditions (March 2015)

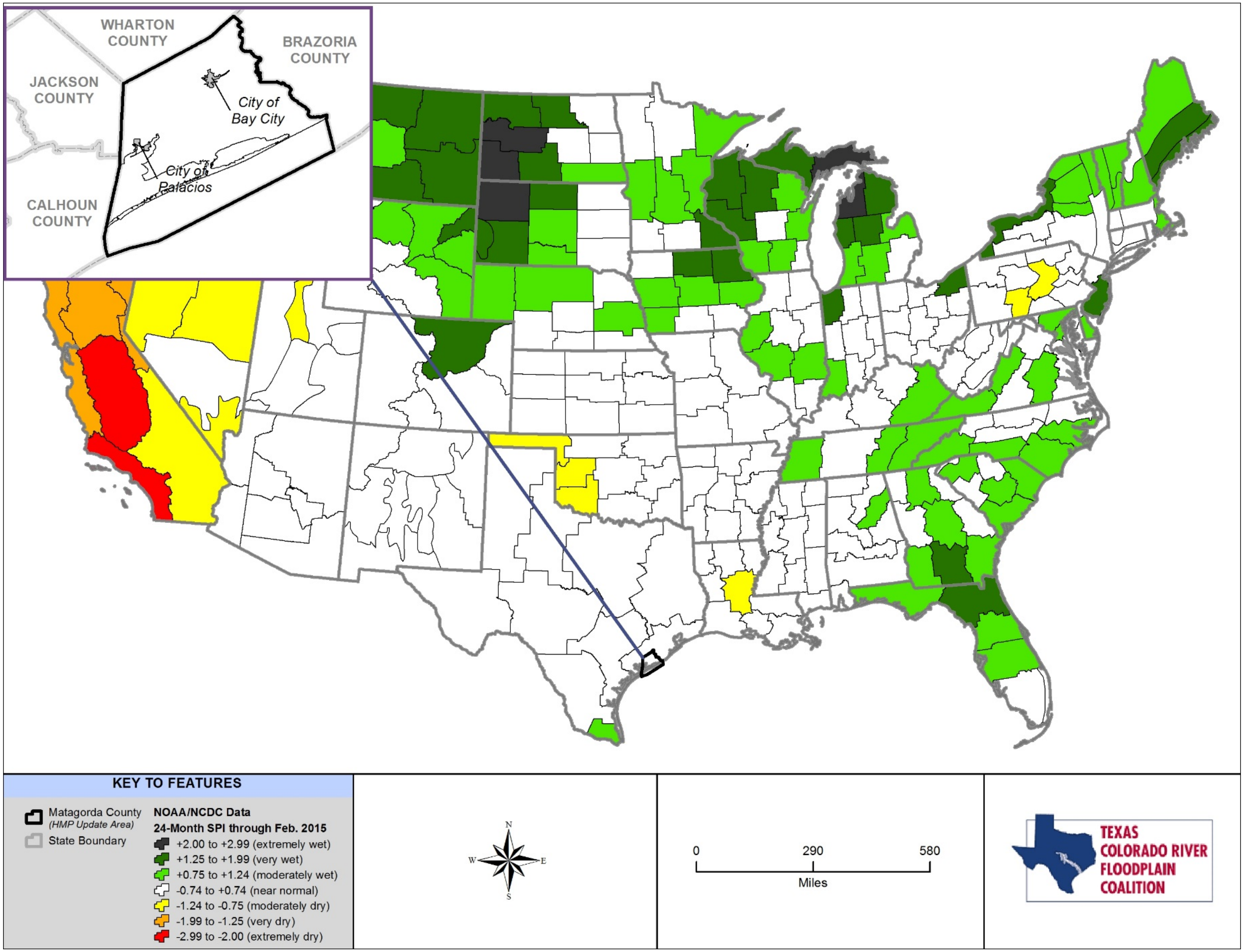


Figure 10-10. 24-Month Standardized Precipitation Index (through February 2015)

Because of Texas's humid sub-tropical to semi-arid conditions, drought is a regular but unpredictable occurrence in the state. However, because of natural variations in climate and precipitation sources, it is rare for all of Texas to be deficient in moisture at the same time. Single season droughts over some portion of the state are quite common. From 1950 to 1957, Texas experienced the most severe drought in recorded history. By the time the drought ended, 244 of Texas' 254 counties had been declared federal disaster areas. In 2011, Texas experienced its most intense single-year drought in recorded history.

Droughts occur regularly in South Texas and are a normal condition. However, they can vary greatly in their intensity and duration. The entire HMP update area is at risk to drought conditions. Drought is one of the few hazards that has the potential to directly or indirectly impact every person in the participating communities as well as adversely affect the local economy. Table 10-2 lists past drought events for Matagorda County and the participating communities in this HMP update.

TABLE 10-2.
HISTORIC DROUGHT EVENTS IN MATAGORDA COUNTY AND PARTICIPATING COMMUNITIES (1996-2014)

Date	Estimated Damage Cost		Injuries	Deaths
	Property	Crops		
April 1996	$0	$0	0	0
May 1996	$0	$0	0	0
June 1996	$0	$0	0	0
May 1998	$0	$0	0	0
June 1998	$0	$0	0	0
July 1998	$0	$0	0	0
August 1998	$1,713,941	$12,511,771	0	0
August 2000	$0	$0	0	0
September 2000	$0	$7,623,312	0	0

Extreme Heat

The entire planning area is at risk to extreme heat events; however, these events may be exacerbated in urban areas, where reduced air flow, reduced vegetation, and increased generation of waste heat can contribute to temperatures that are several degrees higher than in surrounding rural (Matagorda County Unincorporated Areas) or less urbanized areas. This phenomenon is known as urban heat island effect. This can happen in the City of Bay City and City of Palacios.

The record highs for Texas occur during May through October. The Matagorda County (and participating communities) area experiences an average of 7 days with temperatures 100°F and above during these months, according to data recorded by the NWS between 2000 and 2014. During 2011, Texas experienced the hottest summer in U.S. history with an average temperature of 86.8°F. The planning area experienced more than 40 days with temperatures 100°F and above in 2011. Figure 6-3 shows the annual average maximum temperature distribution in Texas.

Even though the NCDC storm events database doesn't list any documented specific past events for extreme heat, the local participating communities in this HMP update report that extreme heat days do occur a few days in the year during the summer months.

10.2.3 Frequency

Drought

The probability of a future drought in Matagorda County is likely, and participating communities is likely, with an event possible in the next 6 years or less. According to information from the National Climatic Data Center, Matagorda County had 3 documented drought years between 1996 and 2014. Based on this historical information, the probability of a drought occurring in any given year is 17%. (About 1 in 6 years). The same frequency (1 in 6 years) applies to the future probability.

Short duration droughts occur much more frequently. Various studies indicate that drought occurrence in Texas is expected to increase in frequency and will continue be an inevitable factor in the climate of Texas. Table 10-2 lists historic drought events. Furthermore, since drought effects a large area (more regional than city specific) historical analysis are applied to all participating communities equally.

Extreme Heat

On average, Matagorda County and participating communities have experienced 77 days per year where temperatures exceed 90°F so the frequency of extreme heat events is expected to be very likely in any given year (per NOAA's Regional Climate Center data and local records). Matagorda County and participating communities can expect similar numbers in the future (77 days per year and highly likely).

10.2.4 Severity

Drought

Drought impacts are wide-reaching and may be economic, environmental, or societal. The most significant impacts associated with drought in Texas are those related to water intensive activities such as agriculture, wildfire protection, municipal usage, commerce, tourism, recreation, and wildlife preservation. An ongoing drought may leave an area more prone to wildfires. Drought conditions can also cause soil to compact, increasing an area's susceptibility to flooding, and reduce vegetation cover, which exposes soil to wind and erosion. A reduction of electric power generation and water quality deterioration are also potential problems. Drought impacts increase with the length of a drought, as carry-over supplies in reservoirs are depleted and water levels in streams and groundwater decline.

According to the information in this hazard profile, drought impacts on Matagorda County could be considered moderate; that is, less than 25% of property (mainly agricultural) is severely damaged; crop fields become withered; cattle herds are thinned; and for coastal communities, fishermen net light loads. Due to the low probability of severe drought, the overall significance is considered moderate with significant potential impact. Drought can have a widespread impact on the environment and the economy, depending upon its severity, although it typically does not result in loss of life or damage to property, as do other natural disasters. The National Drought Mitigation Center uses three categories to describe likely drought impacts:

- **Agricultural** – Drought threatens crops that rely on natural precipitation.
- **Water supply** – Drought threatens supplies of water for irrigated crops and for communities.
- **Fire hazard** – Drought increases the threat of wildfires from dry conditions in forest and rangelands.

On average, the nationwide annual impacts of drought are greater than the impacts of any other natural hazard. They are estimated to be between $6 billion and $8 billion annually in the United States and occur primarily in the agriculture, transportation, recreation and tourism, forestry, and energy sectors. Social and environmental impacts are also significant, although it is difficult to put a precise cost on these impacts.

The severity of a drought depends on the degree of moisture deficiency, the duration, and the size and location of the affected area. The longer the duration of the drought and the larger the area impacted, the more severe the potential impacts. Droughts are not usually associated with direct impacts on people or property, but they can have significant impacts on agriculture, which can impact people indirectly.

When measuring the severity of droughts, analysts typically look at economic impacts on a planning area. A drought directly or indirectly impacts all people in affected areas. All people could pay more for water if utilities increase their rates due to shortages. Agricultural impacts can result in loss of work for farm workers and those in related food processing jobs. Other water- or electricity-dependent industries are commonly forced to shut down all or a portion of their facilities, resulting in further layoffs. A drought can harm recreational companies that use water (e.g., swimming pools, water parks, and river rafting companies) as well as landscape and nursery businesses because people will not invest in new plants if water is not available to sustain them.

Drought generally does not affect groundwater sources as quickly as surface water supplies, but groundwater supplies generally take longer to recover. Reduced precipitation during a drought means that groundwater supplies are not replenished at a normal rate. This can lead to a reduction in groundwater levels and problems such as reduced pumping capacity or wells going dry. Shallow wells are more susceptible than deep wells. Reduced replenishment of groundwater affects streams. Much of the flow in streams comes from groundwater, especially during the summer when there is less precipitation and after snowmelt ends. Reduced groundwater levels mean that even less water will enter streams when steam flows are lowest.

Additionally, there is increased danger of wildfires associated with most droughts. Millions of board feet of timber have been lost due to drought, and in many cases erosion has occurred, which caused serious damage to aquatic life, irrigation, and power production by heavy silting of streams, reservoirs, and rivers.

Extreme Heat

Drought also is often accompanied by extreme heat. When temperatures reach 90ºF and above, people are vulnerable to heat cramps, heat exhaustion, and heat stroke. Pets and livestock are also vulnerable to heat-related injuries. Crops can be vulnerable as well.

Based on the information in this hazard profile, the magnitude/severity of extreme temperatures is considered moderate; that is, less than 25 % of property (mainly agricultural) is severely damaged or injuries/illnesses are treatable or do not result in permanent disability. Due to the expansive nature of soils in this area, extreme heat could pose foundation issues. Overall significance is considered minimal: moderate potential impact.

10.2.5 Warning Time

Drought

Droughts are climatic patterns that occur over long periods of time. Only generalized warnings can take place due to the numerous variables that scientists have not pieced together well enough to make accurate and precise predictions. Empirical studies conducted over the past century have shown that meteorological drought is never the result of a single cause. It is the result of many causes, often synergistic in nature.

Scientists at this time do not know how to predict drought more than a month in advance for most locations. Predicting drought depends on the ability to forecast precipitation and temperature. Anomalies of precipitation and temperature may last from several months to several decades. How long these anomalies last depends on interactions between the atmosphere and the oceans, soil moisture and land surface processes, topography, internal dynamics, and the accumulated influence of weather systems on the global scale.

Texas is semi-arid to humid sub-tropical, thus, drought is a regular and natural occurrence in the state. The main source of water supply in the state is precipitation and much of this occurs in the spring and fall. Some snowfall does occur in the wintertime. Although drought conditions are difficult to predict, low levels of spring precipitation may act as an indicator that drought conditions are occurring.

Extreme Heat

NOAA issues watch, warning, and advisory information for extreme heat. Extreme heat is a regular and natural occurrence in the state.

10.3 SECONDARY HAZARDS

Drought

The secondary hazard most commonly associated with drought is wildfire. A prolonged lack of precipitation dries out vegetation, which becomes increasingly susceptible to ignition as the duration of the drought extends. According to the *State of Texas 2014 Emergency Management Plan* (Drought Annex), economic impacts may also occur for industries that are water intensive such as agriculture, wildfire protection, municipal usage, commerce, tourism, recreation and wildfire preservation. Additionally, a reduction of electric power generation and water quality deterioration are also potential effects. Drought conditions can also cause soil to compact, decreasing its ability to absorb water, making an area more susceptible to flash flooding and erosion. A drought may also increase the speed at which dead and fallen trees dry out and become more potent fuel sources for wildfires. Drought may also weaken trees in areas already affected by insect infestations, causing more extensive damage to trees and increasing wildfire risk, at least temporarily. An ongoing drought that severely inhibits natural plant growth cycles may impact critical wildlife habitats. Drought impacts increase with the length of a drought, as carry-over supplies in reservoirs are depleted and water levels in groundwater basins decline.

Extreme Heat

Excessive heat events can cause failure of motorized systems such as ventilation systems used to control temperatures inside buildings. The lack of air conditioning in businesses and homes can exacerbate existing health conditions, particularly in senior citizens.

10.4 CLIMATE CHANGE IMPACTS

The long-term effects of climate change on regional water resources are unknown, but global water resources are already experiencing the following stresses without climate change:

- Growing populations
- Increased competition for available water
- Poor water quality
- Environmental claims
- Uncertain reserved water rights
- Groundwater overdraft
- Aging urban water infrastructure.

With a warmer climate, droughts could become more frequent, more severe, and longer-lasting. From 1987 to 1989, losses from drought in the U.S. totaled $39 billion (Congressional Office of Technology Assessment [OTA] 1993). More frequent extreme events such as droughts could end up being more cause for concern than the long-term change in temperature and precipitation averages.

The best advice to water resource managers regarding climate change is to start addressing current stresses on water supplies and build flexibility and robustness into any system. Flexibility helps to ensure a quick response to changing conditions, and robustness helps people prepare for and survive the worst conditions. With this approach to planning, water system managers will be better able to adapt to the impacts of climate change.

10.5 EXPOSURE

Because droughts cannot be directly modeled in HAZUS, annualized losses were estimated using geographic information system- (GIS) based analysis, historical data (frequency and damage) analysis, and statistical risk assessment methodology. Event frequency, severity indicators, expert opinions, and historical knowledge of the region were used for this assessment. The primary data source was the HAZUS 2.2 data inventory (updated 2010 U.S. Census Data and 2014 RS Means Square Foot Costs), and 2012 Census of Agriculture augmented with state and federal datasets as well as the National Drought Mitigation Center reports.

All people, property, and environments in the planning area would be exposed to some degree to the impacts of moderate to extreme drought conditions and extreme heat. Populations living in densely populated urban areas are likely to be more exposed to extreme heat events. Furthermore, farms and agriculture will be greatly impact by drought and extreme temperature. For drought which could all be potentially impacted by a drought. By applying historical averages on losses and events (probability) to current economic totals, the exposure rate for the entire HMP update area is approximately $198 million (See Table 10-4). This number is for the entire planning area. Even though most farmlands are usually outside the city limits, droughts still impact local communities economically.

Table 10-3 lists the structures and populations most exposed to drought and extreme heat.

TABLE 10-3
EXPOSED STRUCTURES AND POPULATION

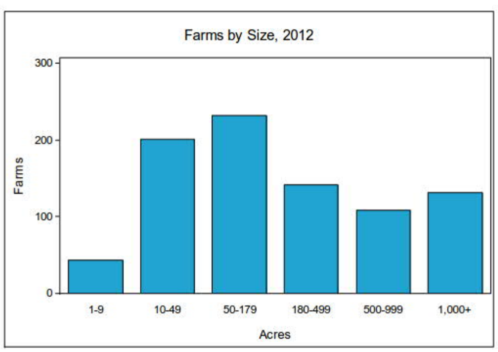
Jurisdiction	Residential	Commercial	Other *	**Total Structures**	**Total Population**
Unincorporated Area	5,744	121	35	5,900	17,631
City of Bay City	1,785	17	10	1,812	4,718
City of Palacios	6,787	29	16	6,832	10,028
Matagorda County Total	14,316	167	61	14,544	32,377

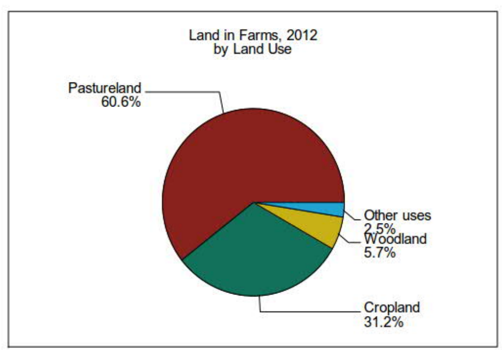
*Other includes industrial, agricultural, religious, governmental, and educational classifications.

2012 CENSUS OF AGRICULTURE
COUNTY PROFILE

Matagorda County
Texas

	2012	2007	% change
Number of Farms	856	903	- 5
Land in Farms	568,055 acres	577,594 acres	- 2
Average Size of Farm	664 acres	640 acres	+ 4
Market Value of Products Sold	$129,703,000	$106,756,000	+ 21
Crop Sales $77,024,000 (59 percent) Livestock Sales $52,679,000 (41 percent)			
Average Per Farm	$151,522	$118,224	+ 28
Government Payments	$5,271,000	$5,890,000	- 11
Average Per Farm Receiving Payments	$17,807	$21,339	- 17





USDA **US Department of Agriculture**
National Agricultural Statistics Service

www.agcensus.usda.gov

Figure 10-11. USDA Census of Agriculture Matagorda County Profile 2012

10.6 VULNERABILITY

Drought produces a complex web of impacts that spans many sectors of the economy and reaches well beyond the area experiencing physical drought. This complexity exists because water is integral to the ability to produce goods and provide services. Drought can affect a wide range of economic, environmental, and social activities. The vulnerability of an activity to the effects of drought usually depends on its water demand, how the demand is met, and what water supplies are available to meet the demand. Extreme heat can exacerbate the effects of drought.

Because droughts cannot be directly modeled in HAZUS, annualized losses were estimated using geographic information system- (GIS) based analysis, historical data (frequency and damage) analysis, and statistical risk assessment methodology. Event frequency, severity indicators, expert opinions, and historical knowledge of the region were used for this assessment. The primary data source was the HAZUS inventory data (updated with 2010 Census Data and 2014 RS Means Square Foot Costs), and the 2012 Census of Agriculture augmented with state and federal data sets as well as the National Drought Mitigation Center reports and local knowledge.

10.6.1 Population

Extreme Heat

According to the EPA, the individuals with the following characteristics are typically at greater risk to the adverse effects of excessive heat events: individuals with physical or mobility constraints, cognitive impairments, economic constraints, and social isolation.

See Table 10-4 for populations most vulnerable to extreme heat and drought per jurisdiction.

TABLE 10-4
MOST VULNERABLE POPULATION

Jurisdiction	Youth Population (< 16)	% of Total Population	Elderly Population (> 65)	% of Total Population	Economically Disadvantage (Income < $20,000)	% of Total Population
Unincorporated Area	4,912	27.86	2,146	12.17	1,749	9.92
City of Bay City	1,441	30.54	623	13.20	549	11.64
City of Palacios	2,192	21.86	1,829	18.24	527	5.26
Matagorda County Total	8,545	26.39	4,598	14.20	2,825	8.73

10.6.2 Property

Drought

No structures will be directly affected by drought conditions, though some structures may become vulnerable to wildfires, which are more likely following years of drought. Droughts can also have significant impacts on landscapes, structure foundation issues (because of soil expansion and contraction) which could cause a financial burden to property owners. However, these impacts are not considered critical in planning for impacts from the drought hazard.

Loss estimations for drought are not based on damage functions, because no such damage functions have been generated. Instead, loss estimates were developed representing projected damages (annualized loss) on historical events, statistical analysis, and probability factors. These were applied to the exposed agriculture values of the participating communities to create an annualized loss (Table 10-5).

**TABLE 10-5.
LOSS ESTIMATES FOR DROUGHT EVENTS**

Jurisdiction	Exposed Value ($)	Annualized Loss ($)	Annualized Loss (%)
Unincorporated Area	92,486,746	1,205,963	1.3
City of Bay City	82,721,940	8,522	< 0.1
City of Palacios	23,021,516	1,341	< 0.1
Matagorda County Total	**198,230,202**	**1,215,826**	**0.6%**

Extreme Heat

Typically the only impact extreme heat has on general building stock is increased demand on air conditioning equipment, which in turn may cause strain on electrical systems. Due to the expansive nature of soils in this area, extreme heat also could pose foundation issues. It costs an average homeowner at least $5000 to fix or repair structure foundation issues.

Vulnerability Narrative

All participating communities are at risk to drought and extreme heat events. In addition to the documented impacts from the Drought Impact Reporter listed in Section 10.2.1, the participating communities also experience the following for both drought and extreme heat events:

- **City of Bay City -** The City will be at a greater risk of rolling blackouts during an extreme heat event due to high usage. This would have a greater effect on the young, elderly and economically disadvantaged that may not have the means to respond to such an event. Lawn watering and other outdoor water activities will have to be scheduled and rationed. Property owners and city facilities not using drought tolerant landscaping are increasing their vulnerability to drought. Communities who are not implementing drought planning increase their vulnerability to its effects. Critical infrastructure, such as water supply facilities, in need of maintenance increases risk as water shortages can be expected in the wake of drought.
- **City of Palacios -** The City of Palacios will be at a greater risk of rolling blackouts during an extreme heat event due to high usage. This would have a greater effect on the young, elderly and economically disadvantaged populations that may not have the means to respond to such an event. Uninformed residents and business owners on the effects of drought on their properties or water conservation tactics are more vulnerable as well. Critical facilities and residents without secondary power sources are at an increased risk as this would hinder their ability to serve residents.
- **Matagorda County (Unincorporated Area) -** Unincorporated county areas are at a greater risk of rolling blackouts during an extreme heat event due to high usage from other areas of the electrical grid. Due to the rural nature of some of Matagorda County’s Unincorporated Areas, response times restoring outages caused by a black out could be lengthy. This would have a greater effect on the young, elderly and economically disadvantaged. Areas with emergency response services at a greater distance are at a greater risk as well. Many residents may not know of the risks extreme heat can place on themselves, their families, and homes. Those uninformed on the

risks and hazards associated with drought are more vulnerable to its effects. Communities and residents without secondary water supply sources increase their vulnerability as well.

Community Perception of Vulnerability

See front page of current chapter for a summary of hazard rankings for Matagorda County and participating communities in this plan update. Chapter 19 gives a detailed description of this rankings and Chapter 20 addresses mitigations actions for this hazard vulnerability.

10.6.3 Critical Facilities

Drought

Critical facilities as defined for this plan will continue to be operational during a drought. Critical facility elements such as landscaping may not be maintained due to limited resources, but the risk to the planning area's critical facilities inventory will be largely aesthetic. For example, when water conservation measures are in place, landscaped areas will not be watered and may die. These aesthetic impacts are not considered significant.

Extreme Heat

Power outages may occur as a result of extreme heat events. Additionally, transportation systems may experience disruption in services. It is common in Texas for concrete pavements to experience "blowouts or heaves" both on local highway and the higher volume parkway and interstate systems. Blowouts occur when pavements expand and cannot function properly within their allotted spaces. Pavement sections may rise up several inches during such events. These conditions can cause motor vehicle accidents in their initial stages and can shut down traffic lanes or roadways entirely until such times as the conditions are mitigated.

10.6.4 Environment

Environmental losses from drought are associated with damage to plants, animals, wildlife habitat, and air and water quality; forest and range fires; degradation of landscape quality; loss of biodiversity; and soil erosion. Some of the effects are short-term and conditions quickly return to normal following the end of the drought. Other environmental effects linger for some time or may even become permanent. Wildlife habitat, for example, may be degraded through the loss of wetlands, lakes, and vegetation. However, many species will eventually recover from this temporary aberration. The degradation of landscape quality, including increased soil erosion, may lead to a more permanent loss of biological productivity. Although environmental losses are difficult to quantify, growing public awareness and concern for environmental quality has forced public officials to focus greater attention and resources on these effects.

10.6.5 Economic Impact

Economic impact will be largely associated with industries that use water or depend on water for their business. For example, landscaping businesses were affected in the droughts of the past as the demand for service significantly declined because landscaping was not watered. Agricultural industries will be impacted if water usage is restricted for irrigation. The tourism sector may also be impacted.

10.7 FUTURE TRENDS IN DEVELOPMENT

Each municipal planning partner in this effort has an established comprehensive plan or policies directing land use and dealing with issues of water supply and the protection of water resources. These plans provide the capability at the local municipal level to protect future development from the impacts of drought. All planning partners reviewed their plans under the capability assessments performed for this effort. Deficiencies identified by these reviews can be identified as mitigation initiatives to increase the capability to deal with future trends in development. Vulnerability to drought will increase as population growth increases, putting more demands on existing water supplies. Future water use planning should consider increases in population as well as potential impacts of climate change.

10.8 SCENARIO

An extreme multi-year drought could impact the region with little warning. Combinations of low precipitation and unusually high temperatures could occur over several consecutive years. Intensified by such conditions, extreme wildfires could break out throughout the planning area, increasing the need for water. Surrounding communities, also in drought conditions, could increase their demand for water supplies relied upon by the planning partnership, causing social and political conflicts. If such conditions persisted for several years, the economy of Matagorda County could experience setbacks, especially in water dependent industries.

10.9 ISSUES

The following are extreme heat and drought-related issues:

- Identification and development of alternative water supplies.
- Utilization of groundwater recharge techniques to stabilize the groundwater supply.
- The probability of increased drought frequencies and durations due to climate change.
- The promotion of active water conservation even during non-drought periods.
- Increasing vulnerability to drought over time as demand for water from different sectors increases.
- The effects of climate change may result in an increase in frequency of extreme heat events.
- The effects of recent droughts have exposed the vulnerability of the planning areas economy to drought events.
- Environmental and erosion control impact analysis for transportation projects.
- Wildlife habitat management for landowners.
- Human health impacts from droughts and extreme heat.
- Monitoring and evaluating risks to power supply and water rights.
- Development of mitigation- or response-based state drought plans.

CHAPTER 11.
EARTHQUAKE

EARTHQUAKE RANKING	
Matagorda County	Low
City of Bay City	Low
City of Palacios	Low

DEFINITIONS

Earthquake — The shaking of the ground caused by an abrupt shift of rock along a fracture in the earth or a contact zone between tectonic plates.

Epicenter — The point on the earth's surface directly above the hypocenter of an earthquake. The location of an earthquake is commonly described by the geographic position of its epicenter and by its focal depth.

Fault — A fracture in the earth's crust along which two blocks of the crust have slipped with respect to each other.

Focal Depth — The depth from the earth's surface to the hypocenter.

Hypocenter — The region underground where an earthquake's energy originates.

Liquefaction — Loosely packed, water-logged sediments losing their strength in response to strong shaking, causing major damage during earthquakes.

11.1 GENERAL BACKGROUND

11.1.1 How Earthquakes Happen

An earthquake is a sudden release of energy from the earth's crust that creates seismic waves. Tectonic plates become stuck, putting a strain on the ground. When the strain becomes so great that rocks give way, fault lines occur. At the Earth's surface, earthquakes may manifest themselves by a shaking or displacement of the ground, which may lead to loss of life and destruction of property. Size of an earthquake is expressed quantitatively as magnitude and local strength of shaking as intensity. The inherent size of an earthquake is commonly expressed using a magnitude. For a more detailed description of seismic/earthquake hazards visit FEMA's web site on hazards, http://www.fema.gov/hazard.

Earthquakes tend to reoccur along faults, which are zones of weakness in the crust. Even if a fault zone has recently experienced an earthquake, there is no guarantee that all the stress has been relieved. Another earthquake could still occur.

Geologists classify faults by their relative hazards. Active faults, which represent the highest hazard, are those that have ruptured to the ground surface during the Holocene period (about the last 11,000 years). Potentially active faults are those that displaced layers of rock from the Quaternary period (the last 1,800,000 years). Determining if a fault is "active" or "potentially active" depends on geologic evidence, which may not be available for every fault. Although there are probably still some unrecognized active faults, nearly all the movement between the two plates, and therefore the majority of the seismic hazards, are on the well-known active faults.

Faults are more likely to have earthquakes on them if they have more rapid rates of movement, have had recent earthquakes along them, experience greater total displacements, and are aligned so that movement can relieve accumulating tectonic stresses. A direct relationship exists between a fault's length and location and its ability to generate damaging ground motion at a given site. In some areas, smaller, local faults produce lower magnitude quakes, but ground shaking can be strong, and damage can be significant as a result of the fault's proximity to the area. In contrast, large regional faults can generate great magnitudes but, because of their distance and depth, may result in only moderate shaking in the area.

11.1.2 Earthquake Classifications

Earthquakes are typically classified in one of two ways: by the amount of energy released, measured as **magnitude**; or by the impact on people and structures, measured as **intensity**.

Magnitude

Currently the most commonly used magnitude scale is the moment magnitude (M_w) scale, with the follow classifications of magnitude:

- Great $M_w > 8$
- Major $M_w = 7.0 - 7.9$
- Strong $M_w = 6.0 - 6.9$
- Moderate $M_w = 5.0 - 5.9$
- Light $M_w = 4.0 - 4.9$
- Minor $M_w = 3.0 - 3.9$
- Micro $M_w < 3$

Estimates of moment magnitude roughly match the local magnitude scale (ML) commonly called the Richter scale. One advantage of the M_w scale is that, unlike other magnitude scales, it does not saturate at the upper end. That is, there is no value beyond which all large earthquakes have about the same magnitude. For this reason, M_w scale is now the most often used estimate of large earthquake magnitudes.

Intensity

Currently the most commonly used intensity scale is the modified Mercalli intensity scale, with ratings defined as follows (U.S. Geological Survey [USGS] 1989):

- I. Not felt except by a very few under especially favorable conditions.
- II. Felt only by a few persons at rest, especially on upper floors of buildings.
- III. Felt quite noticeably by persons indoors, especially on upper floors of buildings. Many people do not recognize it is an earthquake. Standing cars may rock slightly. Vibrations similar to the passing of a truck. Duration estimated.
- IV. Felt indoors by many, outdoors by few during the day. At night, some awakened. Dishes, windows, doors disturbed; walls make cracking sound. Sensation like a heavy truck striking building. Standing cars rocked noticeably.
- V. Felt by nearly everyone; many awakened. Some dishes, windows broken. Unstable objects overturned. Pendulum clocks may stop.
- VI. Felt by all; many frightened. Some heavy furniture moved; a few instances of fallen plaster. Damage slight.
- VII. Damage negligible in buildings of good design and construction; slight in well-built ordinary structures; considerable in poorly built or badly designed structures. Some chimneys broken.
- VIII. Damage slight in specially designed structures; considerable damage in ordinary buildings with partial collapse. Damage great in poorly built structures. Fall of chimneys, factory stacks, columns, monuments, walls. Heavy furniture overturned.
- IX. Damage considerable in specially designed structures; well-designed frame structures thrown out of plumb. Damage great in substantial buildings, with partial collapse. Buildings shifted off foundations.
- X. Some well-built wooden structures destroyed; most masonry and frame structures destroyed with foundations. Rails bent.
- XI. Few, if any (masonry) structures remain standing. Bridges destroyed. Rails bent greatly.
- XII. Damage total. Lines of sight and level are distorted. Objects thrown into the air.

11.1.3 Ground Motion

Earthquake hazard assessment is also based on expected ground motion. This involves determining the annual probability that certain ground motion accelerations will be exceeded, then summing the annual probabilities over the time period of interest. The most commonly mapped ground motion parameters are the horizontal and vertical peak ground accelerations (PGA) for a given soil or rock type. Instruments called accelerographs record levels of ground motion due to earthquakes at stations throughout a region. These readings are recorded by state and federal agencies that monitor and predict seismic activity.

Maps of PGA values form the basis of seismic zone maps that are included in building codes such as the International Building Code. Building codes that include seismic provisions specify the horizontal force due to lateral acceleration that a building should be able to withstand during an earthquake. PGA values are directly related to these lateral forces that could damage "short-period structures" (e.g., single-family dwellings). Longer-period response components create the lateral forces that damage larger structures with longer natural periods (apartment buildings, factories, high-rises, bridges). Table 11-1 lists damage potential and perceived shaking by PGA factors, compared to the Mercalli scale.

TABLE 11-1.
MERCALLI SCALE AND PEAK GROUND ACCELERATION COMPARISON

Modified Mercalli Scale	Perceived Shaking	Potential Structure Damage		Estimated PGA[a] (%g)
		Resistant Buildings	Vulnerable Buildings	
I	Not Felt	None	None	<0.17%
II to III	Weak	None	None	0.17% - 1.4%
IV	Light	None	None	1.4% - 3.9%
V	Moderate	Very Light	Light	3.9% - 9.2%
VI	Strong	Light	Moderate	9.2% - 18%
VII	Very Strong	Moderate	Moderate/Heavy	18% - 34%
VIII	Severe	Moderate/Heavy	Heavy	34% - 65%
IX	Violent	Heavy	Very Heavy	65% - 124%
X to XII	Extreme	Very Heavy	Very Heavy	>124%

a. PGA measured in percent of g, where g is the acceleration of gravity
Sources: USGS, 2008; USGS, 2010

11.1.4 Effect of Soil Types

The impact of an earthquake on structures and infrastructure is largely a function of ground shaking, distance from the source of the quake, and liquefaction. Liquefaction is a secondary effect of an earthquake in which soils lose their shear strength and flow or behave as liquid, thereby damaging structures that derive their support from the soil. Liquefaction generally occurs in soft, unconsolidated sedimentary soils. A program called the National Earthquake Hazard Reduction Program (NEHRP) creates maps based on soil characteristics to help identify locations subject to liquefaction. Table 11-2 summarizes NEHRP soil classifications. NEHRP Soils B and C typically can sustain ground shaking without much effect, dependent on the earthquake magnitude. The areas that are commonly most affected by ground shaking have NEHRP Soils D, E, and F. In general, these areas are also most susceptible to liquefaction.

TABLE 11-2. NEHRP SOIL CLASSIFICATION SYSTEM

NEHRP Soil Type	Description	Mean Shear Velocity to 30 meters (meters per second)
A	Hard Rock	1,500
B	Firm to Hard Rock	760-1,500
C	Dense Soil/Soft Rock	360-760
D	Stiff Soil	180-360
E	Soft Clays	< 180
F	Special Study Soils (liquefiable soils, sensitive clays, organic soils, soft clays >36 meters thick)	

11.2 HAZARD PROFILE

Earthquakes can last from a few seconds to over five minutes; they may also occur as a series of tremors over several days. The actual movement of the ground in an earthquake is seldom the direct cause of injury or death. Casualties generally result from falling objects and debris, because the shocks shake, damage, or demolish buildings and other structures. Disruption of communications, electrical power supplies and gas, sewer and water lines should be expected. Earthquakes may trigger fires, dam failures, landslides, or releases of hazardous material, compounding their disastrous effects.

Small, local faults produce lower magnitude quakes, but ground shaking can be strong and damage can be significant in areas close to the fault. In contrast, large regional faults can generate earthquakes of great magnitudes but, because of their distance and depth, they may result in only moderate shaking in an area.

The severity of earthquakes is influenced by several factors, including the depth of the quake, the geology in the area, and the soils. The severity of soil liquefaction is dependent on the soils grain size, thickness, compaction, and degree of saturation.

11.2.1 Past Events

Most past earthquakes in Texas have been of low magnitude and have mainly occurred in west Texas, or the Panhandle area. Figure 11-1 shows the location of recorded and documented earthquake events in Texas as well as the planning area. As can be seen in Figure 11-2, the probability of a severe earthquake in Matagorda County and participating communities is low. According to the State Hazard Mitigation Plan, the probability of an earthquake in the Central Region is considered rare. This includes Matagorda County and participating communities. Although a small event is possible, it would pose little to no risk for the area. According to the USGS Earthquake Hazard Program, no earthquakes have been recorded in Matagorda County and the participating communities since 1847, (the earliest date data are available).

11.2.2 Location

While Texas does face some earthquake hazard, this hazard is very small in comparison to many other states. The biggest threat appears to be from the New Madrid fault system in Missouri, a system powerful enough to pose a risk to the north Texas area. Two regions, near El Paso and in the Panhandle, should expect earthquakes with magnitudes of approximately 5.5 to 6.0 to occur every 50 to 100 years, with even larger earthquakes possible. In Central Texas, the hazard is generally low, but residents should be aware that small earthquakes can occur, including some that are theoretically triggered by oil or gas production. Elsewhere in Texas, earthquakes are exceedingly rare. However, the hazard level is not zero anywhere in Texas; small earthquakes are possible almost anywhere, and all regions face possible ill effects from very large, distant earthquakes. Figure 11-2 shows earthquake hazard threats in the U.S. Figure 11-1 shows the location of recorded past events and Figure 11-2 shows probability of earthquake hazard threats in the U.S.

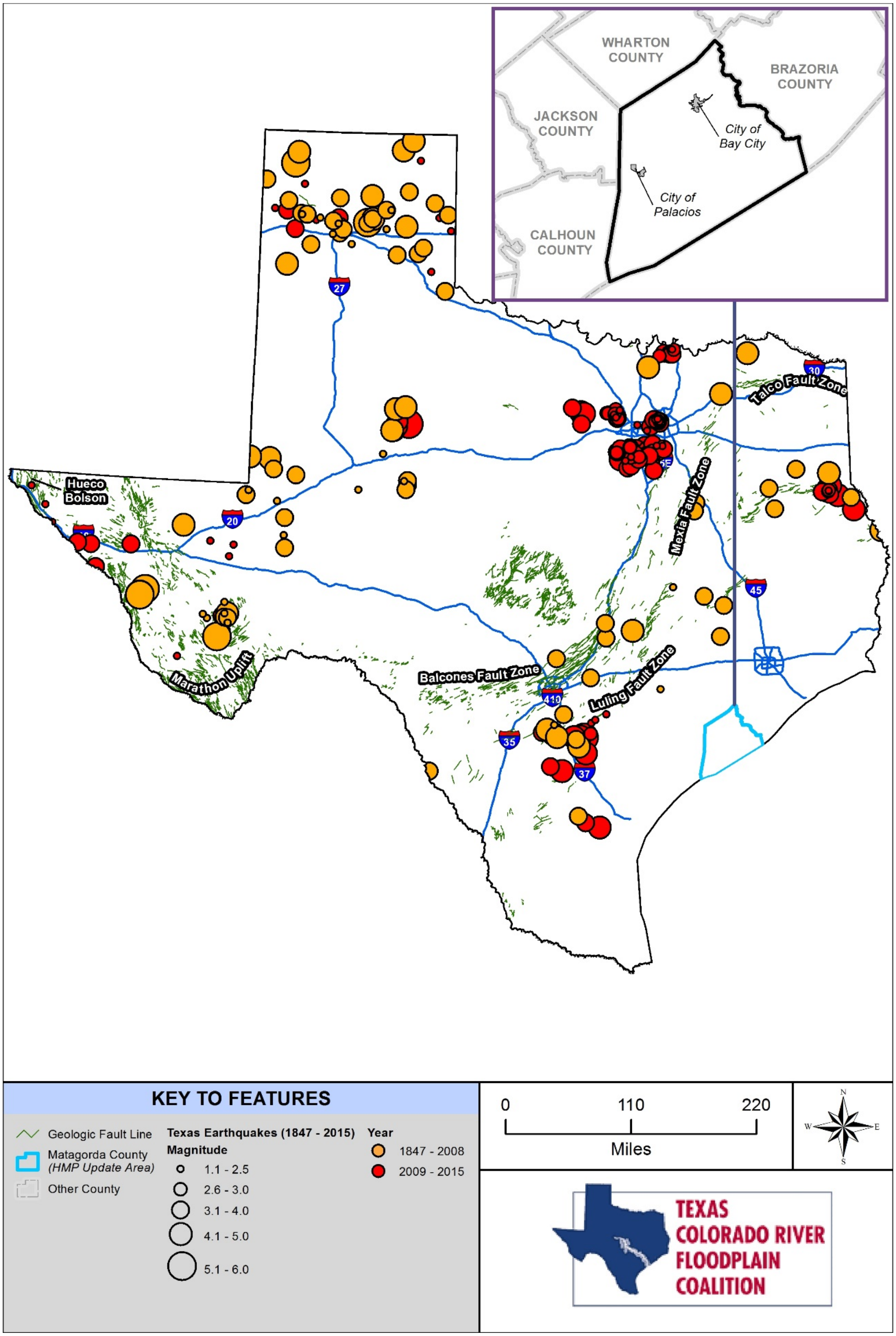


Figure 11-1. Texas Earthquakes (1847-2015)

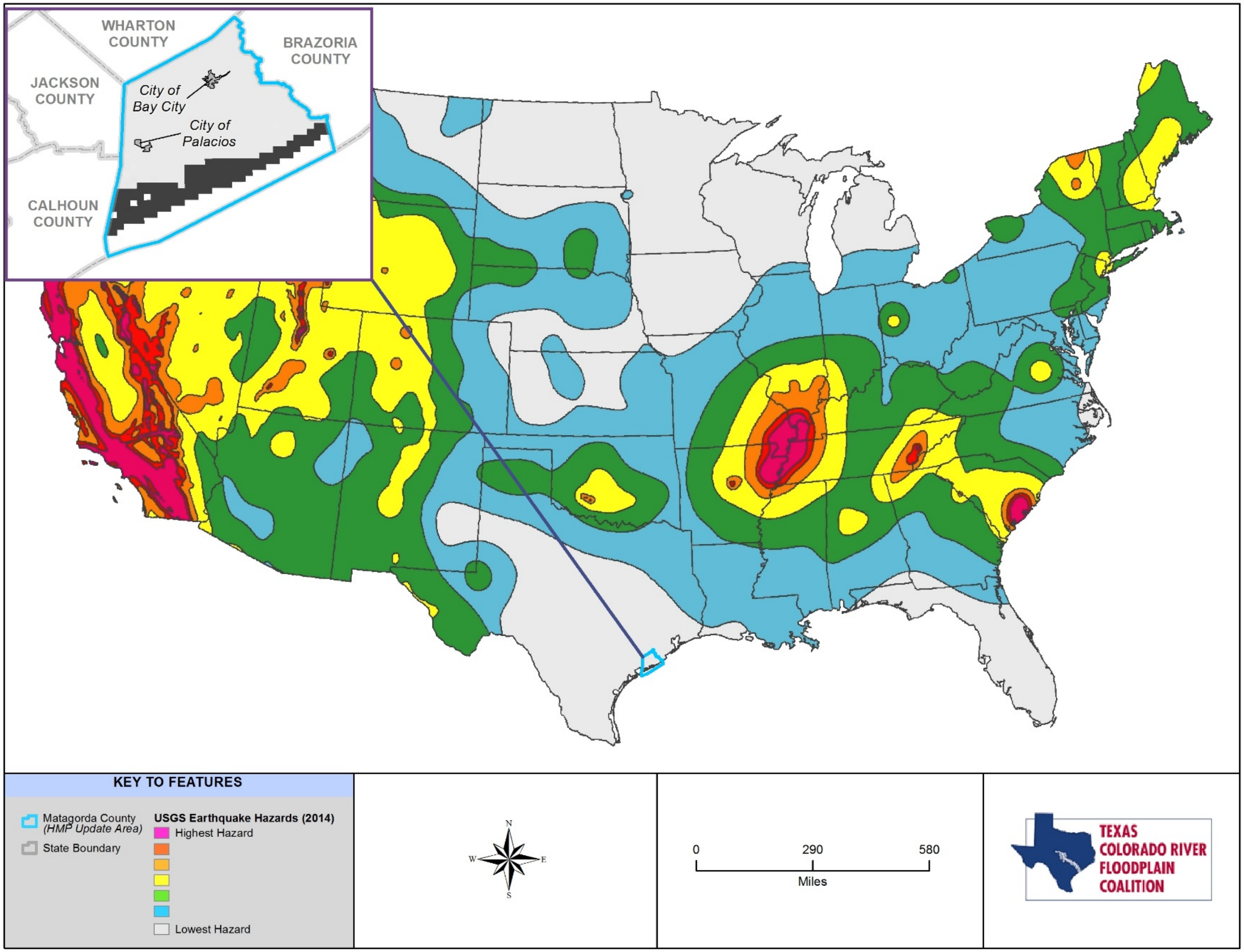


Figure 11-2. Probabilistic Earthquake Hazard Map for the U.S.

Faults have been classified based on the geologic time frame of their latest suspected movement (in order of activity occurrence, most recent is listed first):

- H Holocene (within past 15,000 years)
- LQ Late Quaternary (15,000 to 130,000 years ago)
- MLQ Middle to Late Quaternary (130,000 to 750,000 years ago)
- Q Quaternary (approximately past 2 million years)
- LC Late Cenozoic (approximately past 23.7 million years)

Known named faults in Texas are the Balcones Fault Zone, Mexia Fault Zone, Luling Fault Zone, Hueco Bolson, Marathon Uplift, and Talco Fault Zone.

The impact of an earthquake is largely a function of the following components:

- Ground shaking (ground motion accelerations)
- Liquefaction (soil instability)
- Distance from the source (both horizontally and vertically)

No earthquake scenarios were selected for this plan because an earthquake event for the planning area is rare, according to the *2013 State of Texas Hazard Mitigation Plan*.

11.2.3 Frequency

According to the USGS, the probability that a magnitude 5 or greater earthquake will occur in the planning area in the next few years is unlikely (event not probable in next 10 years). The USGS Earthquake Probability Mapping application estimates that the probability that a magnitude 5 or greater earthquake will occur in the next 500 years in Matagorda County and the participating community is 2 percent or less. Overall, the probability of a damaging earthquake somewhere in Matagorda County and participating community is considered rare. Small earthquakes that cause no or little damage are more likely (see Figure 11-2). The future probability of an earthquake event in Matagorda County and the participating communities is unlikely (event not probable in next 10 years).

11.2.4 Severity

Earthquakes can cause structural damage, injury, and loss of life, as well as damage to infrastructure networks, such as water, power, communication, and transportation lines. Damage and life loss can be particularly devastating in communities where buildings were not designed to withstand seismic forces (e.g., historic structures). Other damage-causing effects of earthquakes include surface rupture, fissuring, settlement, and permanent horizontal and vertical shifting of the ground. Secondary impacts can include landslides, rock falls, liquefaction, fires, dam failure, and hazardous materials incidents.

There are no known deaths or injuries from earthquakes in Matagorda County and the participating communities. Some of the past earthquake events in Texas were severe enough to cause minor property damage such as broken windows or contents falling from shelves. The very low probability of an event suggests that potential for these impacts is minimal.

The severity of an earthquake can be expressed in terms of intensity or magnitude. Intensity represents the observed effects of ground shaking on people, buildings, and natural features. The USGS has created ground motion maps based on current information about several fault zones. These maps show the PGA that has a certain probability (2% or 10%) of being exceeded in a 50-year period, as shown on Figure 11-3. The PGA is measured in numbers of g's (the acceleration associated with gravity). The HAZUS modeled 500-Year probabilistic PGA is less than 2% as shown in Figure 11-4. Figure 11-4 shows the 500-year probability event, which produces only a light ground shaking and is likely to cause no damage. Vibrations feel like those of a heavy truck passing by. This means that during an event of such magnitude, dishes, windows, and doors rattle; walls and frames of structures creak; liquids in open vessels are slightly disturbed; and standing vehicles rock noticeably.

Magnitude is related to the amount of seismic energy released at the hypocenter of an earthquake. It is calculated based on the amplitude of the earthquake waves recorded on instruments. Whereas intensity varies depending on location with respect to the earthquake epicenter, magnitude is represented by a single, instrumentally measured value for each earthquake event.

In simplistic terms, the severity of an earthquake event can be measured in the following terms:

- How hard did the ground shake?
- How did the ground move? (horizontally or vertically)
- How stable was the soil?
- What is the fragility of the built environment in the area of impact?

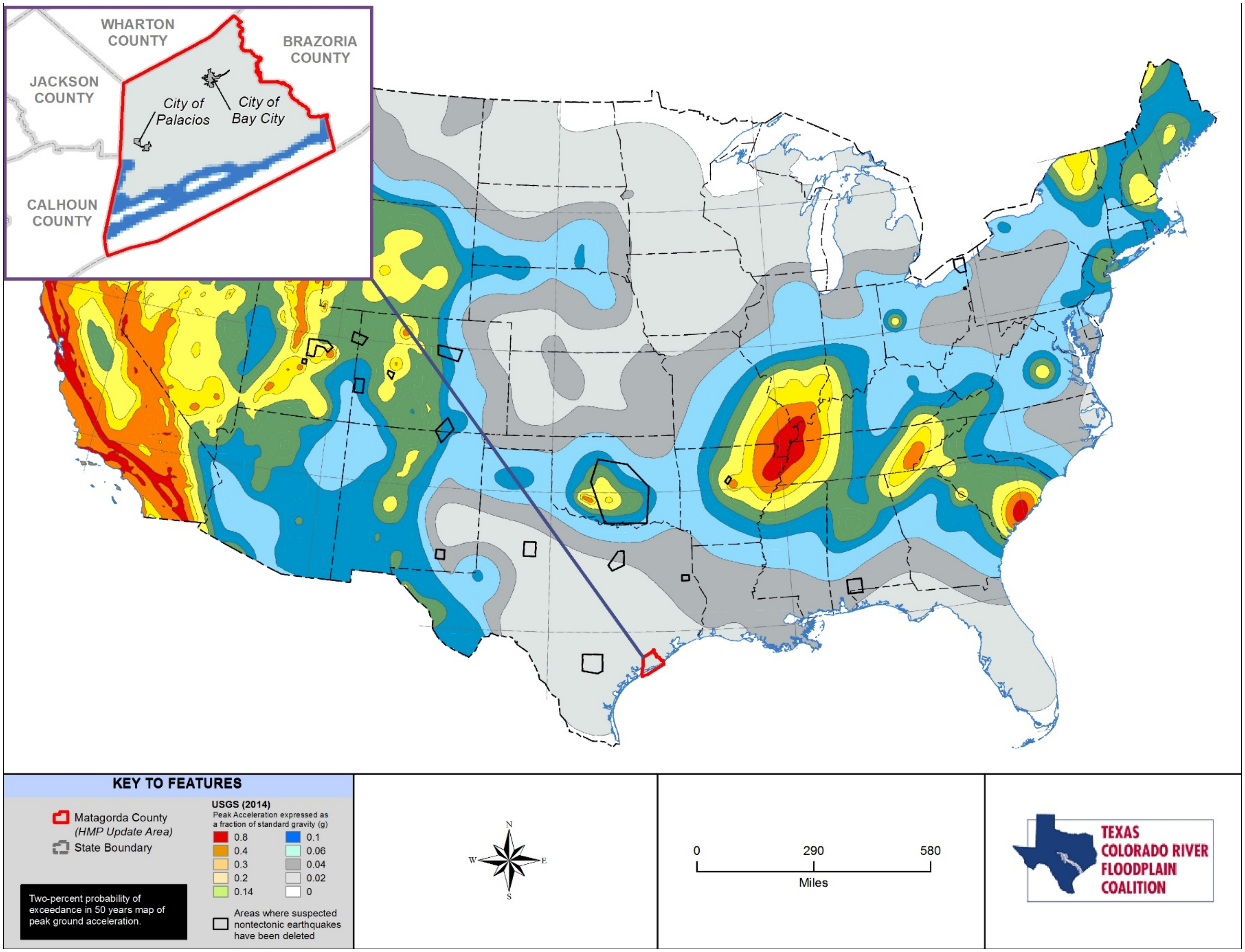
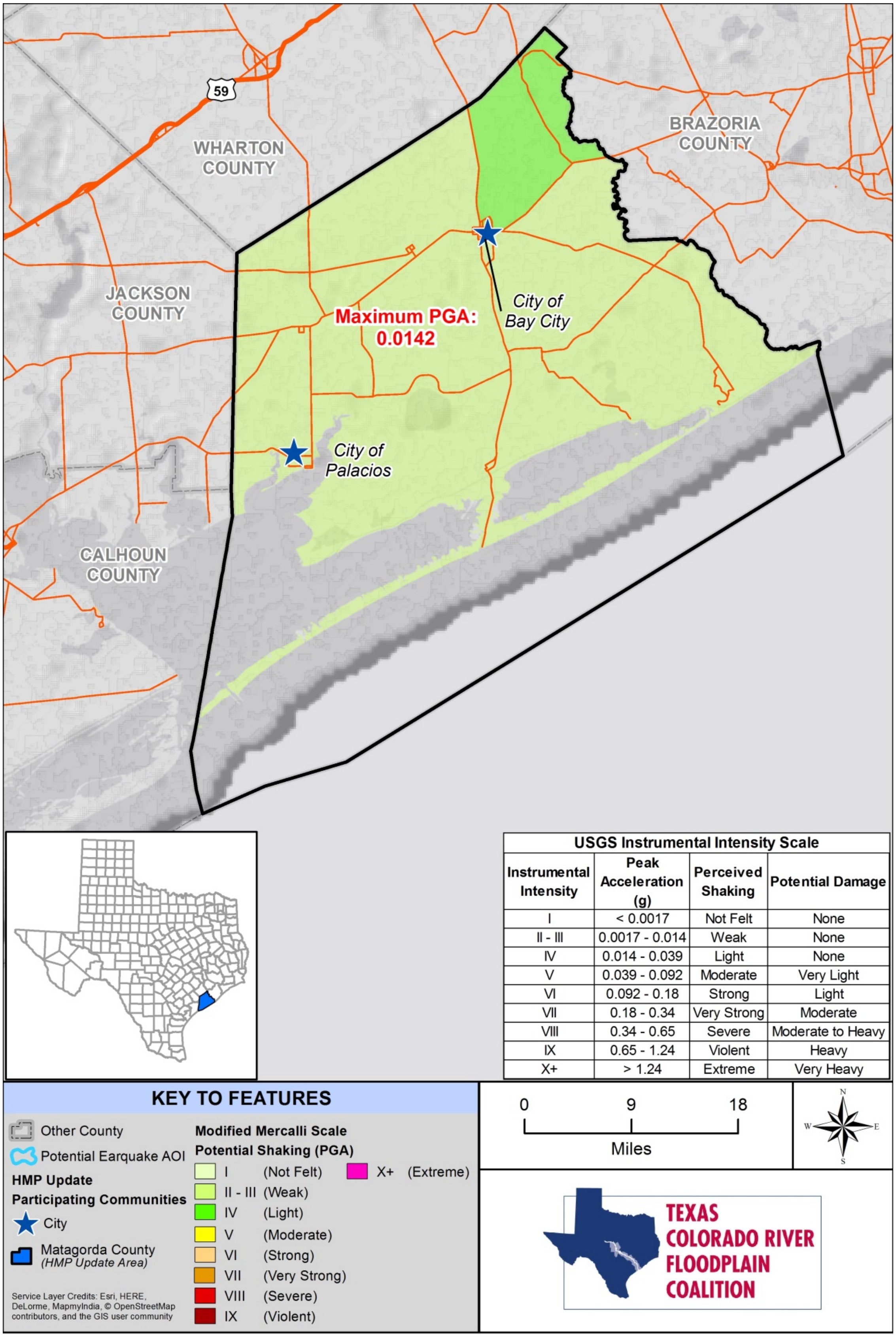


Figure 11-3. Peak Ground Acceleration (10% Probability of Exceedance in 50-Year Map of Peak Ground Acceleration)



USGS Instrumental Intensity Scale

Instrumental Intensity	Peak Acceleration (g)	Perceived Shaking	Potential Damage
I	< 0.0017	Not Felt	None
II - III	0.0017 - 0.014	Weak	None
IV	0.014 - 0.039	Light	None
V	0.039 - 0.092	Moderate	Very Light
VI	0.092 - 0.18	Strong	Light
VII	0.18 - 0.34	Very Strong	Moderate
VIII	0.34 - 0.65	Severe	Moderate to Heavy
IX	0.65 - 1.24	Violent	Heavy
X+	> 1.24	Extreme	Very Heavy

Figure 11-4. 500-Year Probability Event in Matagorda County

11.2.5 Warning Time

Part of what makes earthquakes so destructive is that they generally occur without warning. The main shock of an earthquake can usually be measured in seconds, and rarely lasts for more than a minute. Aftershocks can occur within the days, weeks, and even months following a major earthquake.

By studying the geologic characteristics of faults, geoscientists can often estimate when the fault last moved and estimate the magnitude of the earthquake that produced the last movement. Because the occurrence of earthquakes is relatively low to none in the county and the historical earthquake record is short, accurate estimations of magnitude, timing, or location of future dangerous earthquakes in Matagorda County are difficult to estimate.

There is currently no reliable way to predict the day or month that an earthquake will occur at any given location. Research is being done with warning systems that use the low energy waves that precede major earthquakes. These potential warning systems give approximately 40 seconds notice that a major earthquake is about to occur. The warning time is very short but it could allow for someone to get under a desk, step away from a hazardous material they are working with, or shut down sensitive equipment.

11.3 SECONDARY HAZARDS

Earthquakes can cause large and sometimes disastrous landslides and mudslides. River valleys are vulnerable to slope failure, often as a result of loss of cohesion in clay-rich soils. Soil liquefaction occurs when water-saturated sands, silts, or gravelly soils are shaken so violently that the individual grains lose contact with one another and float freely in the water, turning the ground into a pudding-like liquid. Building and road foundations lose load-bearing strength and may sink into what was previously solid ground. Unless properly secured, hazardous materials can be released, causing significant damage to the environment and people. Earthen dams and levees are highly susceptible to seismic events and the impacts of their eventual failures can be considered secondary risks for earthquakes.

11.4 CLIMATE CHANGE IMPACTS

The impacts of global climate change on earthquake probability are unknown. Some scientists say that melting glaciers could induce tectonic activity. As ice melts and water runs off, tremendous amounts of weight are shifted on the earth's crust. As newly freed crust returns to its original, pre-glacier shape, it could cause seismic plates to slip and stimulate volcanic activity according to research into prehistoric earthquakes and volcanic activity. National Aeronautics and Space Administration (NASA) and USGS scientists found that retreating glaciers in southern Alaska may be opening the way for future earthquakes (NASA 2004).

Secondary impacts of earthquakes could be magnified by climate change. Soils saturated by repetitive storms could experience liquefaction during seismic activity due to the increased saturation. Dams storing increased volumes of water due to changes in the hydrograph could fail during seismic events. There are currently no models available to estimate these impacts.

11.5 EXPOSURE

Structures, people, and infrastructure within the participating communities are minimally vulnerable to potential earthquake damages. The *FEMA How-To Guidance, Understanding Your Risks* (FEMA 386-2, page 1-7), suggests the earthquake hazard should be profiled if the PGA is greater than 3%g. Matagorda County and all participating communities PGA is less than 2%g (.02) and there have been no recorded earthquakes in or near the HMP update area. Furthermore, Matagorda County and participating communities do not have any geologic fault lines running though their jurisdiction (See Figure 11-1). Therefore, only a minimum level-1 HAZUS analysis was profiled using the 500-year probability event scenario. The HAZUS analysis produced a maximum PGA of 1.42% (0.0142) for the entire planning area.

11.5.1 Population

The populations along the major geologic fault lines are the most potentially exposed to direct and indirect impacts from earthquakes. There are no fault lines within the HMP update area (See Figure 11-1), therefore, the risk to population is low. The entire county population is at an extremely minimal risk with an event in next few years unlikely (event not probable in next 10 years). The degree of exposure is dependent on many factors, including the age and construction type of the structures people live in, the soil type their homes are constructed on, their proximity to fault location, and other factors. Whether impacted directly or indirectly, the entire population will have to deal with the consequences of earthquakes to some degree. Business interruption could keep people from working, road closures could isolate populations, and functional loss of utilities could impact populations that suffered no direct damage from an event itself.

11.5.2 Property

According to the Matagorda County HAZUS 2.2 inventory data (updated with 2010 U.S. Census Data and 2014 RS Means Square Foot Costs), there are 16,635 buildings within the census blocks that define the planning area with an asset replaceable value of over $4 million (excluding contents). About 98.5% of these buildings (and 83.4% of the building value) are associated with residential housing. Within the participating communities in the HMP update area, there are an estimated 14,544 buildings (residential, commercial, and other) with a total asset inventory (excluding contents) value of over $3.6 million. Other types of buildings in this report include agricultural, education, religious, and governmental structures. All the structures along the major geologic fault lines in the planning area are susceptible to earthquake impacts to varying degrees. There are no fault lines within the HMP update area (See Figure 11-1), therefore the HMP Area is at an extremely minimal risk.

11.5.3 Critical Facilities and Infrastructure

All critical facilities and infrastructure in the planning area are exposed to the earthquake hazard. Table 6-3 and Table 6-4 list the number of each type of facility by jurisdiction. Hazardous material releases can occur during an earthquake from fixed facilities or transportation-related incidents. Transportation corridors can be disrupted during an earthquake, leading to the release of materials to the surrounding environment. Facilities holding hazardous materials are of particular concern because of possible isolation of neighborhoods surrounding them. During an earthquake, structures storing these materials could rupture and leak into the surrounding area or an adjacent waterway, having a disastrous effect on the environment.

11.5.4 Environment

Secondary hazards associated with earthquakes will likely have some of the most damaging effects on the environment. Earthquake-induced landslides can significantly impact surrounding habitat. It is also possible for streams to be rerouted after an earthquake. This can change the water quality, possibly damaging habitat and feeding areas. There is a possibility of streams fed by groundwater drying up because of changes in underlying geology.

11.6 VULNERABILITY

Due to the low risk of occurrence, only a minimum level-1 HAZUS 500-year probability event analysis was conducted. The 500-Year HAZUS modeled event for Matagorda County and the participating communities produced a maximum PGA of 1.42%g (Figure 11-4), which is lower than the FEMA PGA minimum requirement for earthquake analysis (3%g). The potential shaking (0.0142 PGA) of the 500-year event in Matagorda County (and all participating communities) creates a ‘weak’ perceived shaking with no potential damage on the USGS Instrumental Intensity Scale. While the probability of an event is rare, if an event were to occur, it would be of minimal magnitude with no damage.

Due to no previous earthquake events in the planning area and the rare likelihood that such an earthquake event may occur for Matagorda County and the participating communities, annualized economic losses from the HAZUS 500-Year modeled event produced $0. Matagorda County and participating communities can expect no loss of functionality for critical facilities and infrastructures, utility, transportation, and other essential services.

Vulnerability Narrative

The vulnerability of the participating community are described below.

- **City of Bay City -** The City of Bay City classified the hazard risk as 'Low' due to the number of previous events (0), probability of future events (minimal), PGA of less than 2%, and local knowledge. In the event of an extreme Earthquake event surpassing the 500-Year HAZUS modeled event, 1 fire and 3 police departments, 1 medical facility and 10 schools could be affected.
- **City of Palacios-** The City of Palacios classified the hazard risk as 'Low' due to the number of previous events (0), probability of future events (minimal), PGA of less than 2%, and local knowledge. In the event of an extreme Earthquake event surpassing the 500-Year HAZUS modeled event, 1 fire and 1 police department, 1 medical facility, 3 schools and 1 hazardous material facility could be affected.
- **Matagorda County (Unincorporated Area)** – The Unincorporated Areas of Matagorda County classified as the hazard risk as 'Low' due to the number of previous events (0), probability of future events (minimal), PGA of less than 2%, and local knowledge. In the event of an extreme Earthquake event surpassing the 500-Year HAZUS modeled event, 1 fire department, 6 schools and 14 hazardous materials facilities could be affected.

Community Perception of Vulnerability

See front page of current chapter for a summary of hazard rankings for Matagorda County and participating communities in this plan update. Chapter 19 gives a detailed description of this rankings and Chapter 20 addresses mitigations actions for this hazard vulnerability.

11.7 FUTURE TRENDS IN DEVELOPMENT

Land use in the planning area will be directed by master plans adopted by the county and its planning partners as well as local permitting departments and zoning maps. The information in this plan provides the participating partners a tool to ensure that there is no increase in exposure in areas of high seismic risk. Development in the planning area will be regulated through building standards and performance measures so that the degree of risk will be reduced. The International Building Code also establishes provisions to address seismic risk.

11.8 SCENARIO

An earthquake does not have to occur within the planning area to have a significant impact on the people, property and economy of the county. However, any seismic activity of 6.0 or greater on faults within the planning area would have significant impacts throughout the county. Earthquakes of this magnitude or higher would lead to massive structural failure of property on highly liquefiable soils. Levees and revetments built on these poor soils would likely fail, representing a loss of critical infrastructure. These events could cause secondary hazards, including landslides and mudslides that would further damage structures. River valley hydraulic-fill sediment areas are also vulnerable to slope failure, often as a result of loss of cohesion in clay-rich soils.

11.9 ISSUES

Important issues associated with an earthquake include but are not limited to the following:

- Many structures within the planning area were built prior to 1994, when seismic provisions became uniformly applied through building code applications.
- Critical facility owners should be encouraged to create or enhance continuity of operations plans using the information on risk and vulnerability contained in this plan.
- Geotechnical standards should be established that take into account the probable impacts from earthquakes in the design and construction of new or enhanced facilities.
- Earthquakes could trigger other natural hazard events such as dam failures and landslides, which could severely impact the county.
- A worst-case scenario would be the occurrence of a large seismic event during a flood or high-water event. Failures could happen at multiple locations, increasing the impacts of the individual events.
- The cost of retrofitting buildings to meet earthquake seismicity standards may be cost-prohibitive.
- Dams located in the county may not have been engineered to withstand probable seismic events.
- Information regarding liquefaction susceptibility of soils in the planning area is lacking.

CHAPTER 12.
FLOOD

FLOOD RANKING	
Matagorda County	Medium
City of Bay City	Low
City of Palacios	Medium

DEFINITIONS

Flood — The inundation of normally dry land resulting from the rising and overflowing of a body of water.

Floodplain — The land area along the sides of a river that becomes inundated with water during a flood.

100-Year Floodplain — The area flooded by a flood that has a 1% chance of being equaled or exceeded each year. This is a statistical average only; a 100-year flood can occur more than once in a short period of time. The 1% annual chance flood is the standard used by most federal and state agencies.

Riparian Zone — The area along the banks of a natural watercourse.

12.1 GENERAL BACKGROUND

12.1.1 Flood

The following description of flooding is an excerpt from the *2013 State of Texas Flood Mitigation Plan*.

A flood is a general and temporary condition of partial or complete inundation of normally dry land areas from:

- The overflow of stream banks
- The unusual and rapid accumulation of runoff of surface waters from any source
- Mudflows or the sudden collapse of shoreline land

Flooding results when the flow of water is greater than the normal carrying capacity of the stream channel. Rate of rise, magnitude (or peak discharge), duration, and frequency of floods are a function of specific physiographic characteristics. Generally, the rise in water surface elevation is quite rapid on small (and steep gradient) streams and slow in large (and flat sloped) streams.

The causes of floods relate directly to the accumulation of water from precipitation, or the failure of man-made structures, such as dams or levees. Floods caused by precipitation are further classified as coming from: rain in a general storm system, rain in a localized intense thunderstorm, melting snow and ice, and hurricane/tropical storms. Floods may also be caused by structural or hydrologic failures of dams or levees. A hydrologic failure occurs when the volume of water behind the dam or levee exceeds the structure‘s capacity resulting in overtopping. Structural failure arises when the physical stability of the dam or levee is compromised due to age, poor construction and maintenance, seismic activity, rodent tunneling, or myriad other causes. For more information on floods resulting from dam and levee failure refer to Chapter 9 of this plan.

General Rain Floods

General rain floods can result from moderate to heavy rainfall occurring over a wide geographic area lasting several days. They are characterized by a slow steady rise in stream stage and a peak flood of long duration. As various minor streams empty into larger and larger channels, the peak discharge on the mainstream channel may progress upstream or downstream (or remain stationary) over a considerable length of river. General rain floods can result in considerably large volumes of water. Because the rate of rise is slow and the time available for warning is great, few lives are usually lost, but millions of dollars in valuable public and private property are at risk.

Thunderstorm Floods

Damaging thunderstorm floods are caused by intense rain over basins of relatively small area. They are characterized by a sudden rise in stream level, short duration, and a relatively small volume of runoff.

Because there is little or no warning time, the term “flash flood” is often used to describe thunderstorm floods. Texas is known as the “Flash Flood Alley” and the area along the Balcones Escarpment (from Austin south to San Antonio, then west to Del Rio) is one of the nation's three most flash flood-prone regions. Figure 12-1 and Figure 12-2 show the number of flash floods and storm centers in each county. Matagorda County does not lies in the path of the “Flash Flood Alley” but does experience 2 to 3 flash floods per year.

Thunderstorm floods occur in every month of the year in Texas but are most common in the spring and summer. The mean annual number of thunderstorm flood days varies from 40 in eastern Texas to 60 in western Texas. Most flash flooding is caused by slow-moving thunderstorms, thunderstorms repeatedly moving over the same area, or heavy rains from hurricanes and tropical storms.

Flash floods can occur within a few minutes or after hours of excessive rainfall. Flash floods can roll boulders, tear out trees, destroy buildings and bridges, and carve out new channels. Rapidly rising water can reach heights of thirty feet or more. Flash flood-producing rains can also trigger catastrophic mudslides. Often there is no warning that flash floods are coming. Hill Country flash floods devastated the river basin and are a major reason why the LCRA located Mansfield Dam and Lake Travis (the flood control components of the Highland Lake chain) upstream of Austin. Flash flooding poses a deadly danger to residents of the Lower Colorado River Basin. A number of roads run through low-lying areas that are prone to sudden and frequent flooding during heavy rains. Motorists often attempt to drive through barricaded or flooded roadways. It takes only 18 to 24 inches of water moving across a roadway to carry away most vehicles. Floating cars easily get swept downstream, making rescues difficult and dangerous.

Rain on Snowmelt Floods

Winter is the driest time of the year in Texas. Snowfall occurs at least once every winter in the northern half of Texas, although accumulations rarely are substantial except in the High Plains. Snow is not uncommon in the mountainous areas of the Trans-Pecos, though heavy snows (five inches or more) come only once every two or three winters. More often than not, snow falling in the southern half of the state melts and does not stick to the surface; snow stays on the ground only once or twice in every decade. Snowfall rarely is observed before early November and hardly ever occurs after mid-April. Where it is not uncommon, snow is almost always heaviest in either January or February. Mean seasonal snowfall is 15 to 18 inches in the Texas Panhandle and 4 to 8 inches elsewhere in the High and Low Rolling Plains.

Hurricanes and Tropical Storms

The United States has a significant hurricane problem. More than 60% of the U.S. population live in coastal states from Maine to Texas, Washington to California, Hawaii, and Puerto Rico. In the United States, the Atlantic and Gulf Coast coastlines are densely populated and many regions lie less than 3 meters (10 feet) above mean sea level.

Matagorda County, being a Texas Gulf Coast County, is exposed to flooding from hurricanes and tropical storms. Coastal flooding triggered by hurricanes is as destructive as wind but can be even more deadly, and is by far the greatest threat to life and property along the coastline. Storm surge, wave, and tides are the greatest contributors to coastal flooding, while precipitation and river flow also contribute during some storms. Hurricanes produce soaking rain, high winds, flying debris, storm surges, tornadoes, and often the most deadly of all, inland flooding. Rain-triggered flooding is not just limited to coastlines. The reach of a large hurricane can cause deadly flooding well inland to communities hundreds of miles from the coast as intense rain falls from these huge tropical air masses. Increased flooding and erosion rates may cause landslides in some areas, especially mountainous regions.

Besides causing extensive damage in coastal areas, hurricanes and tropical storms can often cause extensive damages to communities several miles inland. Just a few inches of water from a flood can cause tens of thousands of dollars in damage. Examples include Hurricane Katrina, Hurricane Ike, and Tropical Strom Allison. For more information on floods resulting from hurricanes and tropical storms, refer to Chapter 13 of this plan.

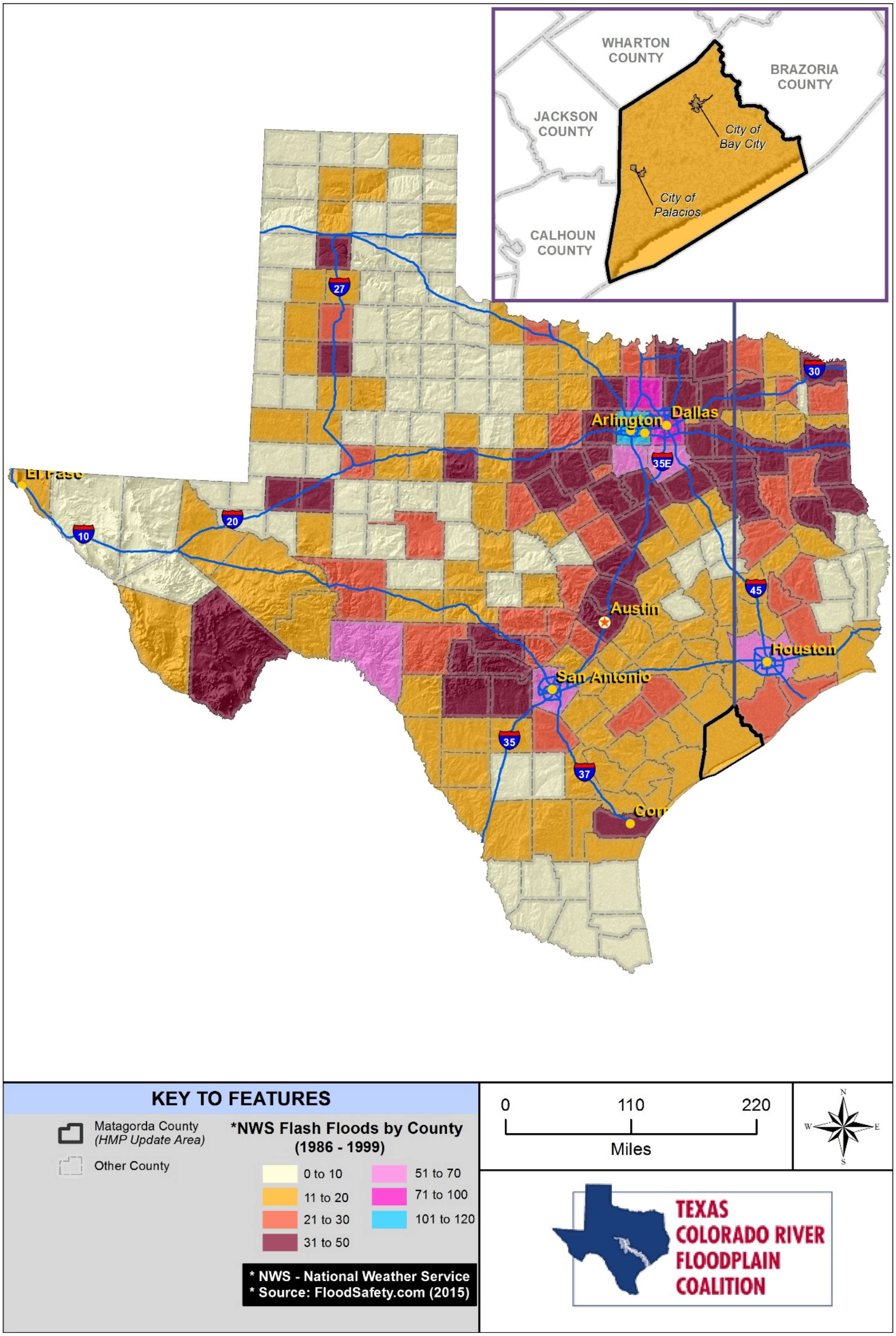


Figure 12-1. Number of Flash Floods in Texas per County (1986-1999)

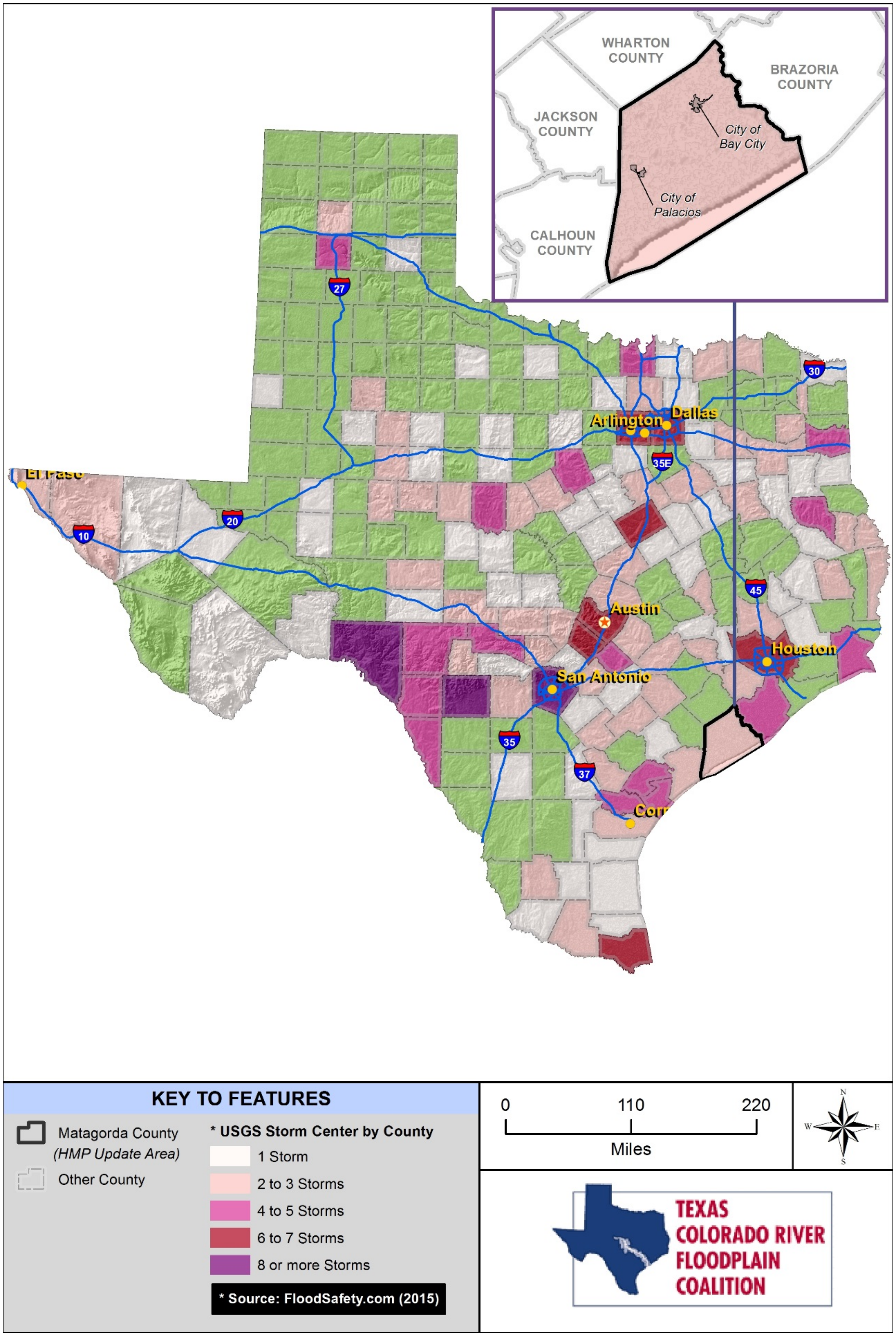


Figure 12-2. Number of Storm Centers in Texas by County

12.1.2 Floodplain

A floodplain is the area adjacent to a river, creek, or lake that becomes inundated during a flood. Floodplains may be broad, as when a river crosses an extensive flat landscape, or narrow, as when a river is confined in a canyon.

When floodwaters recede after a flood event, they leave behind layers of rock and mud. These gradually build up to create a new floor of the floodplain. Floodplains generally contain unconsolidated sediments (accumulations of sand, gravel, loam, silt, or clay), often extending below the bed of the stream. These sediments provide a natural filtering system, with water percolating back into the ground and replenishing groundwater. These are often important aquifers, the water drawn from them being filtered compared to the water in the stream. Fertile, flat reclaimed floodplain lands are commonly used for agriculture, commerce, and residential development.

Connections between a river and its floodplain are most apparent during and after major flood events. These areas form a complex physical and biological system that not only supports a variety of natural resources but also provides natural flood and erosion control. When a river is separated from its floodplain with levees and other flood control facilities, natural, built-in benefits can be lost, altered, or significantly reduced.

12.1.3 Measuring Floods and Floodplains

The frequency and severity of flooding are measured using a discharge probability, which is the probability that a certain river discharge (flow) level will be equaled or exceeded in a given year. Flood studies use historical records to estimate the probability of occurrence for the different discharge levels. The flood frequency equals 100 divided by the discharge probability. For example, the 100-year discharge has a 1% chance of being equaled or exceeded in any given year. These measurements reflect statistical averages only; it is possible for two or more floods with a 100-year or higher recurrence interval to occur in a short time period. The same flood can have different recurrence intervals at different points on a river.

The extent of flooding associated with a 1% annual probability of occurrence (the base flood or 100-year flood) is used as the regulatory boundary by FEMA and many agencies. Also referred to as the special flood hazard area (SFHA), this boundary is a convenient tool for assessing vulnerability and risk in flood-prone communities. Many communities have maps that show the extent and likely depth of flooding for the base flood. Corresponding water surface elevations describe the elevation of water that will result from a given discharge level, which is one of the most important factors used in estimating flood damage.

12.1.4 Floodplain Ecosystems

Floodplains can support ecosystems that are rich in plant and animal species. A floodplain can contain 100 or even 1,000 times as many species as a river. Wetting of the floodplain soil releases an immediate surge of nutrients: those left over from the last flood, and those that result from the rapid decomposition of organic matter that has accumulated since then. Microscopic organisms thrive and larger species enter a rapid breeding cycle. Opportunistic feeders (particularly birds) move in to take advantage. The production of nutrients peaks and falls away quickly, but the surge of new growth endures for some time. This makes floodplains valuable for agriculture. Species growing in floodplains are markedly different from those that grow outside floodplains. For instance, riparian trees (trees that grow in floodplains) tend to be very tolerant of root disturbance and very quick-growing compared to non-riparian trees.

12.1.5 Effects of Human Activities

Because they border water bodies, floodplains have historically been popular sites to establish settlements. Human activities tend to concentrate in floodplains for a number of reasons: water is readily available; land is fertile and suitable for farming; transportation by water is easily accessible; and land is flatter and easier to develop. However, human activity in floodplains frequently interferes with the natural function of floodplains. It can affect the distribution and timing of drainage, thereby increasing flood problems. Human development can create local flooding problems by altering or confining drainage channels. This increases flood potential in two ways: it reduces the stream's capacity to contain flows, and it increases flow rates or velocities downstream during all stages of a flood event. Human activities can interface effectively with a floodplain as long as steps are taken to mitigate the activities' adverse impacts on floodplain functions.

12.2 HAZARD PROFILE

Texas has the most flash flood deaths of any state in the country. Although Matagorda County and participating communities do not fall in the "Flash Flood Alley" area of Texas, it does receive 2 to 3 flash flood events every year. The terrain is punctuated by a large number of limestone or granite rocks and boulders and a thin layer of topsoil, which makes the region very dry and prone to flash flooding. Other factors contributing to flash floods in the area include its location between the Rocky Mountains and the moisture laden Gulf of Mexico. As weather systems stall and dissipate over Texas, and they drop intense rains over small areas. In the past, Matagorda County and participating communities have had significant seasonal floods along the Colorado and Tres Palacios Rivers; however, these floods have been greatly reduced by the construction of large reservoirs along the Colorado River. This has also helped to reduce the impacts of seasonal floods in the planning area.

Flooding in the HMP update area is mostly caused by slow-moving thunderstorms, thunderstorms repeatedly moving over the same area, or heavy rains from hurricanes and tropical storms. Flash floods can occur within a few minutes or after hours of excessive rainfall. These rain events are most often microbursts, which produce a large amount of rainfall in a short amount of time. Flash floods, by their nature, occur suddenly but usually dissipate within hours. Despite their sudden nature, the NWS is usually able to issue advisories, watches, and warnings in advance of a flood.

The potential for flooding can change and increase through various land use changes and changes to land surface. A change in environment can create localized flooding problems inside and outside of natural floodplains by altering or confining watersheds or natural drainage channels. These changes are commonly created by human activities (e.g., development). These changes can also be created by other events such as wildfires. Wildfires create hydrophobic soils, a hardening or "glazing" of the earth's surface that prevents rainfall from being absorbed into the ground, thereby increasing runoff, erosion, and downstream sedimentation of channels.

Potential flood impacts include loss of life, injuries, and property damage. Floods can also affect infrastructure (water, gas, sewer, and power utilities), transportation, jobs, tourism, the environment, and ultimately local and regional economies.

12.2.1 Past Events

The National Climatic Data Center Storm Events Database includes flood events that occurred in Matagorda County and participating communities between 1996 and 2015, as listed in Table 12-1 and shown on Figure 12-9, as well as other events from local resources and experts. Events listed as Matagorda County and participating communities in the table below affected large portions of the HMP update area and can include City of Bay City, City of Palacios, and the Matagorda County unincorporated areas. Specific events described for each participating community is counted and described below. Large flood storms may have effected additional jurisdictions.

TABLE 12-1.
HISTORIC FLOOD EVENTS IN MATAGORDA COUNTY (1996-2015)

Location	Date	Estimated Damage Cost		Injuries	Deaths
		Property	Crops		
Countywide	09/21/1996	$5,000	$0	0	0

TABLE 12-1.
HISTORIC FLOOD EVENTS IN MATAGORDA COUNTY (1996-2015)

Location	Date	Estimated Damage Cost		Injuries	Deaths
		Property	Crops		
Matagorda	10/24/1996	$15,000	$0	0	0
Matagorda (Zone)	11/16/1996	$100,000	$0	0	0
Matagorda (Zone)	04/25/1997	$10,000	$0	0	0
Countywide	05/09/1997	$5,000	$0	0	0
Matagorda (Zone)	08/21/1998	$5,000	$0	0	0
Matagorda (Zone)	09/07/1998	$28,700,000	$0	0	0
Wadsworth	09/10/1998	$0	$0	0	0
Matagorda (Zone)	10/17/1998	$0	$0	0	0
Matagorda (Zone)	11/12/1998	$0	$0	0	0
Countywide	08/31/2001	$50,000	$0	0	0
Northwest Portion	09/01/2001	$20,000	$0	0	0
Matagorda (Zone)	09/05/2002	$0	$0	0	0
Bay City	09/06/2002	$75,000	$0	0	0
Sargent	09/06/2002	$500,000	$0	0	0
Bay City	09/10/2002	$30,000	$0	0	0
Countywide	11/05/2002	$20,000	$0	0	0
Matagorda (Zone)	07/14/2003	$716,300	$0	0	0
Matagorda	09/01/2003	$30,000	$0	0	0
Matagorda (Zone)	09/01/2003	$25,000	$0	0	0
Markham	05/13/2004	$7,000	$0	0	0
Bay City	06/23/2004	$8,000	$0	0	0
Bay City	06/24/2004	$25,000	$0	0	0
Blessing	11/02/2004	$3,000	$0	0	0
Palacios	11/02/2004	$4,000	$0	0	0
Matagorda	06/20/2006	$0	$0	0	0
Midfield	07/26/2006	$4,000	$0	0	0
Matagorda	07/04/2007	$0	$0	0	0
Matagorda (Zone)	09/12/2008	$8,000,000	$0	0	0
Matagorda (Zone)	09/12/2008	$6,000,000	$0	0	0
Collegeport	01/15/2010	$2,000	$0	0	0
Gulf Hills	04/16/2012	$0	$0	0	0
Central Texas Area	5/25/2015	*	*	*	*

Source: http://www.ncdc.noaa.gov and local resources

*Ongoing

Table may list more events than are shown on related figures since some recorded events do not include specific geographic coordinates (GIS-enabled data) for precise graphical representation.

Notable past events from the NCDC Storm Events Database (and confirmed by local data) in Matagorda County and participating communities are described below:

- August 31, 2001 – A series of upper level disturbances produced heavy rain and some severe weather across southern portions of southeast Texas. Rain fall rates of one inch per hour for up to

6 hours at a time were recorded, leading to widespread street flooding, completely washing out some roads. Property damage totaled $50,000, but no injuries or fatalities were associated with the event.

- September 1, 2001 – Flash flooding in the northwest portion of the county caused $20,000 of property damage. The sheriff's office reported flooding on Highway 111 and FM 456. No injuries or fatalities were reported.
- September 6, 2002 – Several homes in Sargent were inundated as a result of a flash flood. No fatalities or injuries were associated with the storm; however, the flooding caused $500,000 of property damage.
- September 6, 2002 – Flash flooding in Bay City caused several homes to be inundated. No injuries or fatalities were reported. Property damage associated with the storm totaled $75,000.
- September 10, 2002 – Thunderstorms in the area led to flooded roads in Bay City and Cedar Lane, causing $30,000 of property damage. No injuries or fatalities were associated with the storm.
- September 1, 2003 – Heavy rains caused flash flooding in and around Matagorda. Three homes were flooded on South Highway 60, resulting in $30,000 of property damage. No injuries or fatalities were reported.
- May 13, 2004 – Flash flooding in Markham resulted in several inundated roads. Lake View, Blue Jay, and Oak Drive roads off of FM 1468 were under water. There were no injuries or fatalities reported, but property damage totaled $7,000.
- June 23, 2004 – Flash flooding on the southeast side of Bay City caused approximately $8,000 of damages and flooded roads along FM 457 and FM 2540. No injuries or fatalities were reported.
- June 24, 2004 – Heavy rains produced a flash flood in Bay City, causing several roads to be inundated. There were no injuries or fatalities resulting from the storm, but property damage totaled $25,000.
- November 2, 2004 – Flash flooding in Blessing and Palacios caused $7,000 of property damage. Residents in the Oak Hollow subdivision experienced water over roads in the area. No injuries or fatalities were reported.
- July 26, 2006 – Flash flooding occurred in Midfield, causing Highway 111 to be flooded from the city to the Jackson County line. No injuries or fatalities were reported. Property damage totaled $4,000.
- January 15, 2010 – A slow-moving coastal low system produced heavy rains that flooded several roads in the Palacios area. Collegeport area roads including St. Mary's Street, Vietnam Street and St. Joseph's Street were impassable due to flooding. No injuries or fatalities were associated with the storm. Property damage totaled $2,000.
- May 23-25, 2015 – An extreme precipitation event occurred throughout the Central and South Texas regions over Memorial Day weekend. A large volume of precipitation fell within a relatively short period of time, resulting in damaging flood waters throughout the region. According to NWS, observed rainfalls in Comal, Guadalupe, Hays, Comal, Travis, and Kerr Counties exceeded 6 inches within a 48-hour period. Areas within Blanco, Comal, and Kendall Counties received at least 8 inches within 48 hours, and a Blanco County rain gauge managed by LCRA was recorded at 9.41 inches over the same time period. On May 25, the Colorado River at Bay City reached a peak flow of approximately 60,000 cubic feet per second (Figure 12-3) and reached an elevation of 36 feet, below its flood stage of approximately 44 feet (Figure 12-4). No flood damages were reported. There were no injuries or fatalities in Matagorda County.

Source: NWS

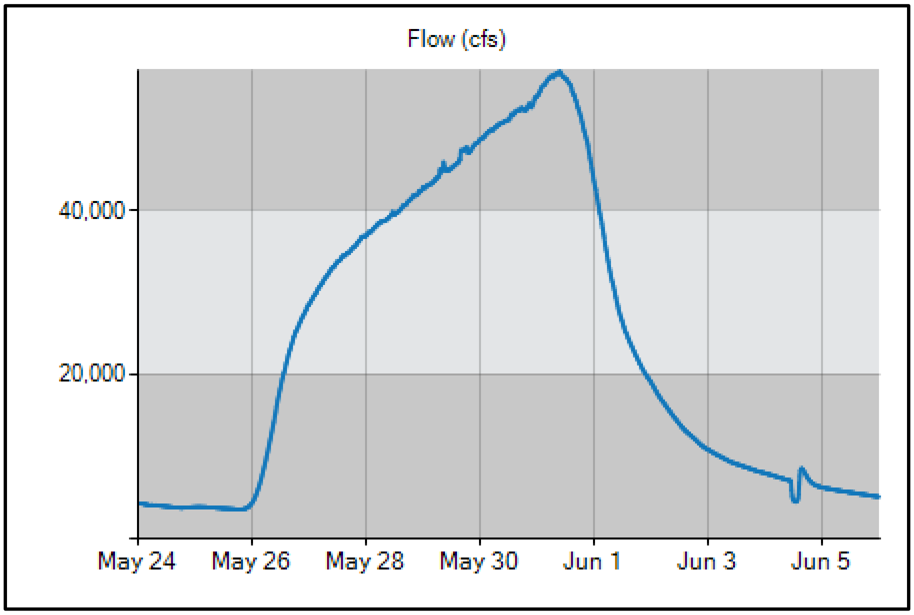


Figure 12-3. Colorado River Flow During May 2015 Flood Event at Bay City

Source: NWS

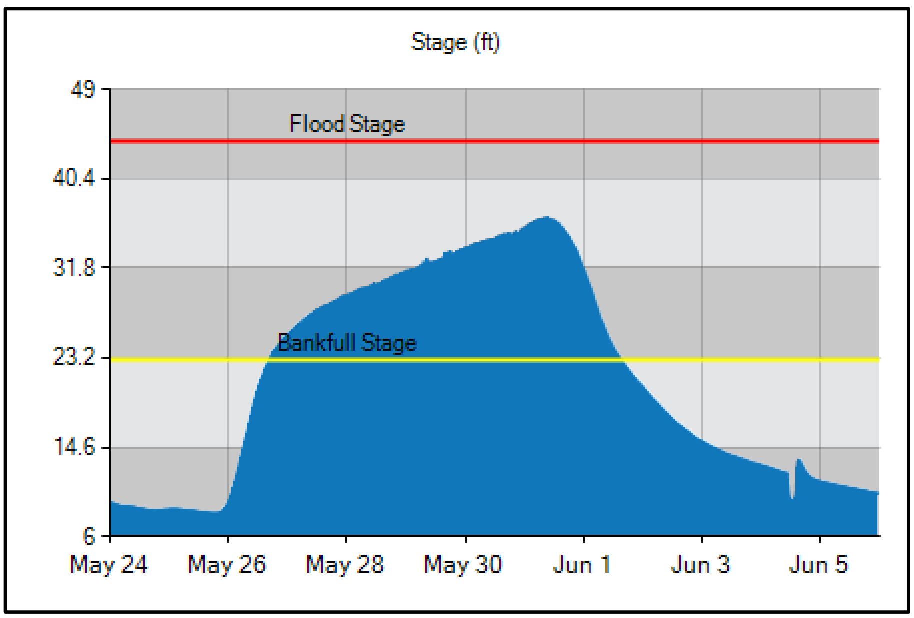


Figure 12-4. Colorado River Flood Stage During May 2015 Flood Event at Bay City

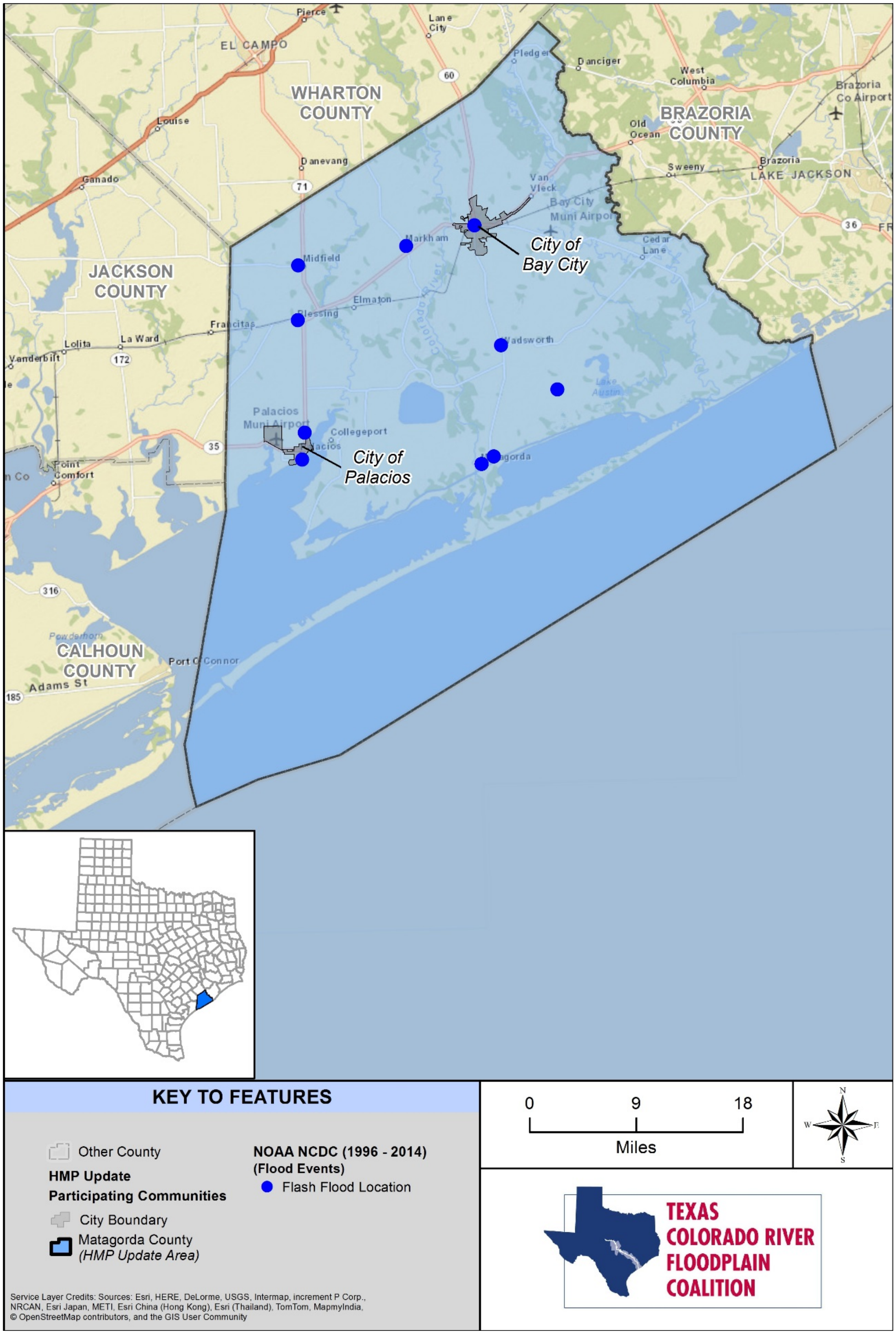


Figure 12-5. Flash Flood Events in Matagorda County and Participating Communities

12.2.2 Location

The majority of Matagorda County lies in the East Matagorda Bay Watershed. The Lower Colorado Watershed and Colorado River run north to south across through the middle of the county. Due to its relatively flat topography, few substantial waterways contribute to the Colorado River, and instead empty into the Matagorda Bay or Gulf of Mexico. The Tres Palacios River and other significant creeks, including Caney, Juanita, Wilson, and Cottonwood, serve as conduits for many bayous and sloughs throughout the county. Run-off is captured to fill several lakes and reservoirs in the county. The LCRA, Houston Lighting and Power Co., and other private owners operate several dams for water supply, power plant cooling, and flood control.

In addition to the riverine flooding, the HMP update area also may experience urban flooding caused by urbanization which can increase the run-off potential of an area. Due to its relatively small urban development, urban flooding is limited. Coastal flooding is typically a result of storm surge, wind-driven waves and heavy rainfall produced by hurricanes, tropical storms, and other large coastal storms that migrate northward from the Gulf.

The floodplain boundary extents for most of the creeks, streams, rivers, and lakes in Matagorda County and the participating communities have been mapped by FEMA during its Map Modernization Program. The resulting FIRMs provide an official depiction of flood hazard risks and risk premium zones for each community and for properties located within it. The updated county-wide maps in Matagorda County are in preliminary phase will be finalized as soon as levee verification is finalized. While the FEMA digital flood data is recognized as best available data for planning purposes, it does not always reflect the most accurate and up-to-date flood risk. Riverine flooding, stormwater flooding, and flood-related losses often do occur outside of delineated Special Flood Hazard Areas (SFHAs).

Matagorda County and the participating communities has 322,544 acres in the 100-year floodplain and 409,968 acres in the 500-year floodplain. Table 12-2 shows the distribution of the acreage across the participating jurisdictions in the planning area.

TABLE 12-2.
ACREAGE IN THE 100-YEAR AND 500-YEAR FLOODPLAIN BY JURISDICTION

Jurisdiction	Area (acres)	
	100-Year	500-Year
Unincorporated Area	320,529	405,409
City of Bay City	463	1,614
City of Palacios	1,552	2,945
Matagorda County Total	**322,544**	**409,968**

Figure 12-6 shows the SFHAs in Matagorda County. Figure 12-7 and Figure 12-8 show the SFHAs for each participating community.

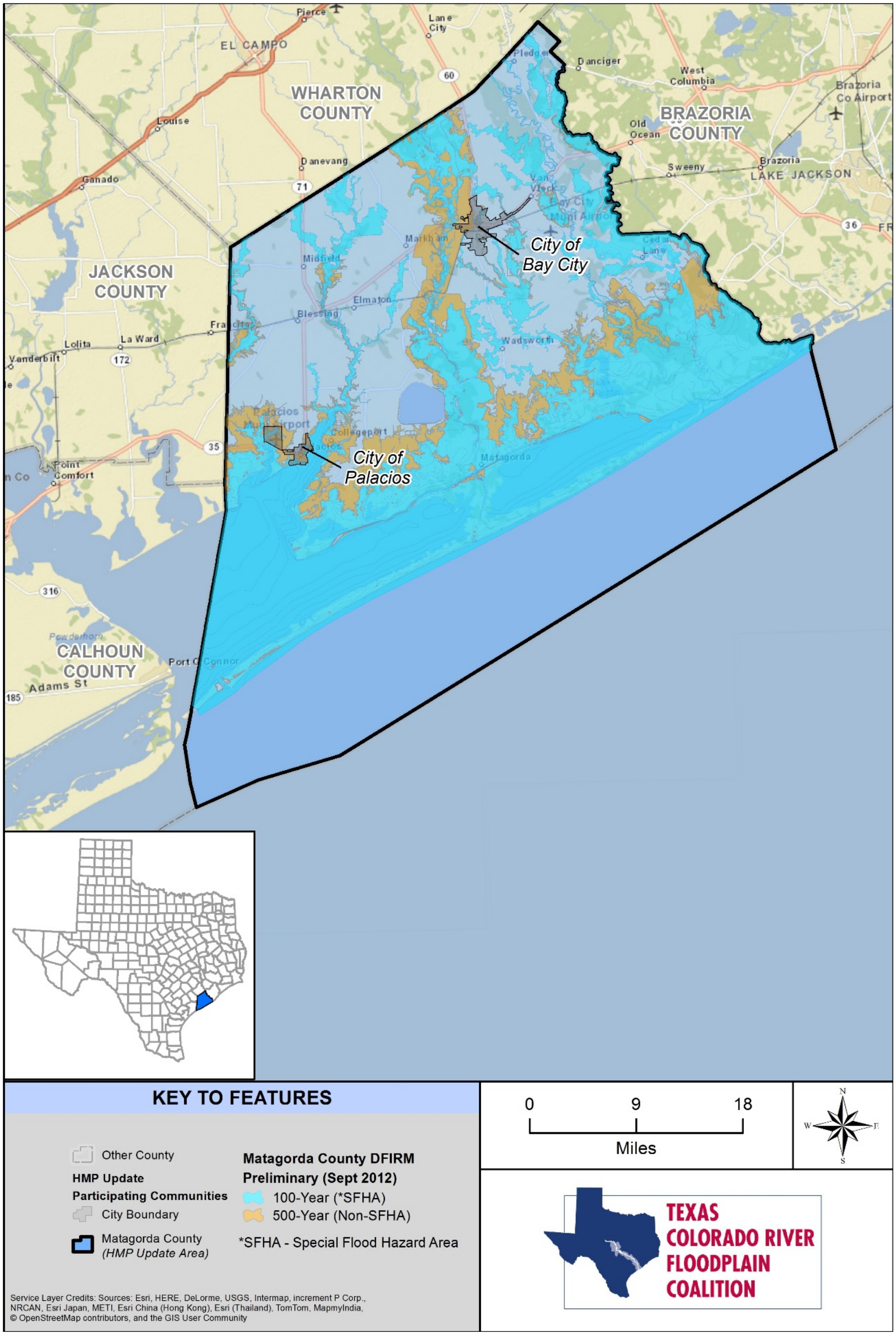


Figure 12-6. Special Flood Hazard Areas in Matagorda County and Participating Communities

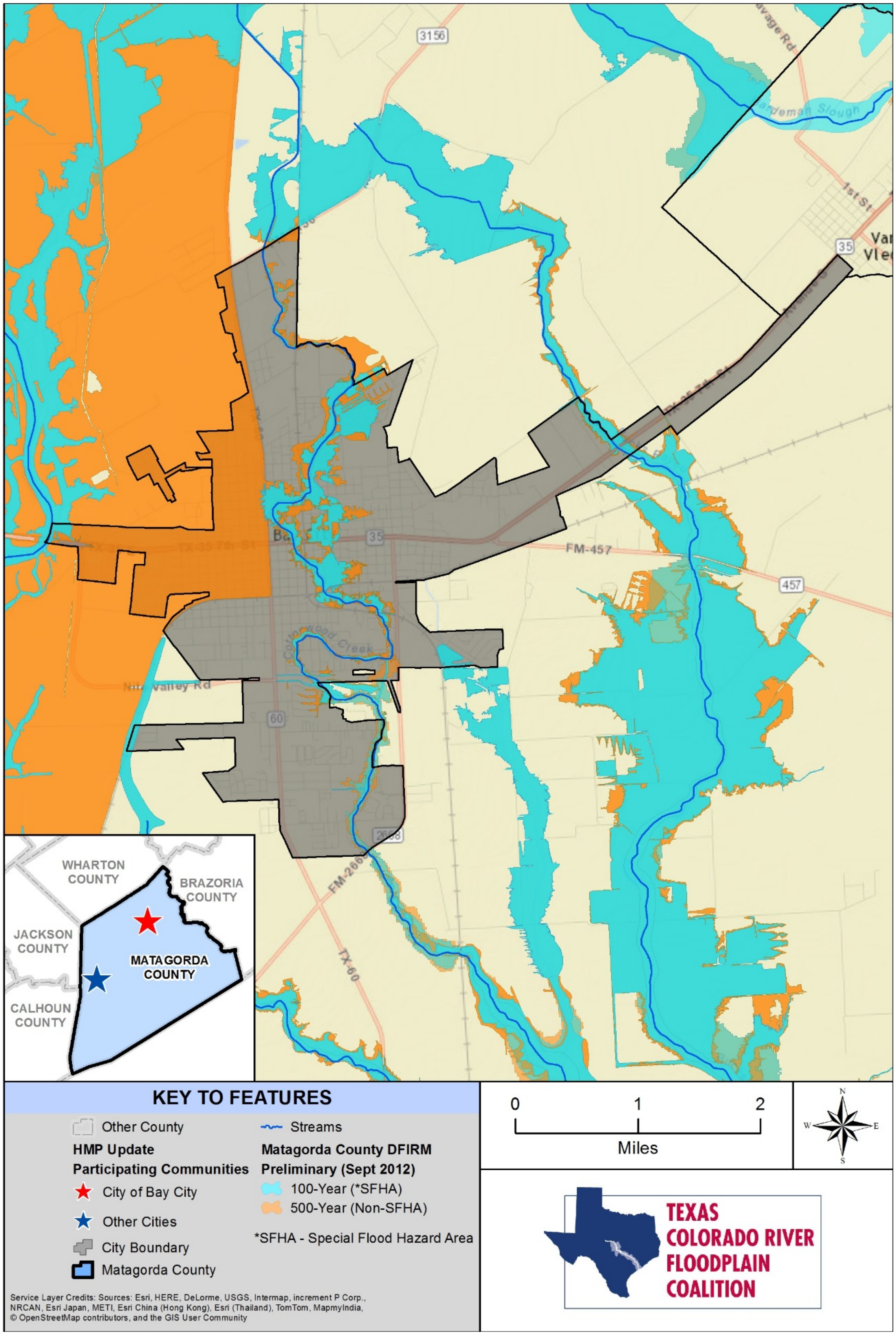


Figure 12-7. Special Flood Hazard Areas in the City of Bay City

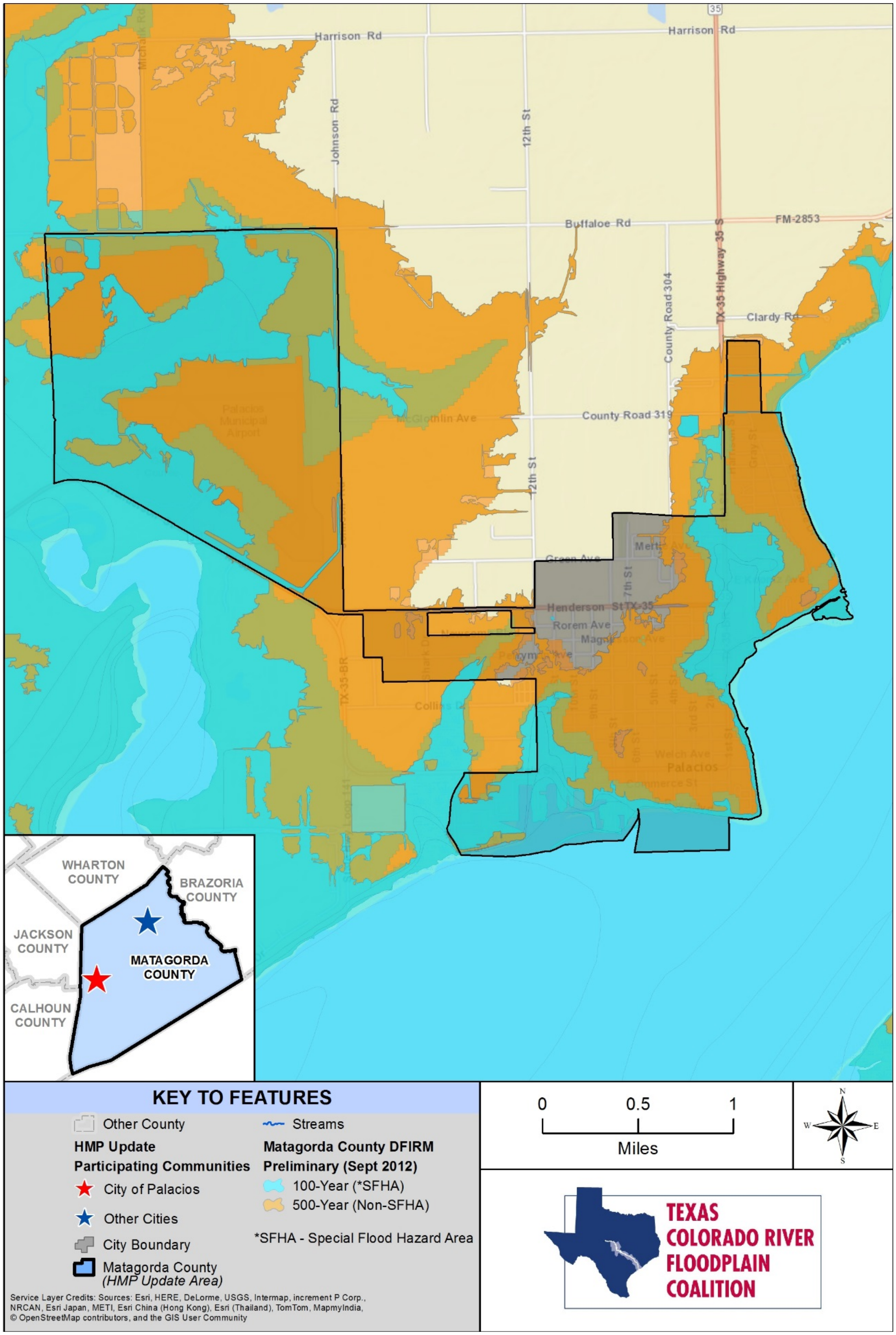


Figure 12-8. Special Flood Hazard Areas in the City of Palacios

12.2.3 Frequency

Seasonal flooding on the Colorado River have increased over time due to increase rainfall events and weather patterns. Flash floods are still considered to be highly likely to occur with nearly a 100% chance of occurrence in any given year. This probability is based on the 33 events over 19 years reported in the National Climatic Data Center Storm Events Database and other historical records (local knowledge and news sources). Based on a historical analysis, Matagorda County unincorporated area can expect 1-2 events per year and has the same frequency and probability for future events. The City of Palacios and the City of Bay City can expect an event once every 2-3 years. These communities also have the same frequency and probability for future events.

12.2.4 Severity

Based on the 100-year HAZUS-MH probabilistic event scenario for Matagorda County and the participating communities, the magnitude/severity of flooding is severe. More than 10% of structures will be moderately (11 – 50%) damaged and over 90,000 tons of debris will be generated requiring over 3,500 truckloads (at 25 tons/truck) to remove the debris generated by the flood. The 100-year HAZUS-MH flood scenario estimates approximately 2,000 households will be displaced and will seek temporary lodging in public shelters. Overall significance is considered severe: high potential impact.

The intensity and magnitude of a flood event is also determined by the depth of flood waters. Table 12-3 describes the type of risk and potential magnitude of an event in relation to water depth. The water depths shown in Table 12-3 are estimated based on elevation data above grade.

TABLE 12-3.
EXTENT SCALE – WATER DEPTH

SEVERITY	WATER DEPTH (feet)	DESCRIPTION
BELOW FLOOD STAGE	0 to 5	Water begins to exceed the low sections of banks and the lowest sections of the floodplain.
ACTION STAGE	5 to 10	Flow is well into the floodplain. Minor low-land flooding reaches low areas of the floodplain. Livestock should be moved from low- lying areas.
FLOOD STAGE	10 to 15	Homes are threatened and properties downstream of river flows or in low-lying areas begin to flood.
MODERATE FLOOD STAGE	15 to 20	At this stage, the lowest homes downstream flood. Roads and bridges in the floodplain flood severely and are dangerous to motorists.
MAJOR FLOOD STAGE	20 and Above	Major flooding approaches homes in the floodplain. Primary and Secondary roads and bridges are severely flooded and very dangerous. Major flooding extents well into the floodplain, destroying property, equipment, and livestock.

The range of flood intensity that Matagorda County and the participating communities experience is high, even for the 100-Year flood events. This ranges from 0 feet to 10 feet in most areas. Even though most of the depths place the participating communities at the ‘action stage’ as shown in Table 12-3, the Colorado River can experience flooding past the flood stage with over 35 feet as shown in Figure 12-4. Based on historical occurrences, the planning area could experience an average of 5-10 inches of water within a 24 hour period. Figure 12-9 to Figure 12-11 shows the flood depths for the area.

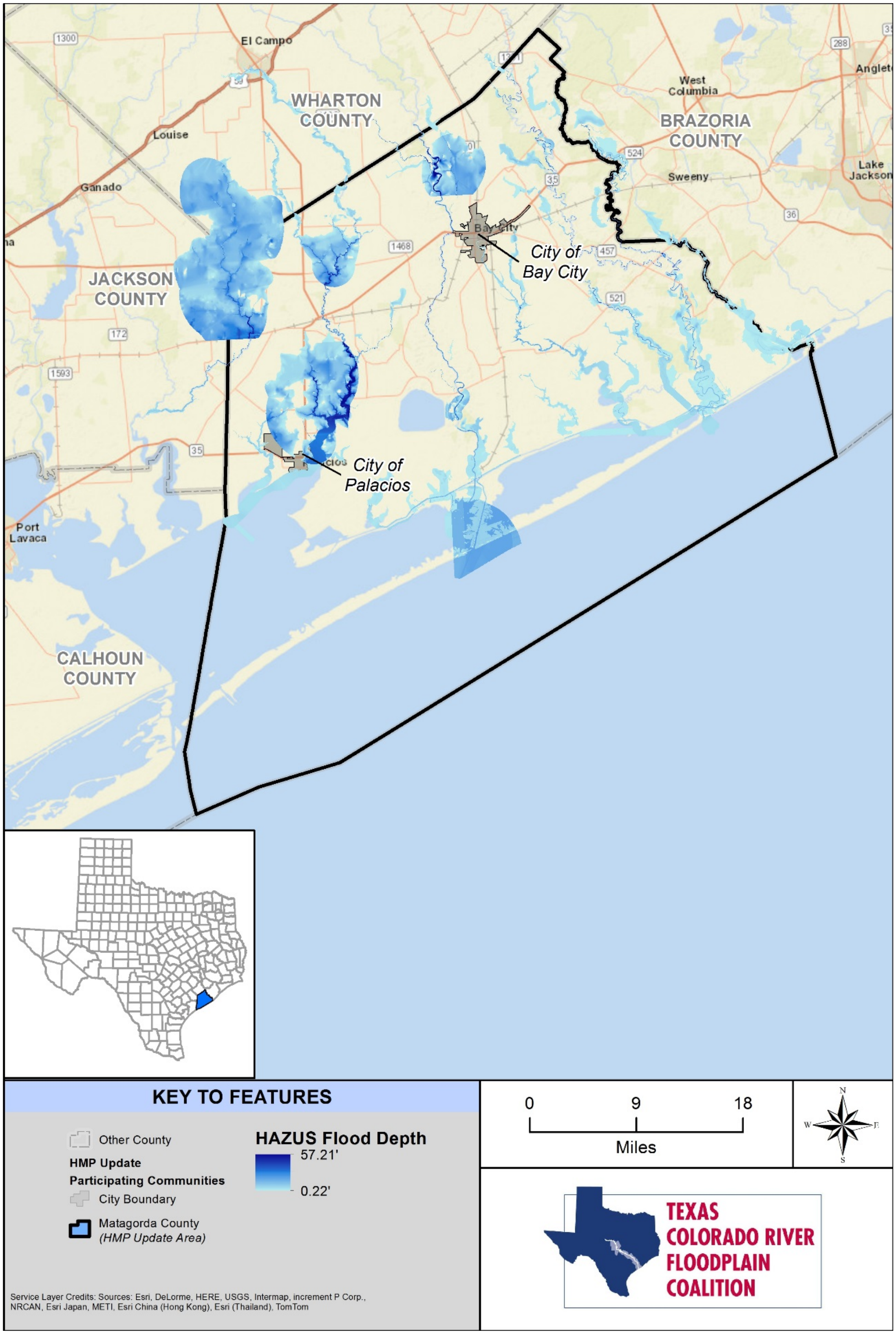


Figure 12-9. Flood Depths in Matagorda County and Participating Communities

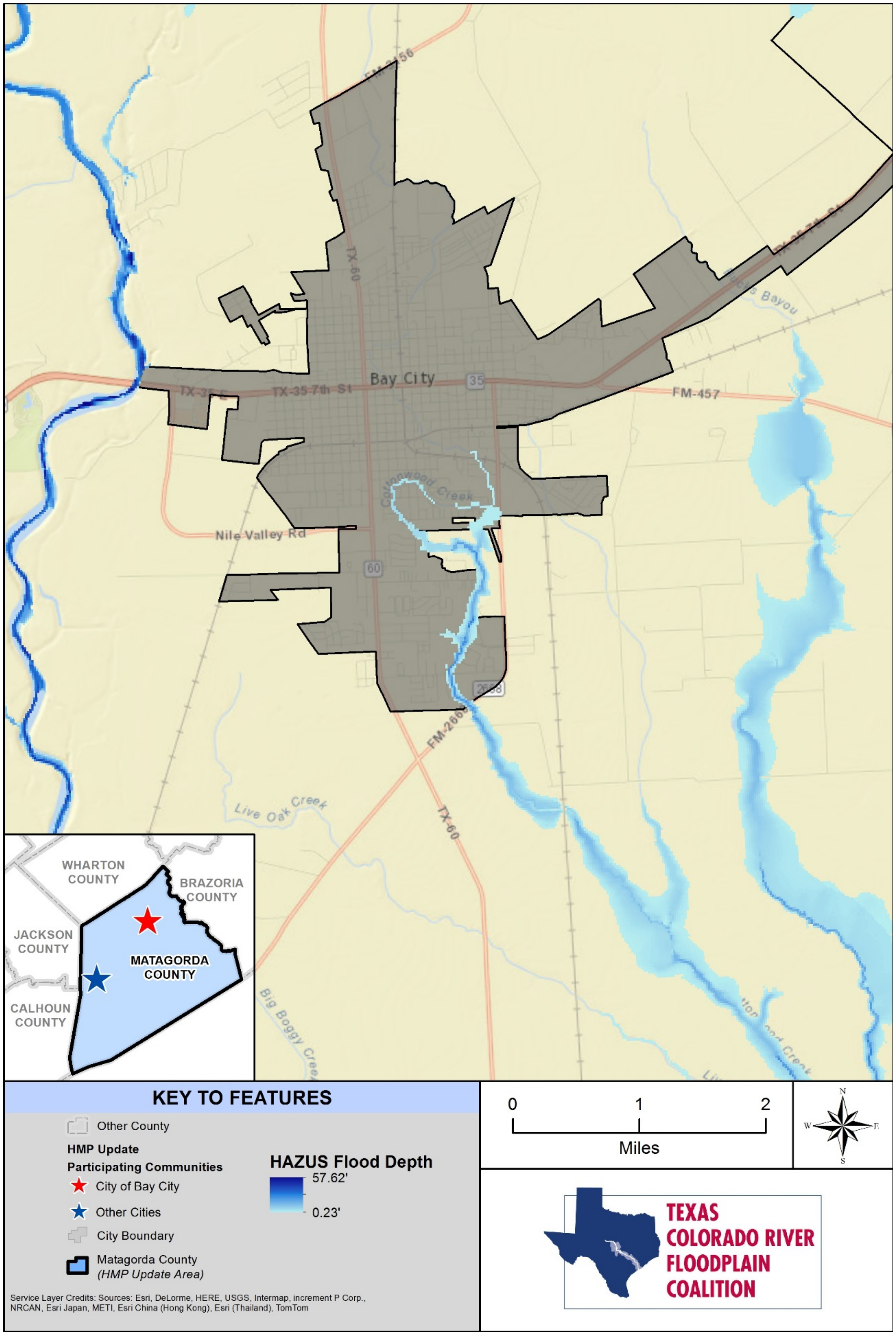


Figure 12-10. Flood Depths in the City of Bay City

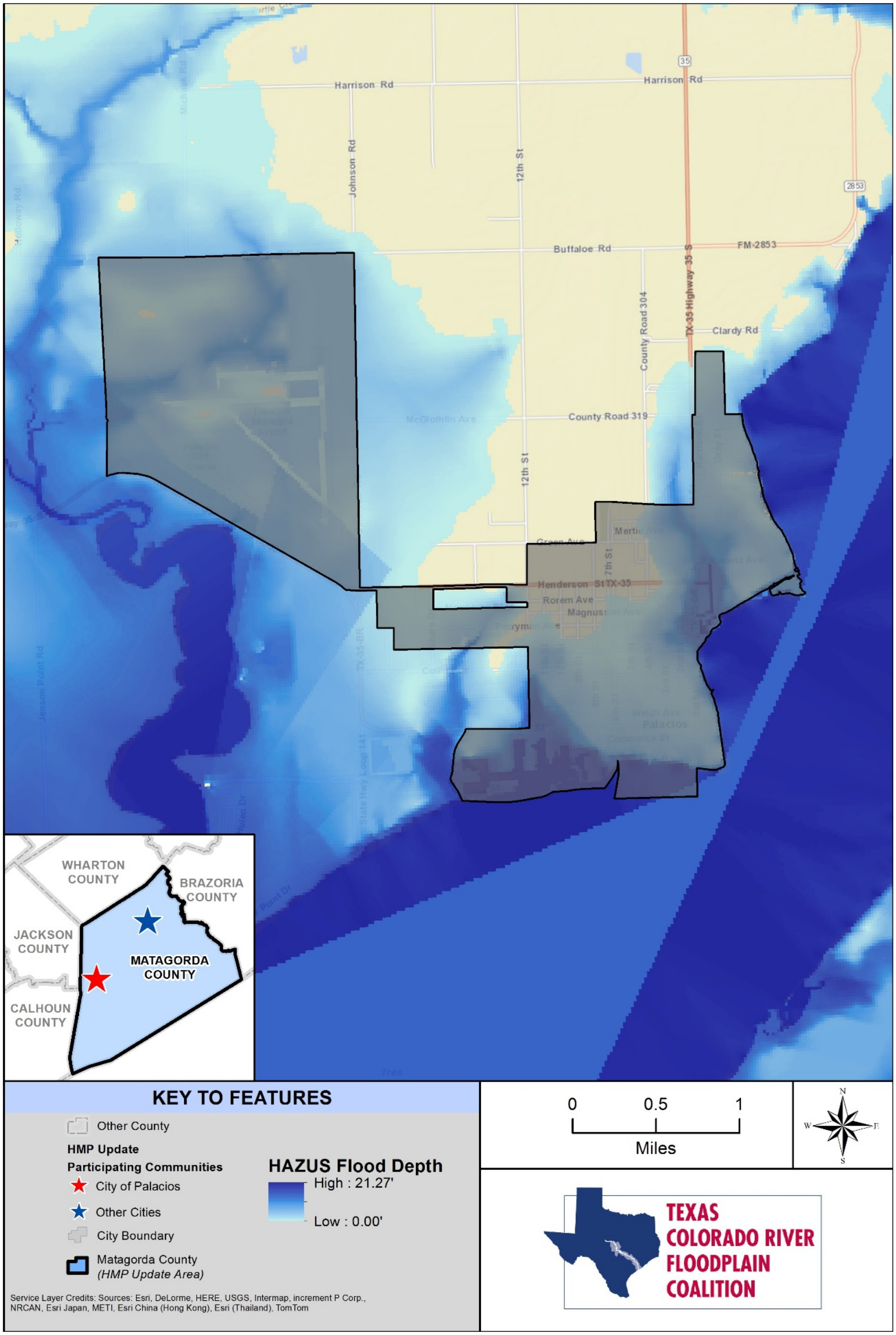


Figure 12-11. Flood Depths in the City of Palacios

12.2.5 Warning Time

Due to the sequential pattern of meteorological conditions needed to cause serious flooding, it is unusual for a flood to occur without warning. Warning times for floods can be between 24 and 48 hours. Flash flooding can be less predictable, but potential hazard areas can be warned in advanced of potential flash flooding danger.

12.3 SECONDARY HAZARDS

The most problematic secondary hazard for flooding is bank erosion, which in some cases can be more harmful than actual flooding. This is especially true in the upper courses of rivers with steep gradients, where floodwaters may pass quickly and without much damage, but scour the banks, edging properties closer to the floodplain or causing them to fall in. Flooding is also responsible for hazards such as landslides when high flows over-saturate soils on steep slopes, causing them to fail. Hazardous materials spills are also a secondary hazard of flooding if storage tanks rupture and spill into streams, rivers, or storm sewers.

12.4 CLIMATE CHANGE IMPACTS

Use of historical hydrologic data has long been the standard of practice for designing and operating water supply and flood protection projects. For example, historical data are used for flood forecasting models. This method of forecasting assumes that the climate of the future will be similar to that of the period of historical record. However, the hydrologic record cannot be used to predict changes in frequency and severity of extreme climate events such as floods. Going forward, model calibration or statistical relation development must happen more frequently, new forecast-based tools must be developed, and a standard of practice that explicitly considers climate change must be adopted. Climate change is already impacting water resources, and resource managers have observed the following:

- Historical hydrologic patterns can no longer be solely relied upon to forecast the water future.
- Precipitation and runoff patterns are changing, increasing the uncertainty for water supply and quality, flood management, and ecosystem functions.
- Extreme climatic events will become more frequent, necessitating improvement in flood protection, drought preparedness, and emergency response.

High frequency flood events (e.g., 10-year floods) in particular will likely increase with a changing climate. Along with reductions in the amount of the snowpack and accelerated snowmelt, scientists project greater storm intensity, resulting in more direct runoff and flooding. Changes in watershed vegetation and soil moisture conditions will likewise change runoff and recharge patterns. As stream flows and velocities change, erosion patterns will also change, altering channel shapes and depths, possibly increasing sedimentation behind dams, and affecting habitat and water quality. With potential increases in the frequency and intensity of wildfires due to climate change, there is potential for more floods following fire, which increase sediment loads and water quality impacts.

As hydrology changes, what is currently considered a 100-year flood may strike more often, leaving many communities at greater risk. Planners will need to factor a new level of safety into the design, operation, and regulation of flood protection facilities such as dams, floodways, bypass channels, and levees, as well as the design of local sewers and storm drains.

12.5 EXPOSURE

The Level 2 HAZUS-MH protocol was used to assess the risk and vulnerability to flooding in the planning area. The model used census data at the block level and calculated floodplain data, which has a level of accuracy acceptable for planning purposes. Where possible, the generated HAZUS-MH flood depth data was enhanced using revised FEMA flood depth grids for the area. The HAZUS 2.2 default inventory (updated with 2010 U.S. Census Data and 2014 RS Means Square Foot Costs) data was used.

12.5.1 Population

Population counts of those living in the floodplain in the planning area were generated by census block demographic data (2010 U.S. Census Bureau data) that intersect with the 100-year and 500-year floodplains identified on FIRMs. The methodology used to generate population estimates intersected census block demographic data with the identified floodplains and then aggregating the resulting data to the community boundaries. Using this approach, it was estimated that the exposed population for the planning area within the 100-year floodplain or SFHA is 6,550 (17% of the total county population). In the 500-year floodplain it is estimated that 14,392 people county-wide live within the mapped non-SFHA areas (39% of the total county population).

12.5.2 Property

Present Land Use

Table 12-4 and Table 12-5 show the present land uses in the 100-year and 500-year floodplains for the entire planning area.

Structures in the Floodplain

Table 12-6 and Table 12-7 summarize the total area and number of structures in the floodplain by participating community. The updated HAZUS-MH model inventory data estimated that there are 5,123 structures (30% of total structures) within the 100-year floodplain and 8,074 structures (49% of total structures) structures within the 500-year floodplain. In the 100-year floodplain, 99% of the structures are residential.

TABLE 12-4.
PRESENT LAND USE IN THE 100-YEAR FLOODPLAIN

Present Use Classification	Area (acres)				% of Total
	City of Bay City	City of Palacios	Unincorporated Area	**Matagorda County Total**	
Barren Land (Rock/Sand/Clay)	1	16	7,385	**7,402**	2.3
Cultivated Crops	11	17	31,903	**31,931**	9.9
Deciduous Forest	9	17	12,758	**12,784**	4.0
Developed High Intensity	26	21	33	**80**	< 0.1
Developed, Low Intensity	134	167	2,016	**2,317**	0.7
Developed, Medium Intensity	86	92	228	**406**	0.1
Developed, Open Space	96	480	7,096	**7,672**	2.4
Evergreen Forest	1	71	99,172	**99,244**	30.8
Emergent Wetlands	0	0	8,522	**8,522**	2.6
Grassland/Herbaceous	11	108	25,760	**25,879**	8.0
Mixed Forest	3	0	8,790	**8,793**	2.7

TABLE 12-4.
PRESENT LAND USE IN THE 100-YEAR FLOODPLAIN

Present Use Classification	Area (acres)				% of Total
	City of Bay City	City of Palacios	Unincorporated Area	**Matagorda County Total**	
Open Water	3	9	15,697	**15,709**	4.9
Pasture/Hay	58	411	58,048	**58,517**	18.1
Shrub/Scrub	7	124	13,858	**13,989**	4.3
Woody Wetlands	18	20	29,264	**29,302**	9.1
Total	**464**	**1,553**	**320,530**	**322,547**	100

TABLE 12-5.
PRESENT LAND USE IN THE 500-YEAR FLOODPLAIN

Present Use Classification	Area (acres)				% of Total
	City of Bay City	City of Palacios	Unincorporated Area	**Matagorda County Total**	
Barren Land (Rock/Sand/Clay)	1	17	7,459	**7,477**	1.8
Cultivated Crops	30	20	53,241	**53,291**	13.0
Deciduous Forest	14	24	16,292	**16,330**	4.0
Developed High Intensity	99	46	77	**222**	0.1
Developed, Low Intensity	505	481	2,644	**3,630**	0.9
Developed, Medium Intensity	312	206	335	**853**	0.2
Developed, Open Space	376	1,089	10,386	**11,851**	2.9
Evergreen Forest	2	78	101,870	**101,950**	24.9
Emergent Wetlands	1	0	11,002	**11,003**	2.7
Grassland/Herbaceous	44	173	31,499	**31,716**	7.7
Mixed Forest	3	0	10,675	**10,678**	2.6
Open Water	4	9	15,820	**15,833**	3.9
Pasture/Hay	180	601	91,113	**91,894**	22.4
Shrub/Scrub	20	166	20,054	**20,240**	4.9
Woody Wetlands	22	36	32,942	**33,000**	8.0

TABLE 12-5.
PRESENT LAND USE IN THE 500-YEAR FLOODPLAIN

Present Use Classification	Area (acres)				% of Total
	City of Bay City	City of Palacios	Unincorporated Area	**Matagorda County Total**	
Total	**1,613**	**2,946**	**405,409**	**409,968**	**100**

TABLE 12-6.
STRUCTURES AND POPULATION IN THE 100-YEAR FLOODPLAIN

Jurisdiction	Structures and Population Affected				
	Residential	Commercial	Other *	**Total Structures Affected**	**Total Population Affected**
Unincorporated Area	4,070	13	9	**4,092**	3,867
City of Bay City	563	13	3	**579**	1,555
City of Palacios	441	5	6	**452**	1,128
Matagorda County Total	**5,074**	**31**	**18**	**5,123**	**6,550**

*Other includes industrial, agricultural, religious, governmental, and educational classifications.

TABLE 12-7.
STRUCTURES AND POPULATION IN THE 500-YEAR FLOODPLAIN

Jurisdiction	Structures and Population Affected				
	Residential	Commercial	Other *	**Total Structures Affected**	**Total Population Affected**
Unincorporated Area	4,695	16	9	4,720	5,313
City of Bay City	1,669	49	13	1,731	4,894
City of Palacios	1,599	15	9	1,623	4,185
Matagorda County Total	**7,963**	**80**	**31**	**8,074**	**14,392**

*Other includes industrial, agricultural, religious, governmental, and educational classifications.

Exposed Value

Table 12-8 and Table 12-9 summarizes the estimated value of exposed buildings in the planning area in the 100-year and 500-year floodplain. The updated HAZUS-MH model inventory data estimated $1.9 billion worth of building and contents exposure to the 100-year flood. This represents 32% of the total assessed value of the planning area. Approximately $3 billion worth of building and contents exposure was estimated to be exposed to the 500-year flood, representing 51% of the total assessed value of the planning area.

TABLE 12-8.
VALUE OF STRUCTURES IN 100-YEAR FLOODPLAIN

Jurisdiction	Value Exposed ($)			Total Assessed Value ($)	% of Total Assessed Value
	Structure	Contents	**Total**		
Unincorporated Area	927,188,160	518,942,503	**1,446,130,664**	2,558,729,176	56.5
City of Bay City	154,126,493	92,644,374	**246,770,867**	2,649,736,203	9.3
City of Palacios	111,139,248	72,161,498	**183,300,746**	669,865,421	27.4
Matagorda County Total	**1,192,453,901**	**683,748,375**	**1,876,202,277**	**5,878,330,800**	**31.9**

TABLE 12-9.
VALUE OF STRUCTURES IN 500-YEAR FLOODPLAIN

Jurisdiction	Value Exposed ($)			Total Assessed Value ($)	% of Total Assessed Value
	Structure	Contents	**Total**		
Unincorporated Area	1,082,066,560	611,605,118	**1,693,671,678**	2,558,729,176	66.2
City of Bay City	430,863,613	275,531,855	**706,395,467**	2,649,736,203	26.7
City of Palacios	375,525,195	224,044,960	**599,570,156**	669,865,421	89.5
Matagorda County Total	**1,888,455,368**	**1,111,181,933**	**2,999,637,301**	**5,878,330,801**	**51.0**

12.5.3 Critical Facilities and Infrastructure

Table 12-10 and Table 12-11 summarize the critical facilities and infrastructure in the 100-year and 500-year floodplain of the planning area. Details are provided in the following sections.

TABLE 12-10.
CRITICAL FACILITIES AND INFRASTRUCTURE IN THE 100-YEAR FLOODPLAIN

	Unincorporated Area	City of Bay City	City of Palacios	**Matagorda County Total**
Medical and Health	0	0	0	**0**
Government Functions	0	0	0	**0**
Protective Functions	0	0	0	**0**
Schools	1	2	2	**5**
Hazardous Materials	7	0	0	**7**
Bridges	89	15	3	**107**
Wastewater	0	1	0	**1**
Power	2	0	0	**2**
Communications	1	0	0	**1**
Transportation	3	0	20	**23**
Dams	6	0	0	**6**

TABLE 12-11.
CRITICAL FACILITIES AND INFRASTRUCTURE IN THE 500-YEAR FLOODPLAIN

	Unincorporated Area	City of Bay City	City of Palacios	**Matagorda County Total**
Medical and Health	0	0	1	**1**
Government Functions	1	2	0	**3**
Protective Functions	0	2	2	**4**
Schools	3	4	3	**10**
Hazardous Materials	10	0	1	**11**
Bridges	98	20	4	**122**
Wastewater	0	2	2	**4**
Power	2	0	0	**2**
Communications	1	0	0	**1**
Transportation	3	1	24	**28**

**TABLE 12-11.
CRITICAL FACILITIES AND INFRASTRUCTURE IN THE 500-YEAR FLOODPLAIN**

	Unincorporated Area	City of Bay City	City of Palacios	**Matagorda County Total**
Dams	9	1	0	**10**

Utilities and Infrastructure

It is important to identify who may be at risk if infrastructure is damaged by flooding. Roads or railroads that are blocked or damaged can isolate residents and can prevent access throughout the county, including emergency service providers needing to get to vulnerable populations or to make repairs. Bridges washed out or blocked by floods or debris also can cause isolation. Water and sewer systems can be flooded or backed up, causing health problems. Underground utilities can be damaged. Levees can fail or be overtopped, inundating the land that they protect. The following sections describe specific types of critical infrastructure.

Roads

The major roads in the planning area that pass through the 100-year floodplain and thus are exposed to flooding are State Highways 35, 60, and 71. In severe flood events, these roads can be blocked or damaged, preventing access to some areas.

Bridges

Flooding events can significantly impact road bridges. These are important because often they provide the only ingress and egress to some neighborhoods. Countywide, there are over 200 bridges that are in or cross over the 100-year floodplain.

Water and Sewer Infrastructure

Water and sewer systems can be affected by flooding. Floodwaters can back up drainage systems, causing localized flooding. Culverts can be blocked by debris from flood events, also causing localized urban flooding. Floodwaters can get into drinking water supplies, causing contamination. Sewer systems can be backed up, causing wastewater to spill into homes, neighborhoods, rivers, and streams.

12.5.4 Environment

Flooding is a natural event, and floodplains provide many natural and beneficial functions. Nonetheless, with human development factored in, flooding can impact the environment in negative ways. Migrating fish can wash into roads or over levees into flooded fields, with no possibility of escape. Pollution from roads, such as oil, and hazardous materials can wash into rivers and streams. During floods, these can settle onto normally dry soils, polluting them for agricultural uses. Human development such as bridge abutments and levees, and logjams from timber harvesting can increase stream bank erosion, causing rivers and streams to migrate into non-natural courses.

12.6 VULNERABILITY

Many of the areas exposed to flooding may not experience serious flooding or flood damage. This section describes vulnerabilities in terms of population, property, infrastructure, and environment. The vulnerability analysis was performed at the census-block level. This methodology is likely to overestimate impacts from both the modeled 100-year and 500-year flood events as it is assumed that both structures and the population are evenly spread throughout census blocks.

12.6.1 Population

A geographic analysis of demographics (county-wide) using the default HAZUS-MH model data (2010 U.S. Census demographics) identified populations vulnerable to the flood hazard as follows. These numbers are calculated assuming that the population/households are evenly distributed over the census blocks.

- Economically Disadvantaged Populations—It is estimated that approximately 1.2% of the population within the 100-year floodplain are economically disadvantaged. Economically disadvantaged is defined as having household incomes of $20,000 or less.
- Population over 65 Years Old—It is estimated that approximately 3% of the population in the 100-year floodplain are over 65 years old.
- Population under 16 Years Old—It is estimated that approximately 3.5% of the population in the 100-year floodplain are under 16 years of age.

The following impacts on persons and households in Matagorda County were estimated for the 100-year and 500-year flood events through the Level 2 HAZUS-MH analysis:

- During an 100-year flood event
  - Displaced population = 2,042
  - Persons requiring short-term shelter = 3,788
- During a 500-year flood event
  - Displaced population = 3,279
  - Persons requiring short-term shelter = 6,775

12.6.2 Property

HAZUS-MH calculates losses to structures from flooding by looking at depth of flooding and type of structure. Using historical flood insurance claim data, HAZUS-MH estimates the percentage of damage to structures and their contents by applying established damage functions to an inventory. For this analysis, the default inventory data provided with HAZUS-MH was used. The analysis is summarized in Table 12-12 for the 100-year flood event. It is estimated that there would be up to $579 million of flood loss from a 100-year flood event in the planning area. This represents 31% of the total exposure to the 100-year flood and 14.69% of the exposed replacement value for the county. Losses are estimated to be $883 million from a 500-year flood event, representing 29% of the exposed replacement value for the county (Table 12-13).

TABLE 12-12.
LOSS ESTIMATES FOR THE 100-YEAR FLOOD EVENT

Jurisdiction	Loss ($)			Exposed Value ($)	% of Total Assessed Value
	Structure	Contents	Total		
Unincorporated Area	298,991,372	212,000,315	**510,991,687**	1,446,130,664	35.3
City of Bay City	1,270,848	1,116,218	**2,387,066**	246,770,867	1.0
City of Palacios	29,976,216	36,005,744	**65,981,960**	183,300,746	36.0
Matagorda County Total	**330,238,436**	**249,122,277**	**579,360,713**	**1,876,202,277**	**30.9**

**TABLE 12-13.
LOSS ESTIMATES FOR THE 500-YEAR FLOOD EVENT**

Jurisdiction	Loss ($)			Exposed Value ($)	% of Total Assessed Value
	Structure	Contents	Total		
Unincorporated Area	401,338,937	284,056,908	**685,395,845**	1,693,671,678	40.5%
City of Bay City	1,757,807	1,597,267	**3,355,074**	706,395,467	0.5%
City of Palacios	95,427,820	98,401,147	**193,828,967**	599,570,156	32.3%
Matagorda County Total	**498,524,564**	**384,055,322**	**882,579,886**	**2,999,637,301**	**29.4%**

National Flood Insurance Program

Table 12-14 lists flood insurance statistics from 1978 to 2015 that help identify vulnerability in the planning area. Matagorda County, City of Bay City, and City of Palacios participate in the NFIP.

**TABLE 12-14.
NATIONAL FLOOD INSURANCE PROGRAM STATISTICS**

Jurisdiction	Initial FIRM Effective Date	Claims	Value of Claims Paid
Unincorporated Area	5/1/1971	1,249	11,653,766
City of Bay City	6/5/1985	467	2,427,150
City of Palacios	5/4/1992	108	339,791
Matagorda County Total	**9/13/2012 ***	**1,824**	**14,420,707**

Source: http://bsa.nfipstat.fema.gov/
* Effective date of initial countywide Flood Insurance Study (FIS)

Properties constructed after a FIRM has been adopted are eligible for reduced flood insurance rates. Such structures are less vulnerable to flooding since they were constructed after regulations and codes were adopted to decrease vulnerability. Properties built before a FIRM is adopted are more vulnerable to flooding because they do not meet code or are located in hazardous areas. The first FIRM for the City of Bay City was available in 1971, the City of Palacios in 1986, and Matagorda County in 1971. Matagorda County and the cities have adopted the 2012 FIRM.

The following information from flood insurance statistics is relevant to reducing flood risk:

- The use of flood insurance in the planning area is less than the national average.
- The average claim (1978 to June 2015) paid in Matagorda County is approximately $7,906, well below the national average.

Matagorda County's continued NFIP compliance is detailed in their floodplain management program and the Floodplain Management Plan that is enforced by the County's Certified Floodplain Administrator. Matagorda County has the following higher floodplain regulations: 1) New development must be elevated a minimum of + two feet above BFE, 2) No development is allowed in the floodway without an engineering study showing 0.00 foot rise, 3) In Zone A the developer must conduct a study, based on fully developed conditions, to define the BFE and floodway boundary before permit issued. As a minimum the new development must be two feet above the natural grade, 4) Elevation certificate required before forming/pouring lowest floor, when structure is completed and prior to final electric connection, 5) Piling and breakaway wall certification required for construction in Zone V, 6) County has adopted cumulative substantial improvement ordinance requiring cumulative for a minimum of five years.

The County has several mitigation actions such as supporting TCRFC for flood reduction projects, construction drainage improvement, and promoting flood insurance listed in Table 20-2. These measures are intended to reduce the future flood risks in the SFHA and continue the County's good standing with NFIP.

The City of Bay City's floodplain management program is detailed in Chapter 46 of the City Ordinance and it is enforced by the Public Works Official that is a CFM. The City has the following higher floodplain regulations: 1) Both residential and non-residential structures must be elevated a minimum of 12 inches about BFE, 2) Manufactured homes can only be placed in existing manufactured home parks or subdivision. The City stated they want to construct regional detentions and buyout properties in the floodplain as mitigation actions listed in Table 20-2.

The City of Palacios' floodplain management program is governed by the part of Chapter 3, Building Code and enforced by the City Manager. The City requires elevation certificates prior to pouring lowest floor, when structure is completed, and before certificate of occupancy. The mitigation actions in Table 20-2 state that the City intends to raise bridges above the BFE, relocate the Police Station outside Flood Zone B, and adopt higher standards for riverine flood damage prevention ordinances.

All the municipal planning partners are informed of the training schedule for their Floodplain Administrators through the TCRFC and the TWDB and attend continuing education seminars and classes on a yearly basis.

Repetitive Loss

A repetitive loss property is defined by FEMA as an NFIP-insured property that has experienced any of the following since 1978, regardless of any changes in ownership:

- Four or more paid losses in excess of $1,000
- Two paid losses in excess of $1,000 within any rolling 10-year period
- Three or more paid losses that equal or exceed the current value of the insured property

Repetitive loss properties make up only 1 to 2% of flood insurance policies in force nationally, yet they account for 40% of the nation's flood insurance claim payments. In 1998, FEMA reported that the NFIP's 75,000 repetitive loss structures have already cost $2.8 billion in flood insurance payments and that numerous other flood-prone structures remain in the floodplain at high risk. The government has instituted programs encouraging communities to identify and mitigate the causes of repetitive losses. A recent report on repetitive losses by the National Wildlife Federation found that 20% of these properties are outside any mapped 100-year floodplain. The key identifiers for repetitive loss properties are the existence of flood insurance policies and claims paid by the policies.

FEMA-sponsored programs, require participating communities to identify repetitive loss areas. A repetitive loss area is the portion of a floodplain holding structures that FEMA has identified as meeting the definition of repetitive loss. Identifying repetitive loss areas helps to identify structures that are at risk but are not on FEMA's list of repetitive loss structures because no flood insurance policy was in force at the time of loss. Figure 12-12 shows the location of repetitive loss properties in Matagorda County and the participating communities.

The City of Bay City has 10 commercial and 32 residential repetitive loss properties. The City of Palacios has 2 commercial and 4 residential repetitive loss properties. Matagorda County unincorporated area has 8 commercial and 98 residential repetitive loss properties.

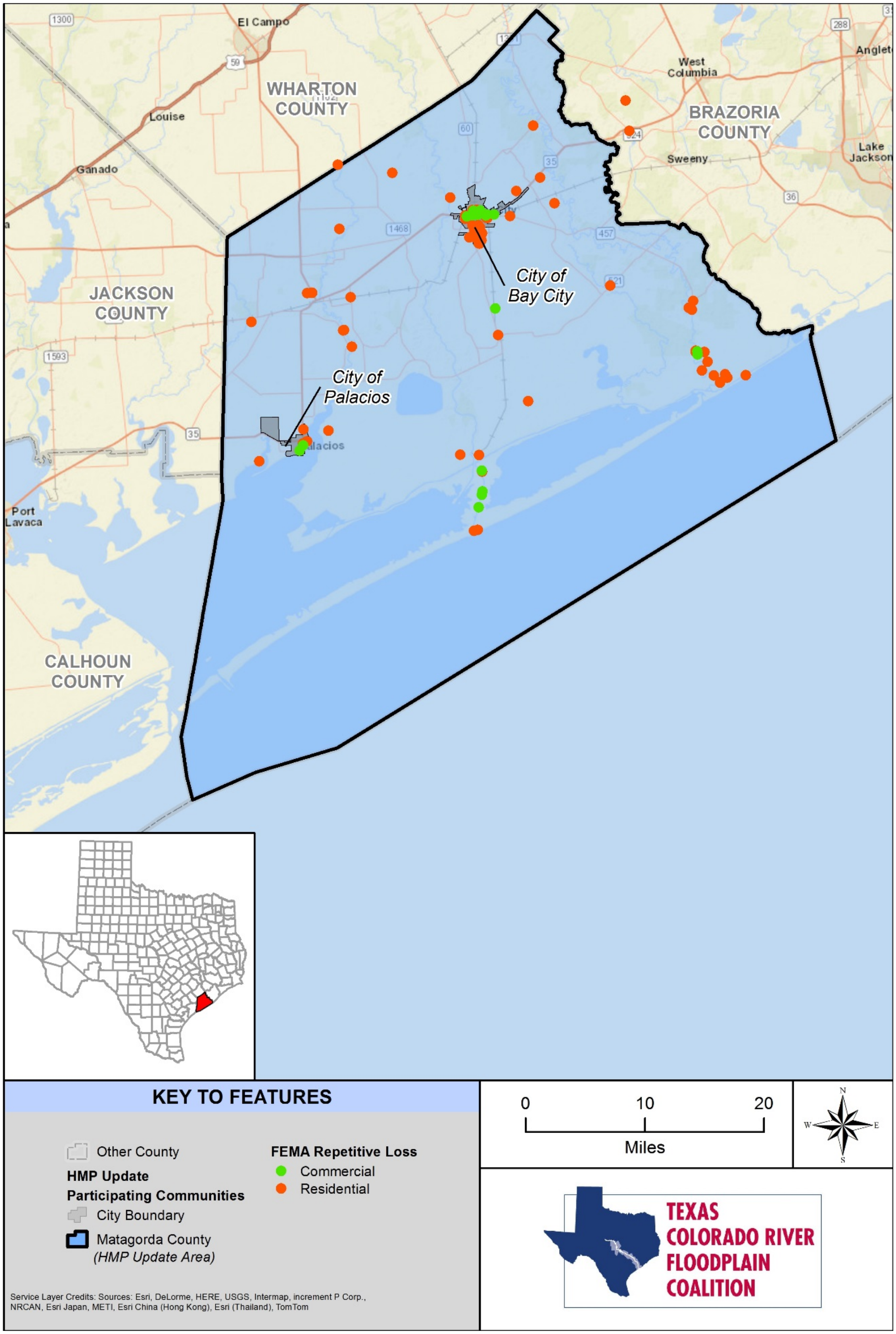


Figure 12-12. Repetitive Loss Properties in Matagorda County

12.6.3 Critical Facilities and Infrastructure

HAZUS-MH was used to estimate the flood loss potential to critical facilities exposed to the flood risk. Using depth/damage function curves to estimate the percent of damage to the building and contents of critical facilities, HAZUS-MH correlates these estimates into an estimate of functional down-time (the estimated time it will take to restore a facility to 100% of its functionality). This helps to gauge how long the planning area could have limited usage of facilities deemed critical to flood response and recovery.

The HAZUS critical facility analysis found that, on average, critical facilities would receive some damage to structure and contents during a 100-year and 500-year flood event. Countywide, the 500-year flood scenario will result in at least moderate damage (10-50% damage) to 1 police station. There will be moderate damage to 2 schools during a 100-Year event (500-year, 5 schools) and 1 school will be substantially damaged (51-100% damage) during a 500-year event. It is estimated that 2 fire stations will have at least some moderate damage (500-year, 3 fire stations). A hospital will be at least be moderately damaged during the 100-year flood event (500-year, 2 hospitals). Significant loss of facility functionality would be lost during these events.

12.6.4 Environment

The environment vulnerable to flood hazard is the same as the environment exposed to the hazard. Loss estimation platforms such as HAZUS-MH are not currently equipped to measure environmental impacts of flood hazards. The best gauge of vulnerability of the environment would be a review of damage from past flood events. Loss data that segregates damage to the environment was not available at the time of this plan. Capturing this data from future events could be beneficial in measuring the vulnerability of the environment for future updates.

12.7 FUTURE TRENDS IN DEVELOPMENT

Matagorda County and its planning partners are equipped to handle future growth within flood hazard areas. All municipal planning partners have plans and policies that address frequently flooded areas. All partners have committed to linking their plans to this hazard mitigation plan update. This will create an opportunity for sound watershed-wide land use decisions and floodplain management practices as future growth impacts flood hazard areas.

Additionally, all municipal planning partners are participants in the NFIP and have adopted flood damage prevention ordinances and adopted the 2012 FIRM in response to its requirements. All municipal planning partners have committed to maintaining their good standing under the NFIP through initiatives identified in Section 6.9, Chapter 7, Section 12.6.2, and Table 20-2.
Recommended Mitigation Actions.

Urban flooding issues that contribute to flash floods are also a concern in more highly developed areas in Matagorda County. Jurisdictions in the county are required to develop a stormwater permitting program as mandated by the National Pollutant Discharge Elimination System. This program will help jurisdictions apply effective mitigation measures for stormwater runoff.

The recent dam modernization program on LCRA's dams meet required design safety standards to resist the water load and pressure of the PMF is a step in the right direction. There is, however, always some residual risk and it is expected that the Emergency Action Plans for the dams will be maintained so the appropriate responses can be exercised in case of a dam failure.

12.8 SCENARIO

An intense, short-duration storm could move slowly across the planning area creating significant flash floods with little or no warning. Injuries or fatalities may result if residents are caught off guard by the flood event. Stormwater systems could be overwhelmed and significant flooding could impact a substantial portion of structures within the planning area. Transportation routes could be cut off due to floodwaters, isolating portions of the planning area. These impacts may last after the floodwater recedes as flash floods in the area have been known to cause extensive damage to roadway infrastructure. Areas that have recently experienced wildfires would contribute to the extent of flooding impacts.

12.9 ISSUES

The major issues for flooding are the following:

- Flash flooding that occurs with little or no warning will continue to impact the planning area.
- The duration and intensity of storms contributing to flooding issues may increase due to climate change.
- Flooding may be exacerbated by other hazards, such as wildfires.
- Damages resulting from flood may impact tourism, which may have significant impacts on the local economy.
- The promotion of flood insurance as a means of protecting private property owners from the economic impacts of frequent flood events should continue.

CHAPTER 13.
HURRICANES AND TROPICAL STORMS

HURRICANE AND TROPICAL STORM RANKING	
Matagorda County	High
City of Bay City	High
City of Palacios	High

DEFINITIONS

Hurricane— A tropical cyclone with maximum sustained surface winds (using the U.S. 1-minute average) of 64 knot (kt) (74 miles per hour [mph]) or more.

Tropical Storm — A tropical cyclone with maximum sustained surface wind speed (using the U.S. 1-minute average) ranges from 34 kt (39 mph) to 63 kt (73 mph).

Tropical Depression— A tropical cyclone with maximum sustained surface wind speed (using the U.S. 1-minute average) ranges from 4 kt (39 mph) to 63 kt (73 mph).

13.1 GENERAL BACKGROUND

13.1.1 Hurricanes and Tropical Storms

The following description of hurricanes and tropical storms was summarized from the *2013 State of Texas Hazard Mitigation Plan*.

According to NOAA, tropical cyclones are classified into three main categories (per intensity): hurricanes, tropical storms, and tropical depressions.

The term hurricane is used for Northern Hemisphere tropical cyclones east of the International Dateline to the Greenwich Meridian. Hurricanes are any closed circulation developed around a low-pressure center in which the winds rotate counter-clockwise in the Northern Hemisphere (or clockwise in the Southern Hemisphere) and whose diameter averages 10 to 30 miles across. A tropical cyclone refers to any such circulation that develops over tropical waters. The key energy source for a tropical cyclone is the release of latent heat from the condensation of warm water. Their formation requires a low-pressure disturbance, warm sea surface temperature, rotational force from the spinning of the earth, and the absence of wind shear in the lowest 50,000 feet of the atmosphere.

Hurricanes are areas of disturbed weather in the tropics with closed isobars and strong and very pronounced rotary circulation. An area of clear weather called an “eye” is present in the center of the circulation. To qualify as a hurricane, the wind speed is 74 miles per hour (mph) or more. Hurricanes are classified into categories based on wind speed and the potential damage they cause. Thunderstorm rain resulting in urban flooding, battering wave action, intense sea level rise, localized coastal erosion, and significant winds are associated with hurricanes.

A tropical storm is a tropical cyclone in which the maximum sustained surface wind speeds range from 39 to 73 mph. At this time the tropical cyclone is assigned a name. During this time, the storm itself becomes more organized and begins to become more circular in shape, resembling a hurricane. Figure 13-1 illustrates historical hurricane paths affecting the entire study area.

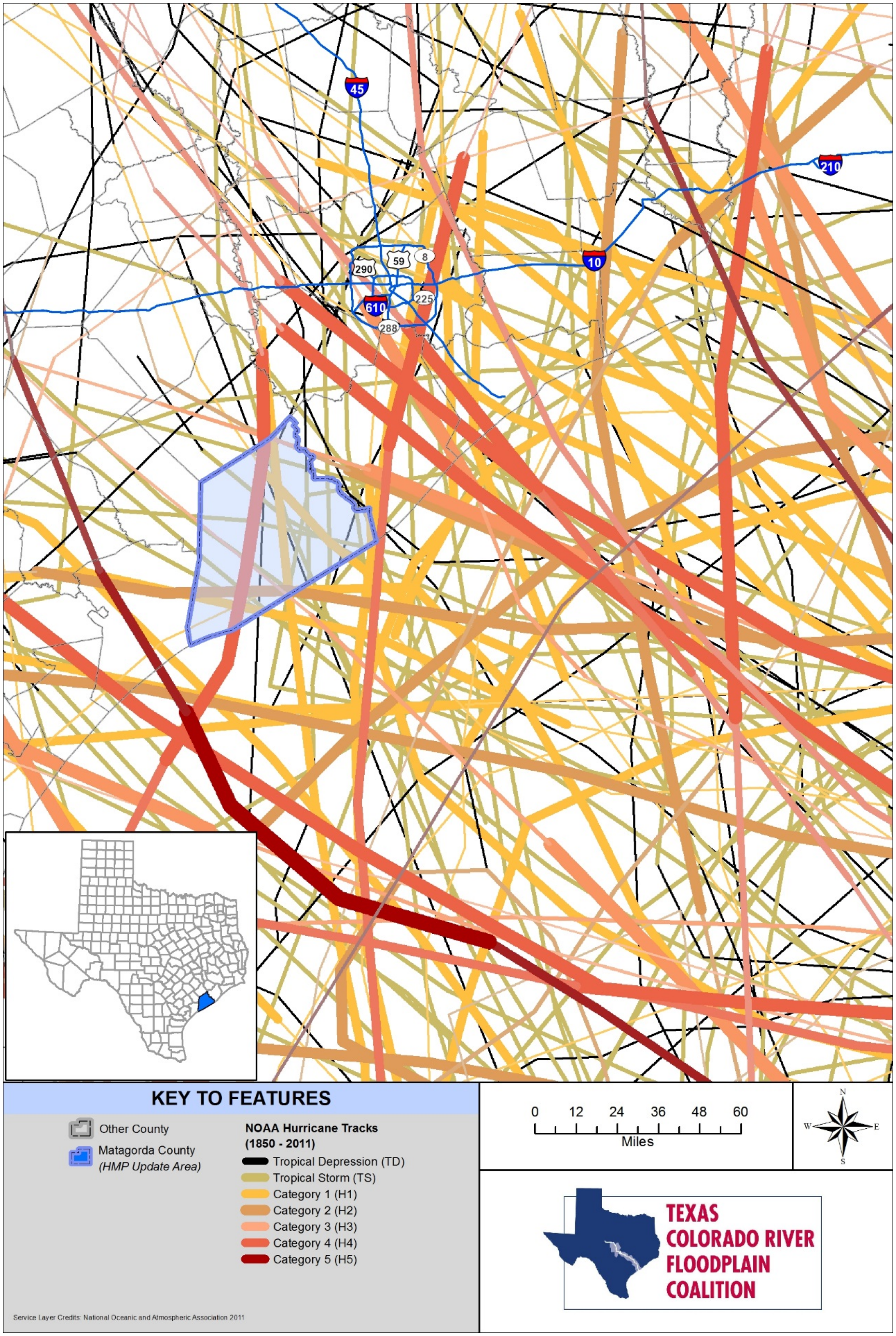


Figure 13-1. Historical Hurricane Paths Affecting Planning Area

13.1.2 Hurricane and Tropical Storm Classifications

Hurricanes are classified according to the Saffir-Simpson Hurricane Wind Scale from a Category 1 to Category 5 by sustained wind intensity. Table 13-1 lists a description of each category.

TABLE 13-1.
SAFFIR-SIMPSON HURRICANE WIND SCALE

Category	Sustained Winds (miles per hour)	Types of Damage Due to Hurricane Winds
1	74-95	Very dangerous winds will produce some damage: Well-constructed frame homes could have damage to roof, shingles, vinyl siding, and gutters. Large branches of trees will snap and shallowly rooted trees may be toppled. Extensive damage to power lines and poles likely will result in power outages that could last a few to several days.
2	96-110	Extremely dangerous winds will cause extensive damage: Well-constructed frame homes could sustain major roof and siding damage. Many shallowly rooted trees will be snapped or uprooted and block numerous roads. Near-total power loss is expected with outages that could last from several days to weeks.
3 (Major)	111-129	Devastating damage will occur: Well-built framed homes may incur major damage or removal of roof decking and gable ends. Many trees will be snapped or uprooted, blocking numerous roads. Electricity and water will be unavailable for several days to weeks after the storm passes.
4 (Major)	130-156	Catastrophic damage will occur: Well-built framed homes can sustain severe damage with loss of most of the roof structure and/or some exterior walls. Most trees will be snapped or uprooted and power poles downed. Fallen trees and power poles will isolate residential areas. Power outages will last weeks to possibly months. Most of the area will be uninhabitable for weeks or months.
5 (Major)	157 or higher	Catastrophic damage will occur: A high percentage of framed homes will be destroyed, with total roof failure and wall collapse. Fallen trees and power poles will isolate residential areas. Power outages will last for weeks to possibly months. Most of the area will be uninhabitable for weeks or months.

Other non-hurricane classifications are tropical storms (39-73 mph) and tropical depressions (0-38 mph)

Source: http://www.nhc.noaa.gov/aboutsshws.php

13.2 HAZARD PROFILE

While hurricanes pose the greatest threat to life and property, tropical storms and depressions also can be devastating. Floods from heavy rains and severe weather, such as tornadoes, can cause extensive damage and loss of life. For example, Tropical Storm Allison produced over 40 inches of rain in the Houston area in 2001, causing approximately $5 billion in damage and multiple fatalities.

13.2.1 Past Events

Due to Matagorda County and participating communities' location on the Texas Gulf Coast, it is directly exposed to hurricanes. The hurricanes usually fade and downgrade to tropical storms or tropical depressions as they move away from the coast. According to NOAA, Matagorda County and participating communities have been directly impacted by more than 24 Atlantic Hurricanes between 1851 and 2011. A record count of the 7 different hurricane categories within this time period shows five measured Category 1 hurricane conditions, two Category 2 hurricane conditions, three Category 4 hurricane conditions, eight measured tropical depression conditions, and seventeen tropical storm conditions. Notable hurricane, tropical storm, and depression landfalls documented by NOAA between 1851 and 2015 for Matagorda County and participating communities are described below:

- August 27, 1945 (Unnamed Category 4 hurricane). Maximum wind speeds were around 115 mph
- September 11, 1961 (Tropical Storm Elena). Maximum wind speeds were around 125 mph
- September 19, 1963 (Tropical Storm Cindy). Maximum wind speeds were around 25 mph
- September 10, 1971 (Tropical Storm Fern). Maximum wind speeds were around 60 mph
- September 5, 1973 (Tropical Storm Delia). Maximum wind speeds were around 50 mph
- September 1, 1979 (Tropical Storm Elena). Maximum wind speeds were around 35 mph
- June 26, 1989 (Tropical Strom Allison). Maximum wind speeds were around 35 mph
- June 9, 2001 (Tropical Strom Allison). Maximum wind speeds were around 35 mph. Tropical Storm Allison started as a disturbance in the Gulf of Mexico. It was not expected to be recorded as one of the most devastating rain events in U.S. history. Allison's slow and erratic progress moving inland and back out to the Gulf set it apart from every storm to hit Texas in the past century. It affected mostly the southeast Texas coast, Louisiana, and the eastern U.S. In just days, the storm dumped 80% of the area's average rainfall. Two million people were affected. Most of the deaths occurred from people walking or drowning in high water. When Allison was finally finished, 41 people were killed across Matagorda Country, 95,000 cars were flooded and 73,000 homes were damaged. More than 30,000 people were left stranded in shelters and there was $5 billion in property damage. Allison is the first tropical storm to ever have its name retired, alongside hurricanes Katrina, Rita, and Ike.
- September 7, 2002 (Tropical Storm Fay). Maximum wind speeds were around 50 mph
- July 15, 2003 (Tropical Storm Claudette). Maximum wind speeds were around 75 mph
- June 16-17, 2015 - Tropical Storm Bill – Tropical Storm Bill made landfall on Matagorda Island, Matagorda County, Texas at 11:45 am. Its maximum sustained wind speed at landfall was 60 mph. Tropical Storm Bill moved inland and was downgraded to a Tropical Depression at 1:00 am on June 17. After spending three days over land as a tropical depression, Bill finally transitioned into a post-tropical cyclone on the afternoon of June 20 over eastern Kentucky. Although Bill brought coastal flooding and gusty winds to the Texas coast at landfall, its primary impact was rainfall flooding. Peak rainfall totals from Bill were: 13.28 inches near El Campo, Texas; 12.53 inches near Healdton, Oklahoma; and 11.77 inches near Ganado, Texas. A Flash Flood Watch was issued by NWS for Matagorda County, but no serious flooding occurred. Rainfall totals for the Matagorda County area during this event ranged from approximately less than 0.25 to 1.0 inch.

13.2.2 Location

A recorded event can occur anywhere in the HMP update area, moving inland from the Gulf of Mexico. Figure 13-2 illustrates historical hurricane paths effecting Matagorda County and participating communities. These hurricane events became tropical depressions or tropical storms by the time they reached Matagorda County and participating communities.

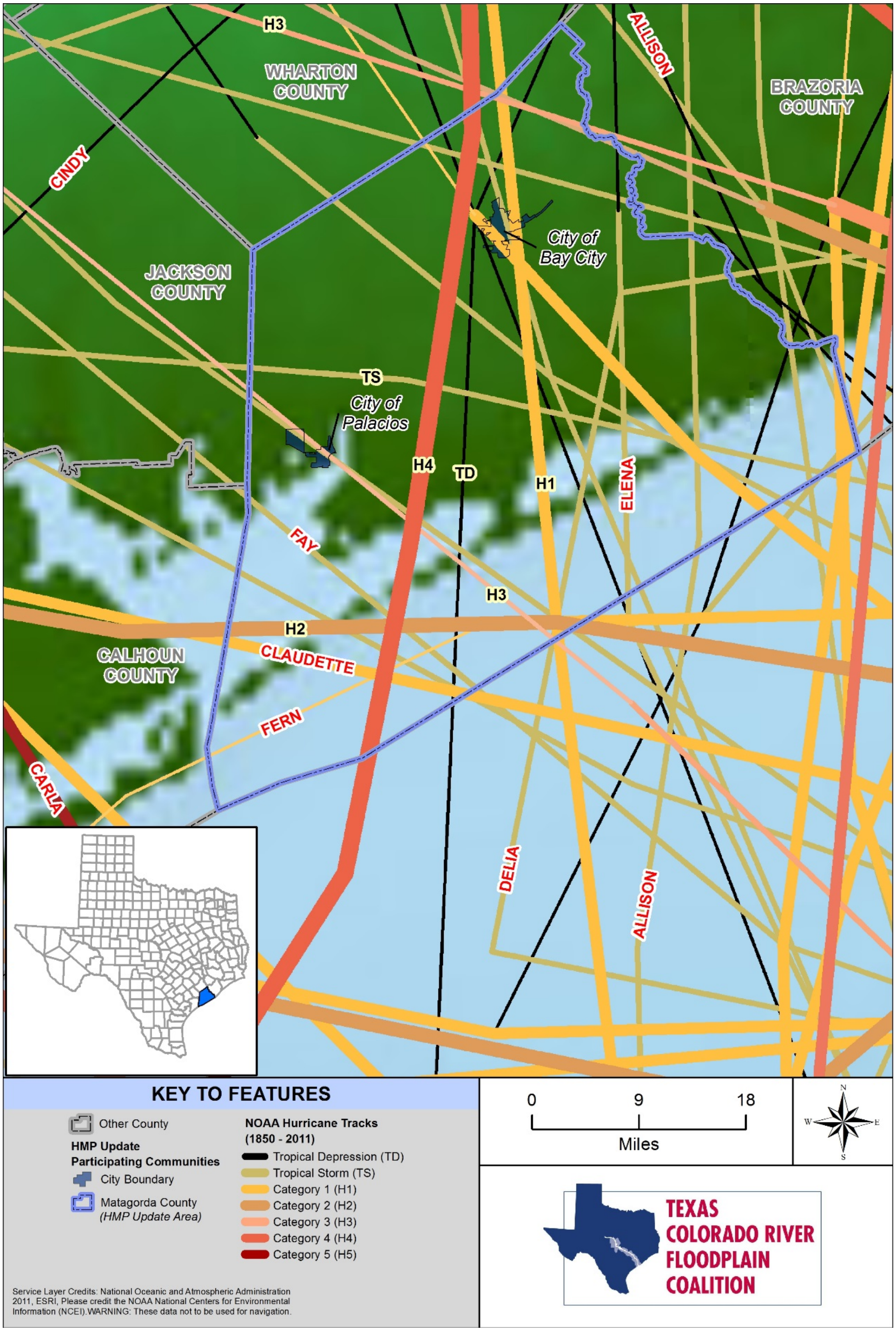


Figure 13-2. Historical Tropical Storms and Hurricanes Affecting Matagorda County

13.2.3 Frequency

Tropical storms are an annual event occurring from May through November in either the Gulf of Mexico or the Atlantic Ocean. The peak of the Atlantic hurricane season is in early- to mid-September. On average, approximately six storms reach hurricane intensity each year. Hurricanes appear to be less frequent during La Niña periods and more prevalent during strong El Niño periods. El Niño, and La Niña, its counterpart, refer to climate conditions in the Pacific Ocean that influence weather patterns in Texas. El Niño is associated with warmer sea surface temperatures and high air pressure systems, while La Niña is associated with cooler ocean temperatures and low air pressure systems. These changes in water temperature and air pressure systems occur in somewhat regular intervals, with El Niño periods having longer durations. Figure 13-3 illustrates the probability of a named tropical storm event throughout the U.S. Between 1851 and 2015, Matagorda County and participating communities experienced 36 tropical events. This relates to a frequency occurrence of approximately 0.22 events per year (an occasional event; possible in the next 5 years).

Future Probability

Matagorda County and participating experienced the effects of 36 tropical events. An occasional event is possible within the next five years (~0.22 events per year) for Matagorda County and participating communities.

Source: http://www.prh.noaa.gov/cphc/pages/FAQ/Climatology.php

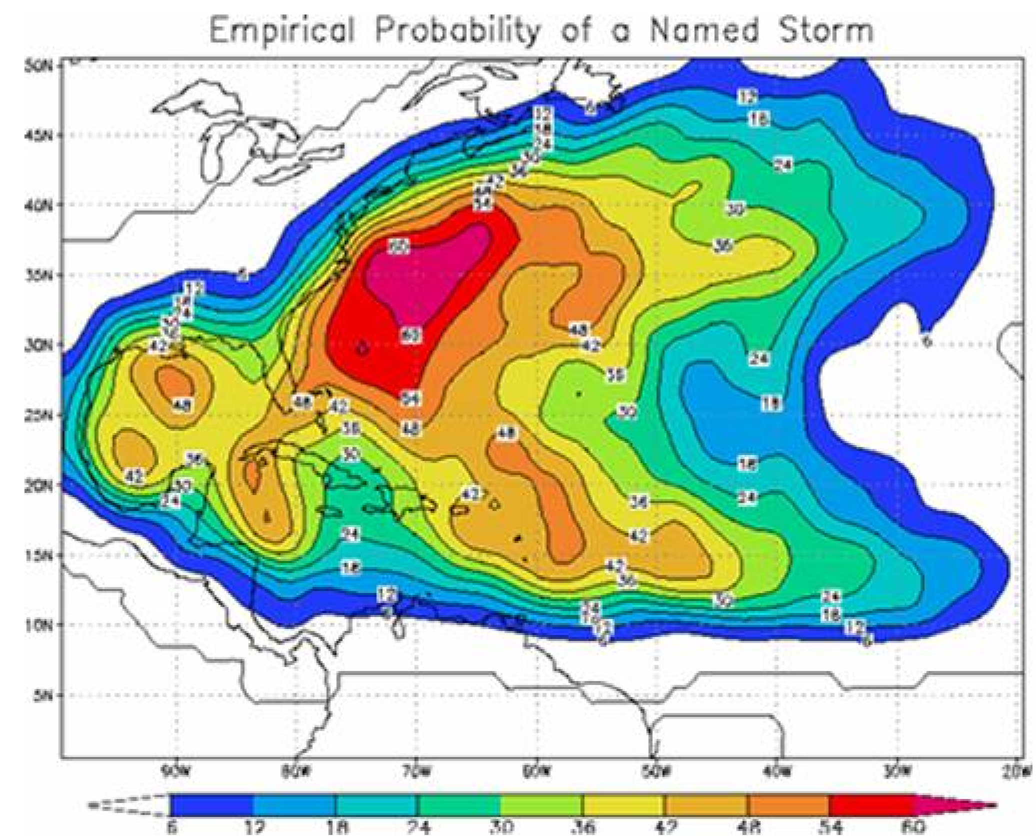


Figure 13-3. Probability of Named Tropical Storm Event

13.2.4 Severity

Historic events indicate that a hurricane will affect Matagorda County and participating communities as a Category 1 to 5 hurricane, thunderstorm, tropical depression, or related weather event (high winds, hail). These hazards are discussed in more detail in Chapter 14.

13.2.5 Warning Time

Meteorologists can often predict the likelihood and path of a hurricane or tropical storm. Meteorologists can give several days of warning before a storm. However, meteorologists cannot predict the exact time of onset or severity of the storm. At times, warning for the onset of severe weather may be limited.

13.3 SECONDARY EVENTS

Secondary events associated with a hurricane reaching Matagorda County and participating communities are similar to that of a tropical storm, depression, or related weather event (such as wind, hail, or lightning). By the time a hurricane reaches Matagorda County and participating communities it will be more closely classified as a secondary weather thunderstorm event (such as wind, hail, or lightning). These are the secondary events of a hurricane or tropical event. Even after the high winds subside, floods brought on by the heavy rainfalls can be dangerous. As a hurricane or tropical storm moves inland and begins to break up, the storm remnants can drop 6 to 12 or more inches of rain, resulting in extensive damage and loss of life. The most significant secondary hazards associated with severe local storms are floods, falling and downed trees, and downed power lines. Landslides occur when the soil on slopes becomes oversaturated and fails. Fires can occur as a result of lightning strikes. High winds from the storm can turn debris into flying projectiles. Debris carried by high winds can also result in injury or damage to property. The lack of proper management of trees may exacerbate damage from high winds. The damage to the infrastructure and land of Matagorda County and participating communities may impact the entire region, as Matagorda County is host to the South Texas Nuclear Power Plant, east of Collegeport.

13.4 CLIMATE CHANGE IMPACTS

It’s unclear whether climate change will increase or decrease the frequency of hurricanes and tropical storms, but warmer ocean surface temperatures and higher sea levels are expected to intensify their impacts. Hurricanes are subject to various climate change-related influences. Warmer sea surface temperatures could intensify tropical storms wind speeds, potentially delivering more damage if they make landfall. Based on sophisticated computer modeling, scientists expect a 2 to 11% increase in average maximum wind speed, with increased frequency of intense storms. Rainfall rates during these storms are also projected to increase by approximately 20%.

In addition, sea level rise is likely to make future coastal storms, including hurricanes, more damaging. Globally averaged, sea level is expected to rise by 1 to 4 feet during the next century, which will amplify coastal storm surge. For example, sea level rise intensified the impact of Hurricane Sandy, which caused an estimated $65 billion in damages in New York, New Jersey, and Connecticut in 2012. Much of this damage was related to coastal flooding (Center for Climate and Energy Solutions no date).

13.5 EXPOSURE

Property, population, and the natural environment are all exposed to hurricanes and tropical storms, however by the time such an event reaches Matagorda County it will be more closely classified as a tropical storm, depression, or related event (such as hail, high winds, or lightning). The entire population of the planning area would be affected by the tropical storm or tropical depression to some degree. Business interruption could keep people from working, road closures could isolate populations, and loss of functions of utilities could impact populations that suffered no direct damage form an event. Table 13-2 lists the exposed structures and population to hurricanes, tropical storms, and tropical depressions per participating community.

TABLE 13-2
EXPOSED STRUCTURES AND POPULATION

Jurisdiction	Residential	Commercial	Other *	**Total Structures**	**Total Population**
Unincorporated Area	5,744	121	35	5,900	17,631
City of Bay City	1,785	17	10	1,812	4,718
City of Palacios	6,787	29	16	6,832	10,028
Matagorda County Total	14,316	167	61	14,544	32,377

*Other includes industrial, agricultural, religious, governmental, and educational classifications.

13.6 VULNERABILITY

The Level 1 HAZUS-MH protocol was used to assess the vulnerability of the planning area to hurricanes and tropical storms. The model used census data at the tract level and modeled storms initiated in the Atlantic Ocean, Caribbean Sea, Gulf of Mexico, and eastern and central Pacific Ocean. Where possible, the HAZUS-MH default building and contents data were enhanced using local GIS data from 2014 Tax Assessor data.

HAZUS-MH calculates losses to structures from hurricanes by looking at wind speeds, winds tracks, and amount of precipitation. Using historical storm data, HAZUS-MH estimates probabilistic storm scenarios. The historic storm database contains precomputed wind fields and storm track for Category 3, 4, and 5 land falling hurricanes from 1900 to 2010. For this analysis, a probabilistic HAZUS-MH hurricane scenario was selected. Table 13-4 lists annualized loss estimates for the 100-year probabilistic event scenario. Peak gust wind speeds for the 100-year probabilistic scenario are between 104 mph and 122 mph (Figure 13-4). Approximately 29% of the buildings (mostly residential) are expected to sustain moderate damages for this scenario. The annualized economic loss estimated for this probabilistic hurricane scenario is $21 million, which represents less than 0.36% of the total replacement value of the building value for each participating community.

Table 13-3 lists the vulnerable population per participating community. Table 13-4 list the impact in terms of dollar losses.

TABLE 13-3
MOST VULNERABLE POPULATION

Jurisdiction	Youth Population (< 16)	% of Total Population	Elderly Population (> 65)	% of Total Population	Economically Disadvantage (Income < $20,000)	% of Total Population
Unincorporated Area	4,912	27.86	2,146	12.17	1,749	9.92
City of Bay City	1,441	30.54	623	13.20	549	11.64

TABLE 13-3
MOST VULNERABLE POPULATION

City of Palacios	2,192	21.86	1,829	18.24	527	5.26
Matagorda County Total	8,545	26.39	4,598	14.20	2,825	8.73

TABLE 13-4.
LOSS ESTIMATES FOR A HURRICANE EVENT

	Annualized Loss ($)			Exposed Value ($)	% of Total Exposed Value
	Structure	Contents	Total		
Unincorporated Area	13,753,912	5,263,541	19,017,453	2,558,729,176	0.74%
City of Bay City	1,731,824	543,991	2,275,815	2,649,736,203	0.09%
City of Palacios	65,908	26,277	92,185	669,865,421	0.01%
Matagorda County Total	**15,551,644**	**5,833,809**	**21,385,453**	**5,878,330,801**	**0.36%**

Vulnerability Narrative

All participating communities are equally at risk to hurricanes, tropical storms, and tropical depressions. The extent of an hurricane event for each jurisdiction is described below.

- **City of Bay City -** Probabilistic Peak Wind Gusts for the City of Bay City are approximately 122 mph. Approximately 13% of the City's housing is manufactured homes. These are more vulnerable to high winds from an event. If an event were to impact critical facilities (such as emergency response facilities and schools) many residents could be negatively affected and response times could increase. Facilities without secondary power supply sources, such as generators, increase this risk. Structures not built with sufficient building codes are more vulnerable to storm damage. Property owners who do not take measures to protect their homes from the structural damage that can occur in a hurricane event increase these risks.
- **City of Palacios -** Probabilistic Peak Wind Gusts for the City of Palacios are approximately 104 mph. Less than 17% of the City's housing is manufactured homes. These are more vulnerable to high winds from an event. Any ungrounded structures or property could become flying debris causing further damage to properties in the area. Property along drainage areas that have not been cleaned out are more prone to flooding. An event could damage critical facilities, including medical facilities, or police and fire stations. Communities who do not ensure alternative power supply sources or secure their infrastructure increase vulnerability as response to the community would become difficult. Damages to major thoroughfares such as TX 35 could increase response times and decrease mobility. Bridges in need of modifications increase these risks.

- **Matagorda County (Unincorporated Area) -** Probabilistic Peak Wind Gusts for Matagorda County Unincorporated Areas range between approximately 104-123 mph. Approximately 20% of the of the Unincorporated Area's housing is manufactured homes. These are more vulnerable to high winds from an event. Properties throughout the HMP update area located along the Colorado River are vulnerable to wave action erosion and flooding caused by high winds and intense rainfall. Communities who do not provide shelter for vulnerable residents increase their risk. Transportation routes impacted by an event (such as TX 71 or TX 35) could limit access to and from emergency responders. Residents in potential dam inundation areas and within floodplains are more vulnerable to secondary events (such as flooding). Residents unable to receive notification (those in communities without emergency alert systems such as Reverse 911), are more at risk as well.

Community Perception of Vulnerability

See front page of current chapter for a summary of hazard rankings for Matagorda County and participating communities in this HMP update. Chapter 19 gives a detailed description of this rankings and Chapter 20 addresses mitigations actions for this hazard vulnerability.

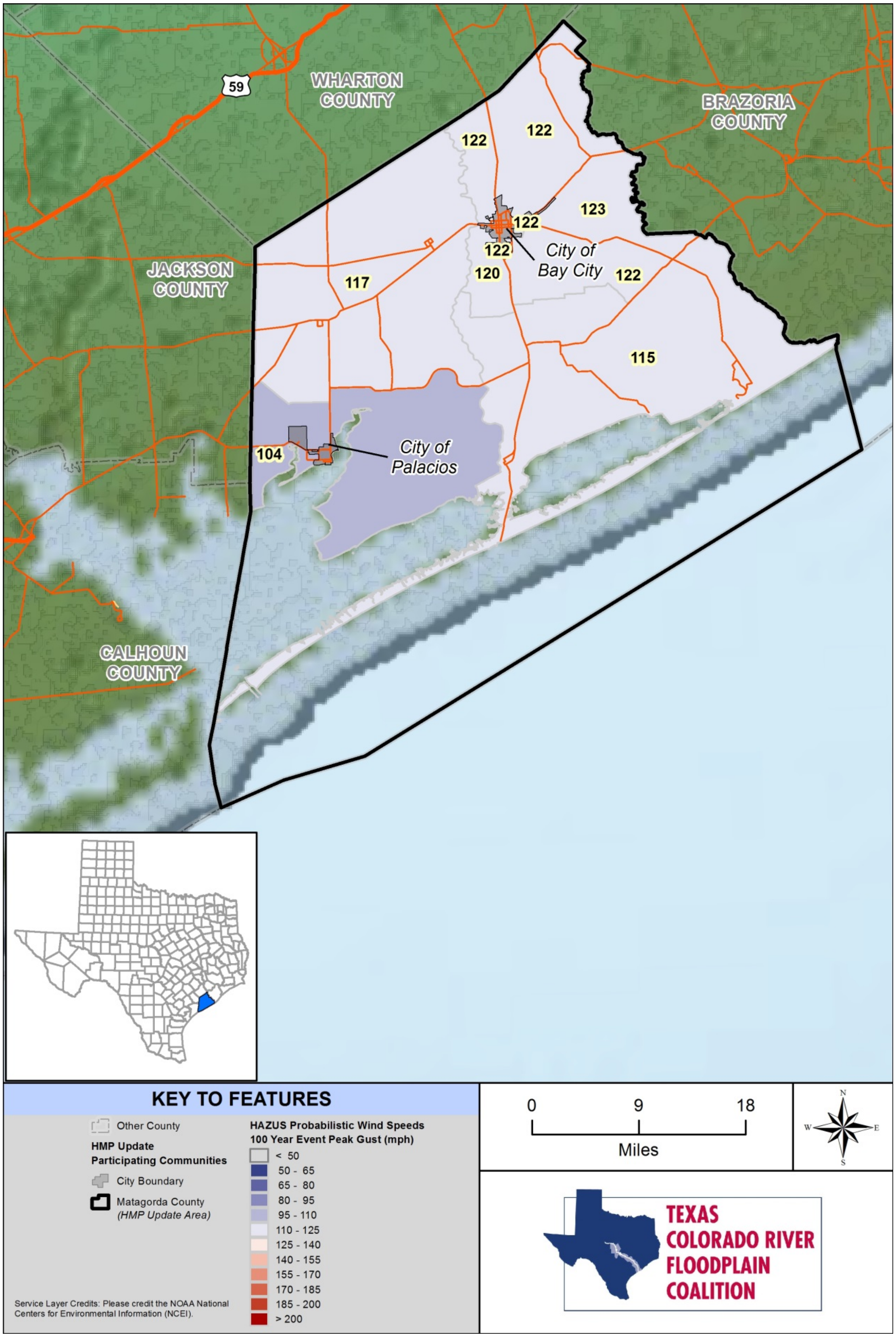


Figure 13-4. 100-Year Probabilistic Peak Wind Gusts for Matagorda County

13.7 FUTURE TRENDS IN DEVELOPMENT

The threat of tropical storms is constant in Texas. From the Gulf of Mexico coastline to Central Texas, the adverse effects of tropical storms and hurricanes will be felt. Tropical storms and hurricanes may cause billions of dollars in damages. Hurricane trends change yearly and with the unclear effects of climate change on tropical developments, future trends are difficult to predict. NOAA's 2015 hurricane season outlook predicted that a below-normal Atlantic hurricane season is likely. This outlook called for a 70% chance of a below-normal season, a 25% chance of a near-normal season, and only a 5% chance of an above-normal season. However, Global Weather Oscillations Inc., a leading hurricane cycle prediction company, says "The 2015 Atlantic Basin hurricane season will be the most active and dangerous in at least 3 years, and the next 3 seasons will be the most dangerous in 10 years." Therefore it is important for communities and community leaders to remain alert and informed of seasonal predictions and developments.

13.8 SCENARIO

A worst case scenario would be for a very large and severe hurricane to make landfall at the Texas Gulf Coast of Matagorda County and the participating communities. Such a powerful storm at landfall would have significant impacts in Matagorda County and beyond. This storm could cause severe flooding, tornadoes, and wind damage to infrastructure throughout the county. This could significantly slow emergency response time and cause public utilities to be offline for weeks. A large of a storm would leave a large path of damage across South and Central Texas straining resources throughout the county and state.

13.9 ISSUES

Important issues associated with a tropical storm in Matagorda County and the participating communities include the following:

- Older building stock in the planning area is built to low code standards or none at all. These structures could be highly vulnerable to severe weather events such as hurricanes and tropical storms.
- Redundancy of power supply must be evaluated.
- The potential for isolation after a severe storm event is high.
- Flash flooding that occurs with little or no warning will continue to impact the planning area.
- The promotion of flood insurance as a means of protecting private property owners from the economic impacts of frequent flood events should continue.
- Roads and bridges blocked by debris or otherwise damaged might isolate populations.
- Warning time may not be adequate for residents to seek appropriate shelter or such shelter may not be widespread throughout the planning area.
- The impacts of climate change on the frequency and severity of hurricanes and tropical storms are not well understood.

CHAPTER 14.
LIGHTNING, HAIL, AND WIND

LIGHTNING, HAIL, AND WIND RANKING			
	Lightning	**Hail**	**Wind**
Matagorda County	Low	Low	Low
City of Bay City	Low	Low	Medium
City of Palacios	Medium	Medium	Medium

14.1 GENERAL BACKGROUND

14.1.1 Lightning, Hail, and Wind

A thunderstorm is a rain event that includes thunder, wind, hail, and lightning. A thunderstorm is classified as "severe" when it contains one or more of the following: hail with a diameter of three-quarter inch or greater, winds gusting in excess of 50 knots (kt) (57.5 mph), or tornadoes. For this hazard mitigation plan, each component of a thunderstorm (lightning, hail, and winds) will be profiled below. Thunderstorms, as a whole, is not a Texas State Hazard per the Texas State Mitigation Plan Update 2013. 'Thunderstorm' is used in this section as a descriptive term to qualify hail, wind, and lightning atmospheric events. Thunderstorms are described below for general reference information and not a profiled hazard.

DEFINITIONS

Severe Local Storm — Small-scale atmospheric systems, including tornadoes, thunderstorms, windstorms, ice storms, and snowstorms. These storms may cause a great deal of destruction and even death, but their impact is generally confined to a small area. Typical impacts are on transportation infrastructure and utilities.

Thunderstorm — A storm featuring heavy rains, strong winds, thunder and lightning, typically about 15 miles in diameter and lasting about 30 minutes. Hail and tornadoes are also dangers associated with thunderstorms. Lightning is a serious threat to human life. Heavy rains over a small area in a short time can lead to flash flooding.

Windstorm — A storm featuring violent winds. Windstorms tend to damage ridgelines that face into the wind.

Three factors cause thunderstorms to form: moisture, rising unstable air (air that keeps rising when disturbed), and a lifting mechanism to provide the disturbance. The sun heats the surface of the earth, which warms the air above it. If this warm surface air is forced to rise (hills or mountains can cause rising motion, as can the interaction of warm air and cold air or wet air and dry air) it will continue to rise as long as it weighs less and stays warmer than the air around it. As the air rises, it transfers heat from the surface of the earth to the upper levels of the atmosphere (the process of convection). The water vapor it contains begins to cool and it condenses into a cloud. The cloud eventually grows upward into areas where the temperature is below freezing. Some of the water vapor turns to ice and some of it turns into water droplets. Both have electrical charges. Ice particles usually have positive charges, and rain droplets usually have negative charges. When the charges build up enough, they are discharged in a bolt of lightning, which causes the sound waves we hear as thunder. Thunderstorms have three stages (see Figure 14-1):

- The **developing stage** of a thunderstorm is marked by a cumulus cloud that is being pushed upward by a rising column of air (updraft). The cumulus cloud soon looks like a tower (called towering cumulus) as the updraft continues to develop. There is little to no rain during this stage but occasional lightning. The developing stage lasts about 10 minutes.
- The thunderstorm enters the **mature stage** when the updraft continues to feed the storm, but precipitation begins to fall out of the storm, and a downdraft begins (a column of air pushing downward). When the downdraft and rain-cooled air spread out along the ground, they form a gust

front, or a line of gusty winds. The mature stage is the most likely time for hail, heavy rain, frequent lightning, strong winds, and tornadoes. The storm occasionally has a black or dark green appearance.

- Eventually, a large amount of precipitation is produced and the updraft is overcome by the downdraft beginning the **dissipating stage**. At the ground, the gust front moves out a long distance from the storm and cuts off the warm moist air that was feeding the thunderstorm. Rainfall decreases in intensity, but lightning remains a danger.

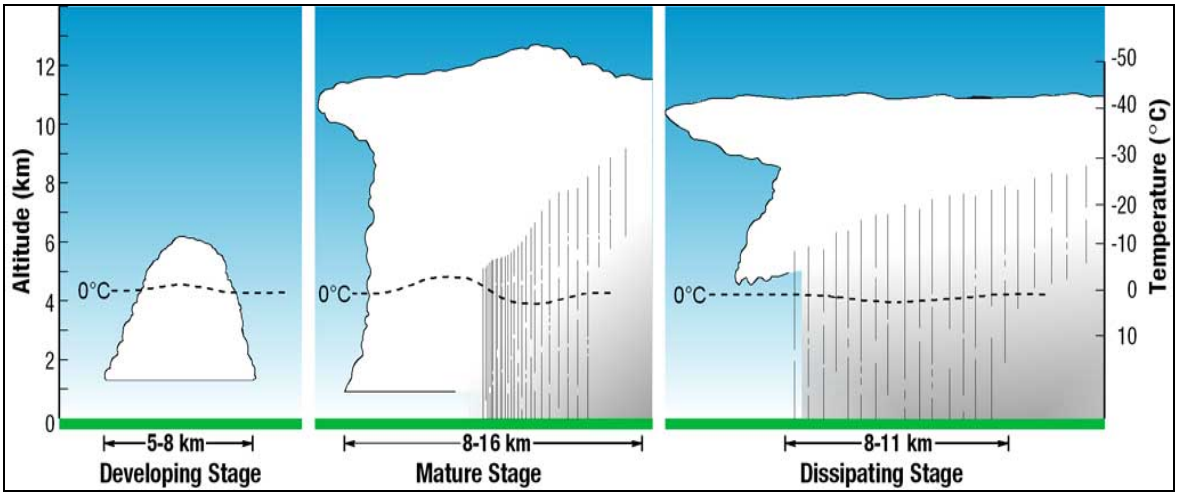


Figure 14-1. Thunderstorm Life Cycle

There are four types of thunderstorms:

- **Single-Cell Thunderstorms**—Single-cell thunderstorms usually last 20 to 30 minutes. A true single-cell storm is rare, because the gust front of one cell often triggers the growth of another. Most single-cell storms are not usually severe, but a single-cell storm can produce a brief severe weather event. When this happens, it is called a pulse severe storm.
- **Multi-Cell Cluster Storm**—A multi-cell cluster is the most common type of thunderstorm. The multi-cell cluster consists of a group of cells, moving as one unit, with each cell in a different phase of the thunderstorm life cycle. Mature cells are usually found at the center of the cluster and dissipating cells at the downwind edge. Multi-cell cluster storms can produce moderate-size hail, flash floods, and weak tornadoes. Each cell in a multi-cell cluster lasts only about 20 minutes; the multi-cell cluster itself may persist for several hours. This type of storm is usually more intense than a single cell storm.
- **Multi-Cell Squall Line—**A multi-cell line storm, or squall line, consists of a long line of storms with a continuous well-developed gust front at the leading edge. The line of storms can be solid, or there can be gaps and breaks in the line. Squall lines can produce hail up to golf-ball size, heavy rainfall, and weak tornadoes, but they are best known as the producers of strong downdrafts. Occasionally, a strong downburst will accelerate a portion of the squall line ahead of the rest of the line. This produces what is called a bow echo. Bow echoes can develop with isolated cells as well as squall lines. Bow echoes are easily detected on radar but are difficult to observe visually.
- **Super-Cell Storm—**A super-cell is a highly organized thunderstorm that poses a high threat to life and property. It is similar to a single-cell storm in that it has one main updraft, but the updraft is extremely strong, reaching speeds of 150 to 175 mph. Super-cells are rare. The main characteristic that sets them apart from other thunderstorms is the presence of rotation. The rotating updraft of a super-cell (called a mesocyclone when visible on radar) helps the super-cell

to produce extreme weather events, such as giant hail (more than 2 inches in diameter), strong downbursts of 80 mph or more, and strong to violent tornadoes.

14.1.2 Lightning

Lightning is an electrical discharge between positive and negative regions of a thunderstorm. A lightning flash is composed of a series of strokes with an average of about four. The length and duration of each lightning stroke vary, but typically average about 30 microseconds.

Lightning is one of the more dangerous and unpredictable weather hazards in the United States and in Texas. Each year, lightning is responsible for deaths, injuries, and millions of dollars in property damage, including damage to buildings, communications systems, power lines and electrical systems. Lightning also causes forest and brush fires as well as deaths and injuries to livestock and other animals. According to the National Lightning Safety Institute, lightning strikes the U.S about 25 million times each year and causes more than 26,000 fires nationwide each year. The institute estimates property damage, increased operating costs, production delays, and lost revenue from lightning and secondary effects to be in excess of $6 billion per year. Impacts can be direct or indirect. People or objects can be directly struck, or damage can occur indirectly when the current passes through or near it.

Intra-cloud lightning is the most common type of discharge. This occurs between oppositely charged centers within the same cloud. Usually it takes place inside the cloud and looks from the outside of the cloud like a diffuse brightening that flickers. However, the flash may exit the boundary of the cloud, and a bright channel can be visible for many miles.

Although not as common, cloud-to-ground lightning is the most damaging and dangerous form of lightning. Most flashes originate near the lower-negative charge center and deliver negative charge to earth. However, a minority of flashes carry positive charge to earth. These positive flashes often occur during the dissipating stage of a thunderstorm's life. Positive flashes are also more common as a percentage of total ground strikes during the winter months. This type of lightning is particularly dangerous for several reasons. It frequently strikes away from the rain core, either ahead or behind the thunderstorm. It can strike as far as 5 or 10 miles from the storm in areas that most people do not consider to be a threat. Positive lightning also has a longer duration, so fires are more easily ignited. And, when positive lightning strikes, it usually carries a high peak electrical current, potentially resulting in greater damage.

The ratio of cloud-to-ground and intra-cloud lightning can vary significantly from storm to storm. Depending upon cloud height above ground and changes in electric field strength between cloud and earth, the discharge stays within the cloud or makes direct contact with the earth. If the field strength is highest in the lower regions of the cloud, a downward flash may occur from cloud to earth. Using a network of lightning detection systems, NOAA monitors a yearly average of 25 million strokes of lightning from the cloud-to-ground. Figure 14-2 shows the lightning flash density for the nation.

U.S. lightning statistics compiled by NOAA between 1959 and 1994 indicate that most lightning incidents occur during the summer months of June, July, and August, and during the afternoon hours from between 2 and 6 p.m.

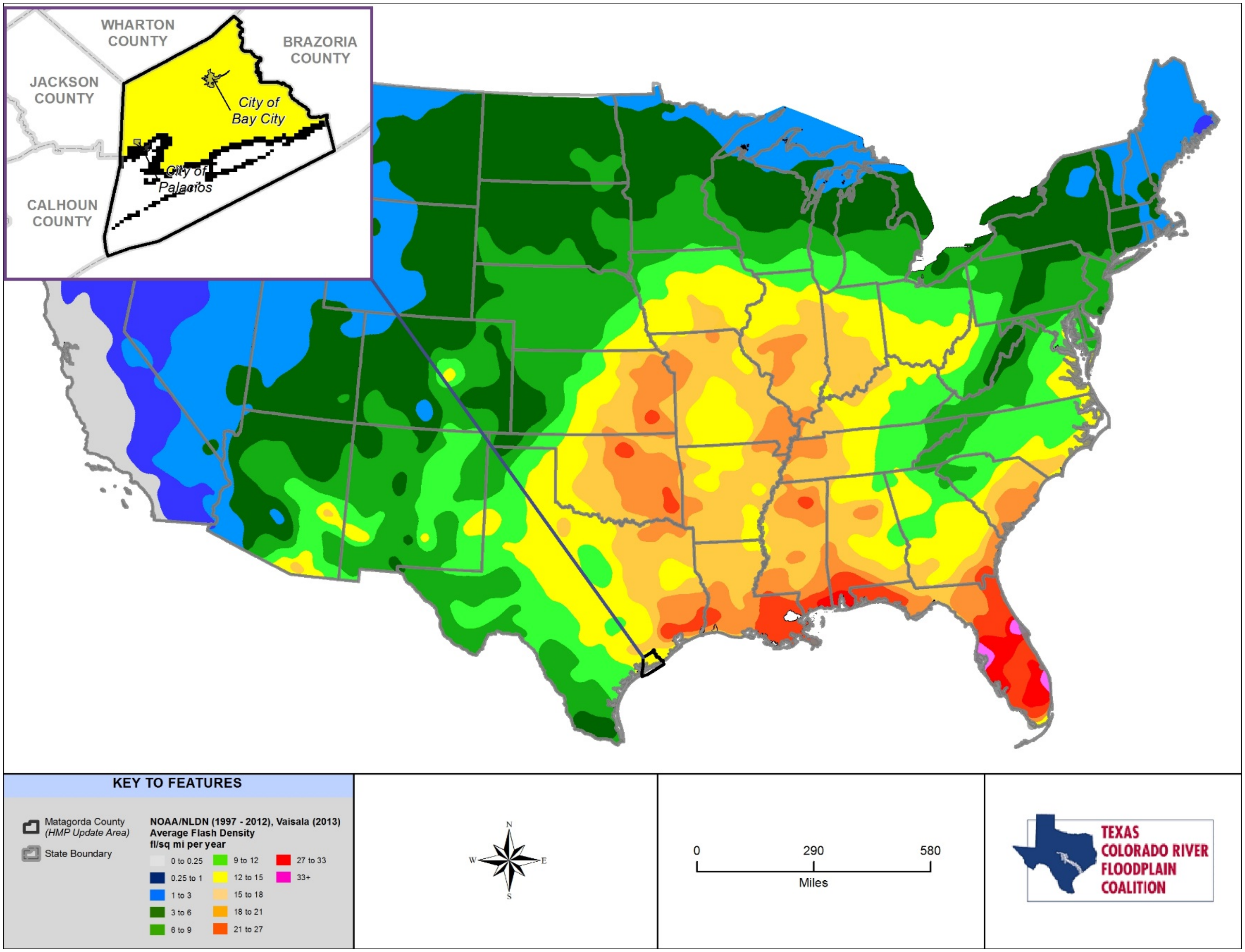


Figure 14-2. Average Annual National Lightning Density

14.1.3 Hail

Hail occurs when updrafts in thunderstorms carry raindrops upward into extremely cold areas of the atmosphere where they freeze into ice. Figure 14-3 shows the hail path across the nation, Matagorda County and participating communities. Recent studies suggest that super-cooled water may accumulate on frozen particles near the back-side of a storm as they are pushed forward across and above the updraft by the prevailing winds near the top of the storm. Eventually, the hailstones encounter downdraft air and fall to the ground.

Hailstones grow two ways: by wet growth or dry growth. In wet growth, a tiny piece of ice is in an area where the air temperature is below freezing, but not super cold. When the tiny piece of ice collides with a super-cooled drop, the water does not freeze on the ice immediately. Instead, liquid water spreads across tumbling hailstones and slowly freezes. Since the process is slow, air bubbles can escape, resulting in a layer of clear ice. Dry growth hailstones grow when the air temperature is well below freezing and the water droplet freezes immediately as it collides with the ice particle. The air bubbles are “frozen” in place, leaving cloudy ice.

Hailstones can have layers like an onion if they travel up and down in an updraft, or they can have few or no layers if they are “balanced” in an updraft. One can tell how many times a hailstone traveled to the top of the storm by counting its layers. Hailstones can begin to melt and then re-freeze together, forming large and very irregularly shaped hail. NWS classifies hail as non-severe and severe based on hail diameter size. Descriptions and diameter sizes are provided in Table 14-1.

Source: NOAA's NWS Storm Prediction Center Severe Report Database 1950 – 2013

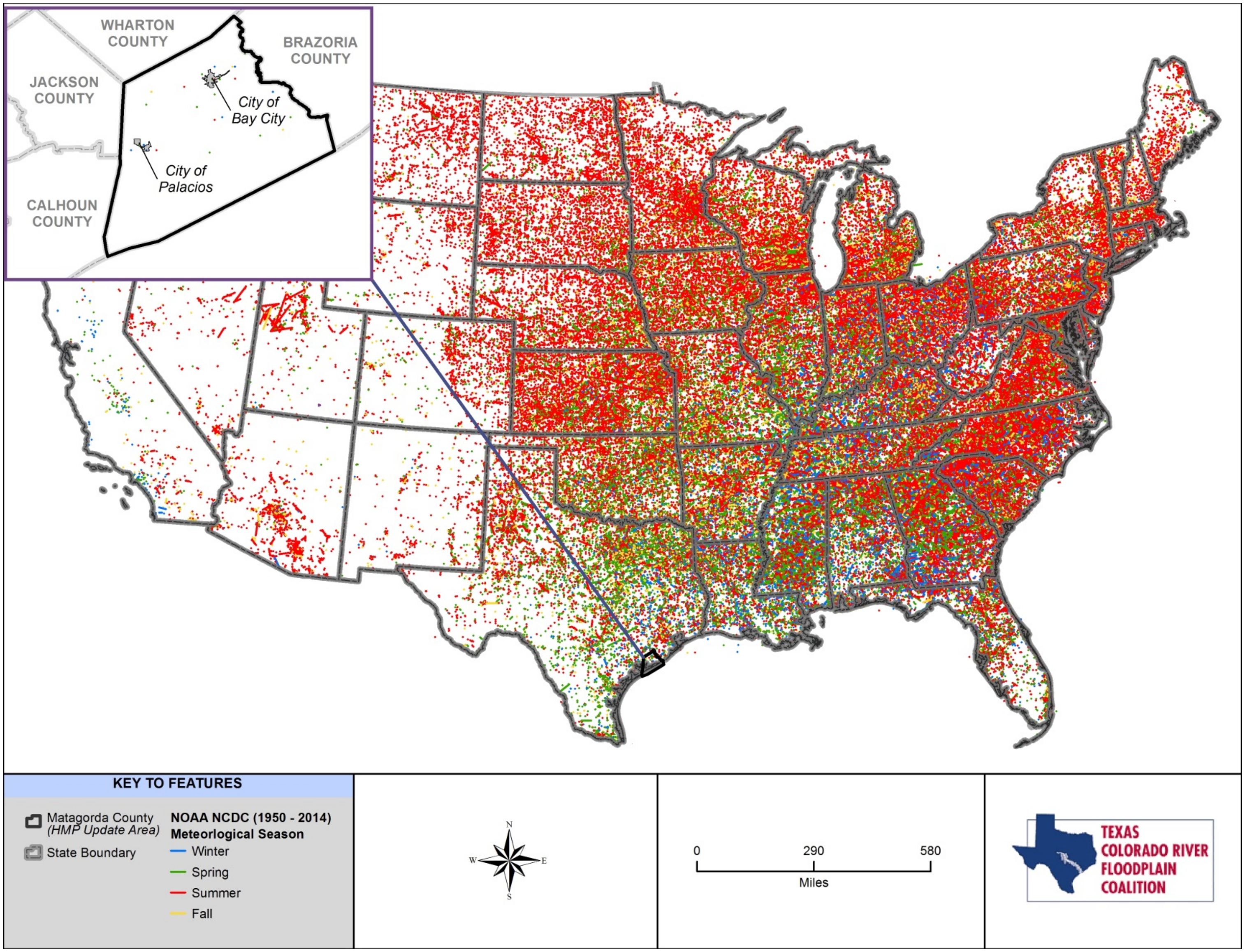


Figure 14-3. National Hail Paths

**TABLE 14-1.
NATIONAL WEATHER SERVICE HAIL SEVERITY**

Severity	Description	Hail Diameter Size
Non-Severe Hail Does not typically cause damage and does not warrant severe thunderstorm warning from National Weather Service.	Pea	1/4"
	Plain M&M Candy	1/2"
	Penny	3/4"
	Nickel	7/8"
Severe Hail Research has shown that damage occurs after hail reaches around one inch in diameter and larger. Hail of this size will trigger a severe thunderstorm warning from National Weather Service.	Quarter	1" (severe)
	Half Dollar	1 1/4"
	Walnut/Ping Pong Ball	1 1/2"
	Golf Ball	1 3/4"
	Hen Egg/Lime	2"
	Tennis Ball	2 1/2"
	Baseball	2 3/4"
	Teacup/Large Apple	3"
	Grapefruit	4"
	Softball	4 1/2"
	Computer CD-DVD	4 3/4"- 5"

NOAA’s National Severe Storms Laboratory used historical data to estimate the daily probability of hail occurrences across the U.S., regardless of storm magnitude. Figure 14-4 shows the average number of hail days per year. The density per 25 square miles in the map’s legend indicates the probable number of hail days for each 25 square mile cell within the contoured zone that can be expected over a similar period of record. It should be noted that the density number does NOT indicate the number of events that can be expected across the entire zone on the map.

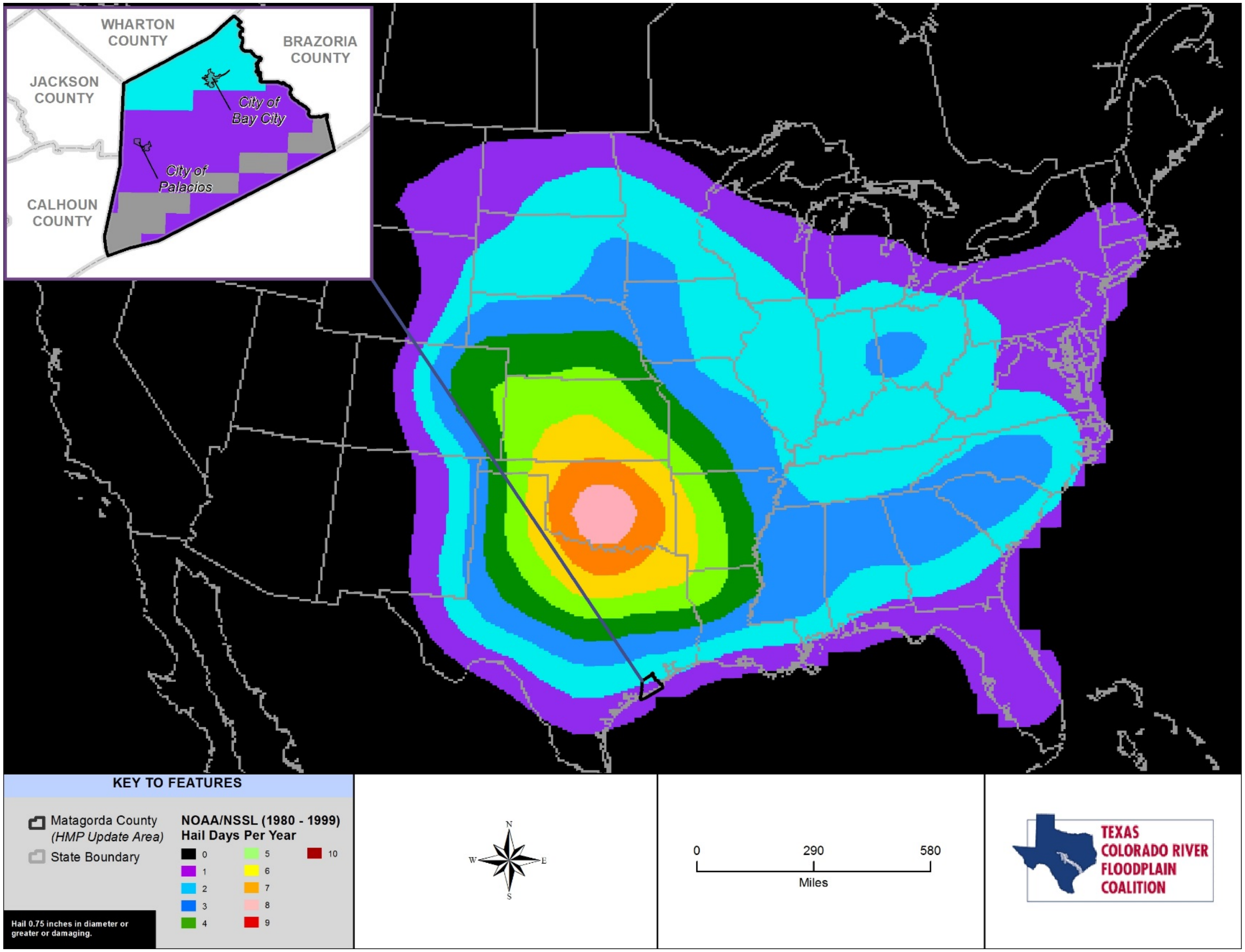


Figure 14-4. National Hail Days per Year

14.1.4 Wind

Damaging winds are classified as those exceeding 60 mph. Figure 14-5 shows the wind zones in the nation. NOAA's NWS Storm Prediction Center Severe Report Database has wind inventory from 1955 to 2014. Figure 14-6 shows the thunderstorm wind paths. Damage from such winds accounts for half of all severe weather reports in the lower 48 states and is more common than damage from tornadoes. Wind speeds can reach up to 100 mph and can produce a damage path extending for hundreds of miles. There are seven types of damaging winds:

- **Straight-line winds—**Any thunderstorm wind that is not associated with rotation; this term is used mainly to differentiate from tornado winds. Most thunderstorms produce some straight-line winds as a result of outflow generated by the thunderstorm downdraft.
- **Downdrafts—**A small-scale column of air that rapidly sinks toward the ground.
- **Downbursts—**A strong downdraft with horizontal dimensions larger than 2.5 miles resulting in an outward burst or damaging winds on or near the ground. Downburst winds may begin as a microburst and spread out over a wider area, sometimes producing damage similar to a strong tornado. Although usually associated with thunderstorms, downbursts can occur with showers too weak to produce thunder.
- **Microbursts—**A small concentrated downburst that produces an outward burst of damaging winds at the surface. Microbursts are generally less than 2.5 miles across and short-lived, lasting only 5 to 10 minutes, with maximum wind speeds up to 168 mph. There are two kinds of microbursts: wet and dry. A wet microburst is accompanied by heavy precipitation at the surface. Dry microbursts, common in places like the high plains and the intermountain west, occur with little or no precipitation reaching the ground.
- **Gust front—**A gust front is the leading edge of rain-cooled air that clashes with warmer thunderstorm inflow. Gust fronts are characterized by a wind shift, temperature drop, and gusty winds out ahead of a thunderstorm. Sometimes the winds push up air above them, forming a shelf cloud or detached roll cloud.
- **Derecho—**A derecho is a widespread thunderstorm wind caused when new thunderstorms form along the leading edge of an outflow boundary (the boundary formed by horizontal spreading of thunderstorm-cooled air). The word "derecho" is of Spanish origin and means "straight ahead." Thunderstorms feed on the boundary and continue to reproduce. Derechos typically occur in summer when complexes of thunderstorms form over plains, producing heavy rain and severe wind. The damaging winds can last a long time and cover a large area.
- **Bow Echo—**A bow echo is a linear wind front bent outward in a bow shape. Damaging straight-line winds often occur near the center of a bow echo. Bow echoes can be 200 miles long, last for several hours, and produce extensive wind damage at the ground.

NOAA's National Severe Storms Laboratory used historical data to estimate the daily probability of wind occurrences across the U.S., regardless of storm magnitude. Figure 14-7 shows the estimates for damaging winds with 50 kts or greater. The density per 25 square miles in the map's legend indicates the probable number of wind for each 25 square mile cell within the contoured zone that can be expected over a similar period of record. It should be noted that the density number does NOT indicate the number of events that can be expected across the entire zone on the map.

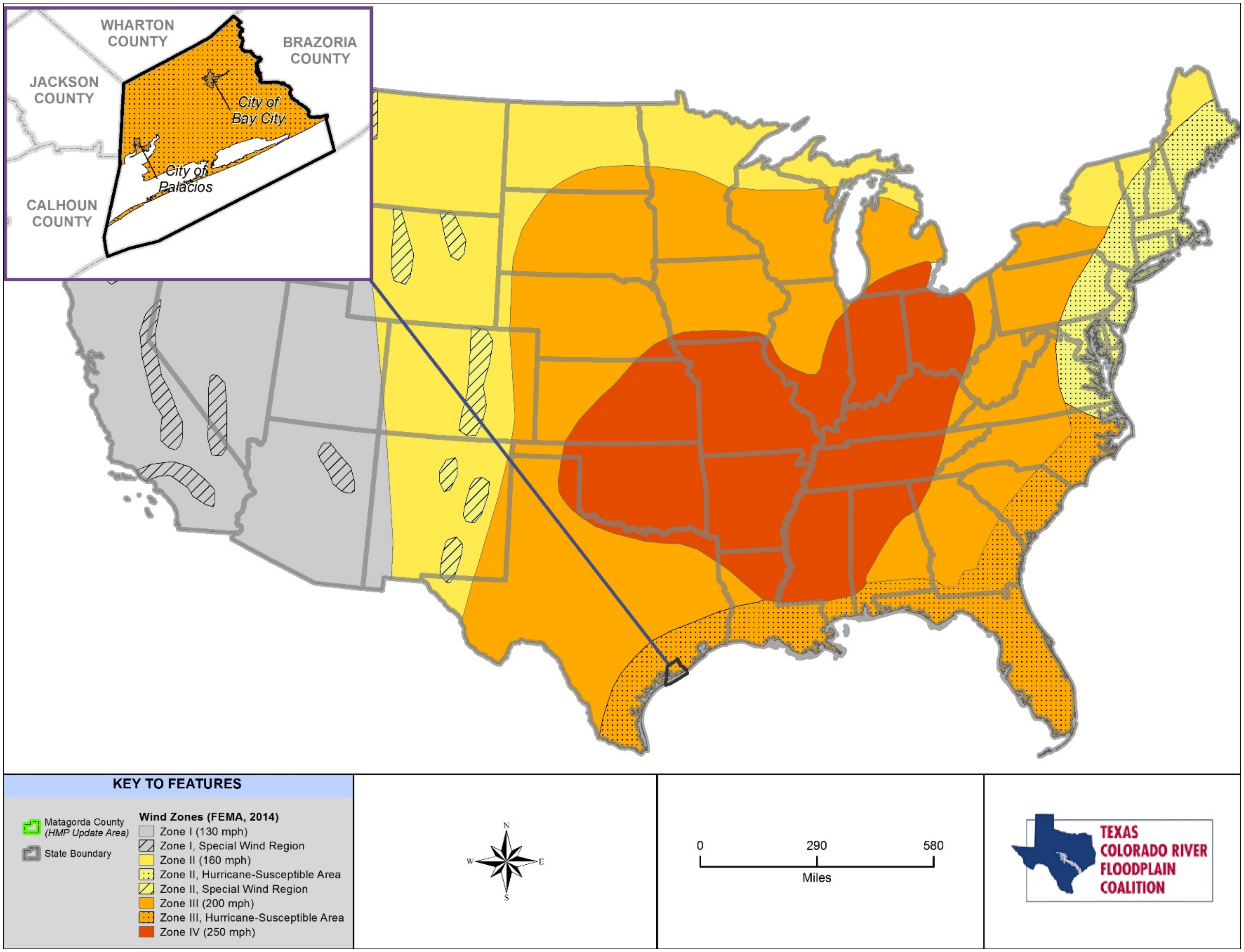


Figure 14-5. National Wind Zones

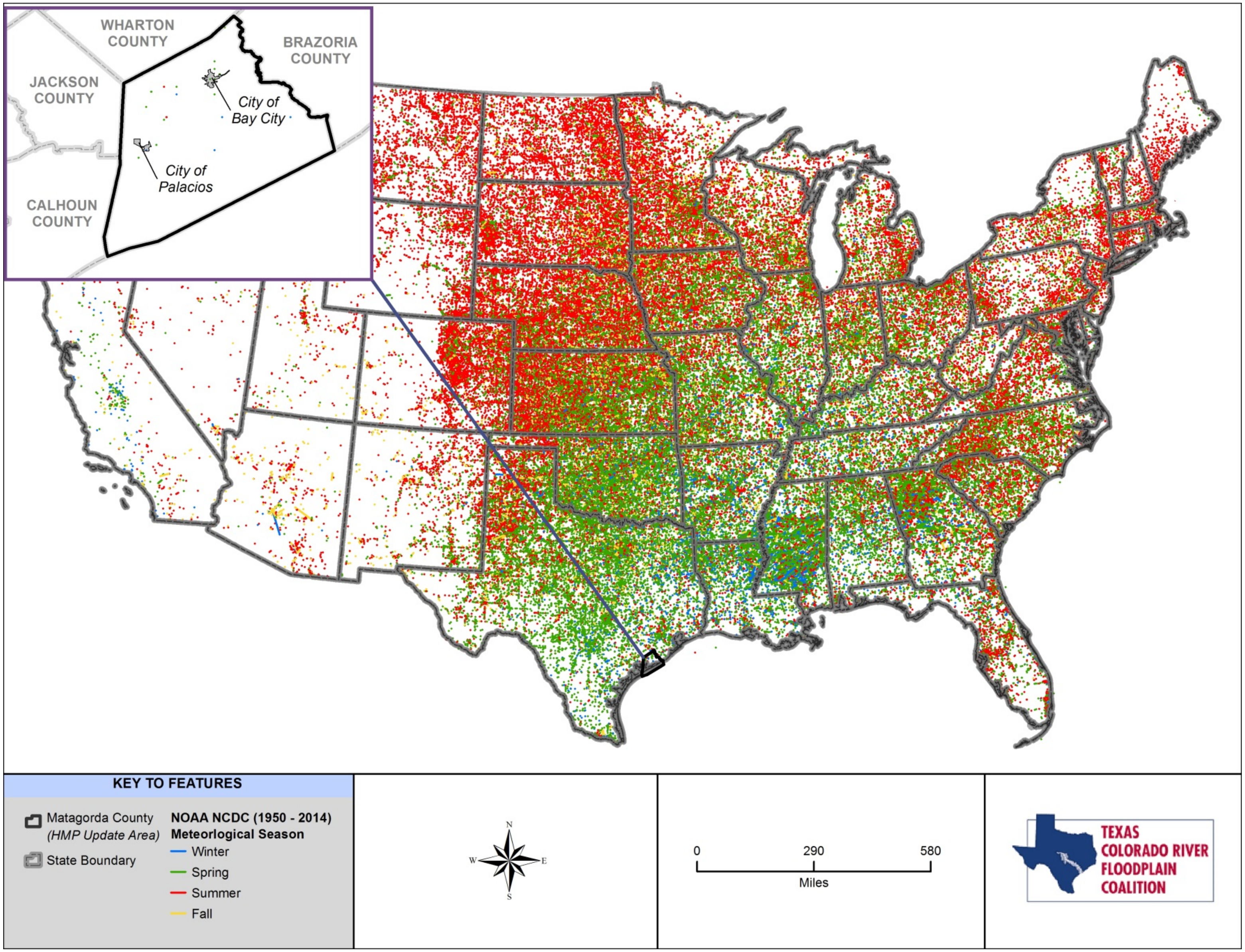


Figure 14-6. National High Wind Paths

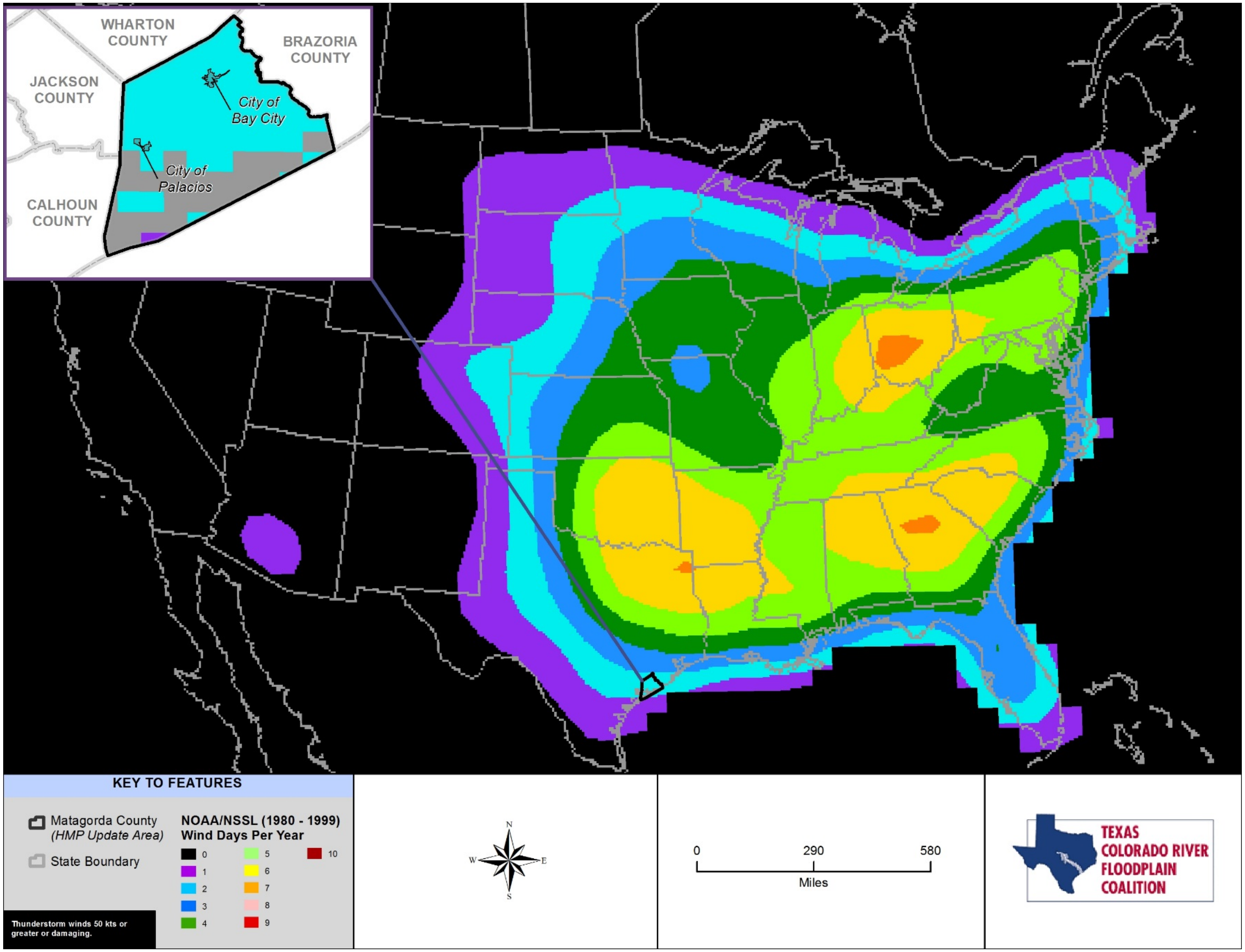


Figure 14-7. National Annual High Wind Days

14.2 HAZARD PROFILE

14.2.1 Past Events

Lightning

Data from the National Lightning Detection Network ranks Texas second in the nation (excluding Alaska and Hawaii) with respect to the number of cloud-to-ground lightning flashes. On average, Texas has more than 2,892,486 cloud-to-ground lightning strikes per year with higher lightning frequency in the western part of the state. Matagorda County and participating communities have an average of 9 to 15 lightning flashes per square mile per year as shown in Figure 14-2. The National Climatic Data Center Severe Weather Data Inventory documents that over 300,000 cloud-to-ground lightning flashes have been reported in Matagorda County from 1986 to 2013. Using an area weighted average, it is estimated that the Matagorda County Unincorporated Area experienced 191,343 cloud-to-ground lightning flashes; the City of Bay City experienced 1,512 cloud-to-ground lightning flashes; and the City of Palacios experienced 855 cloud-to-ground lightning flashes during this same time period (1986-2013).

Figure 14-8 shows state-by-state lightning deaths between 1959 and 2013. Texas ranks second for the number of deaths at 217. Only Florida, with 471 deaths, had more. Texas has a 0.25 death rate per million people from lightning strikes according to 1959 to 2013 data published by NWS.

According to the National Climatic Data Center Storm Events Database as well as locally available data, there was one casualty report from lightning in Matagorda County or participating communities between 1950 and December 2014. This recorded lightning related injury event occurred on June 5, 2007, during an isolated thunderstorm event in the HMP update area. A 52-year old male was struck by lightning and injured while lying on the beach a few miles southwest of the mouth of the Colorado River.

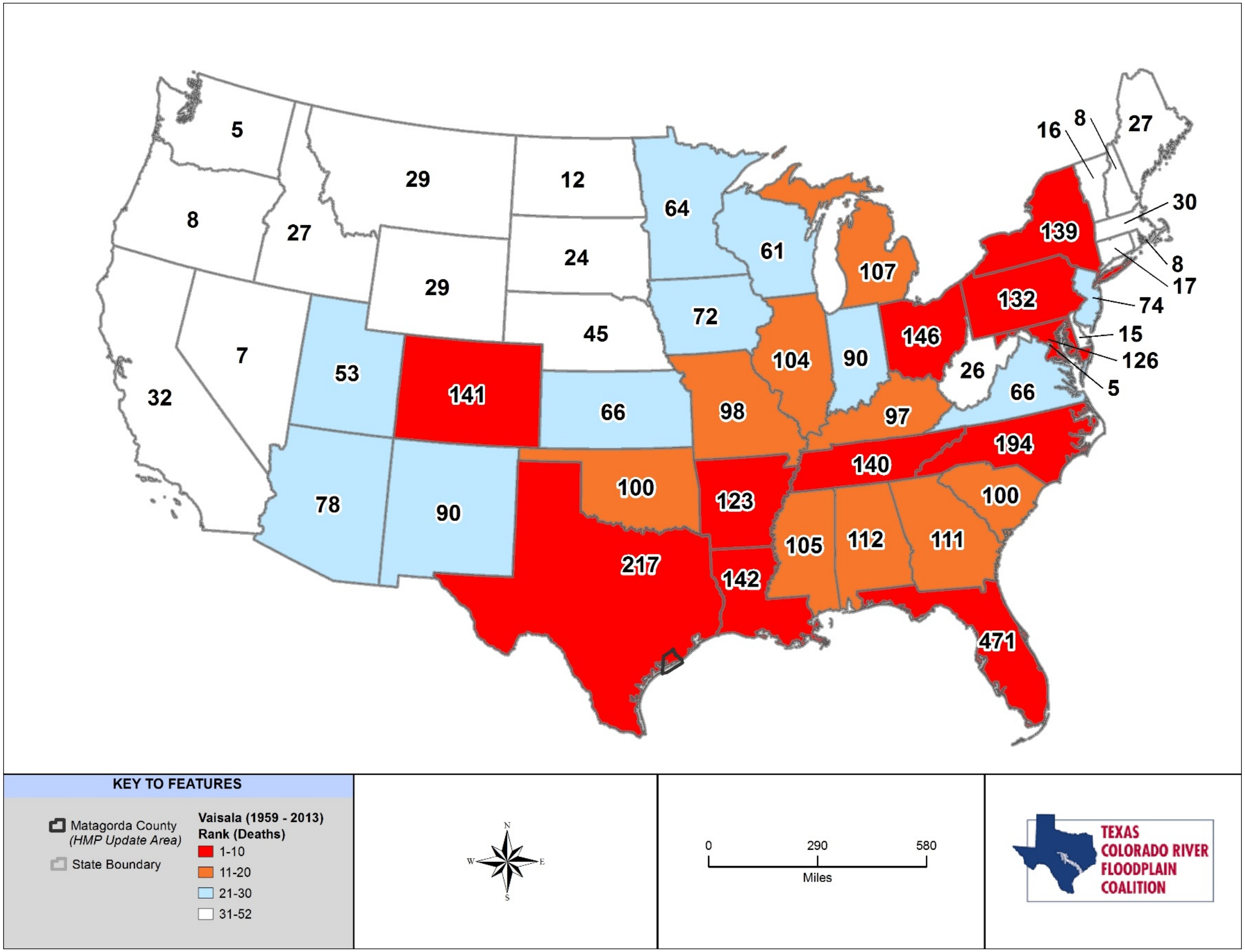


Figure 14-8. Lightning Fatalities in the U.S. (1959-2013)

Hail

The National Climatic Data Center Storm Events Database lists 19 hail events in Matagorda County and participating communities between 1955 and 2014. These events are noted in Table 14-2. None of these events resulted in injuries or deaths. Events listed as Matagorda County, Countywide, County or Matagorda in Table 14-2 affected large portions of the HMP update area. Large systems may have effected additional jurisdictions. These are also included in Table 14-2. Specific events for the participating communities are described below.

Event Descriptions

City of Bay City – The City of Bay City had 11 significant events from 1960 to 2014. Three significant events are described below.

- On April 3, 1993, the Matagorda County Sheriff's Office reported 0.50- to 0.75-inch hail near Bay City and in Van Vleck.
- On April 4, 1995, Matagorda Sheriff’s Office reported one-inch hail north of Bay City along Highway 60.
- On April 8, 2002, Local Sheriff ‘s Office reported 3/4 inch hail on State Highway 60 North, to the north of Bay City.

City of Palacios – The City of Palacios had 1 significant event from 1960 to 2014. The significant event is described below.

- On November 23, 2004, local law enforcement reported 0.75-inch hail in the City of Palacios.

Matagorda County (Unincorporated Areas)- Matagorda County Unincorporated Areas had 25 significant events from 1960 to 2014. Three significant events are described below.

- On August 31, 199o, 1.75 inch hail was reported. No injuries or fatalities were reported.
- On January 14, 1991 a cluster of intense thunderstorms entered the western portion of Matagorda County near 1930 CST, moving to the northeast at 25 mph. At 1945 CST, spotters reported marble to golf ball size hail in a severe thunderstorm in the City of Matagorda. At 1995 CST, a second severe storm produced a tornado at Bay City. The tornadic winds blew two cars into a ditch on the Can Vleck Road, but caused no injuries.
- On April 3, 1993 the Matagorda County Sheriff’s Office reported nickel-size hail just south of Farm to Market Road 521 near Collegeport.

TABLE 14-2.
HISTORIC HAIL EVENTS IN MATAGORDA COUNTY AND PARTICIPATING COMMUNITIES (1950-2014)

Location	Date	Hail Size	Estimated Damage Cost		Injuries	Deaths
			Property	Crops		
MATAGORDA CO.	04/26/1973	2	$0	$0	0	0
MATAGORDA CO.	02/17/1978	1.75	$0	$0	0	0
MATAGORDA CO.	05/14/1981	1	$0	$0	0	0
MATAGORDA CO.	03/23/1982	1	$0	$0	0	0
MATAGORDA CO.	08/31/1990	1.75	$0	$0	0	0

TABLE 14-2.
HISTORIC HAIL EVENTS IN MATAGORDA COUNTY AND PARTICIPATING COMMUNITIES (1950-2014)

Location	Date	Hail Size	Estimated Damage Cost		Injuries	Deaths
			Property	Crops		
MATAGORDA CO.	01/14/1991	1.75	$0	$0	0	0
Bay City	04/04/1995	1	$1,000	$0	0	0
WADSWORTH	02/16/1998	1	$5,000	$0	0	0
BAY CITY	02/27/1999	1	$10,000	$0	0	0
BAY CITY	02/27/1999	1	$10,000	$0	0	0
SARGENT	12/20/1999	1	$25,000	$0	0	0
MIDFIELD	03/13/2003	1.75	$7,000	$0	0	0
BLESSING	03/13/2003	1.75	$5,000	$0	0	0
MARKHAM	01/21/2006	1.75	$5,000	$0	0	0
BAY CITY	05/14/2006	1	$12,000	$0	0	0
BAY CITY	05/14/2006	1.75	$20,000	$0	0	0
BLESSING	05/26/2011	1.75	$1,500	$0	0	0
ASHBY	06/06/2011	1	$0	$0	0	0
BAY CITY	04/04/2012	1	$1,000	$0	0	0

NM Not measured

Source: http://www.ncdc.noaa.gov

Table may list more events than are shown on related figures since some recorded events do not include specific geographic (GIS- enabled data) coordinates for precise graphical representation.

Winds

High winds occur year round in Matagorda County and participating communities. In the spring and summer, which are generally warm and humid in Texas, high winds often accompany severe thunderstorms. The varying topography in the area has the potential for continuous and sudden high wind gusts. The Northern Winds are a fairly common wintertime phenomena in Southern Texas. These winds develop in well-defined areas and can be quite strong with resulting drastic drop in air temperatures. Atmospheric conditions are expected to continue unchanged with windstorms remaining a perennial occurrence. Winds of 0 to near 200 mph are possible in the planning area.

Although these high winds may not be life-threatening, they can disrupt daily activities, cause damage to building and structures, and increase the potential damage of other hazards. Wind resource information is shown in Figure 14-9 as a proxy for typical wind speeds. Wind resource information is estimated by the National Renewable Energy Laboratory (NREL) to identify areas that are suitable for wind energy applications. The wind resource is expressed in terms of wind power classes, ranging from Class 1 (lowest) to Class 7 (highest). Each class represents a range of mean wind power density or approximate mean wind speed at specified heights above the ground (in this case, 50 meters above the ground surface). Table 14-3 identifies the mean wind power density and speed associated with each classification. Figure 14-9 shows the wind power class potential density for Matagorda County and participating communities classified as "Marginal." Significant wind events for Matagorda County and participating communities are highlighted below. They are also listed in Table 14-4. None of these events resulted in injuries or deaths.

Event Descriptions

City of Bay City – The City of Bay City had 16 significant events from 1960 to 2014. Three significant events are described below.

- On April 21, 2006, trees were down due to high winds between Ashwood and Pledger which damaged an automotive windshield.
- On May 1, 2004, 50 knot wind gust downed some tree branches.
- On May 10, 2013, severe thunderstorm winds downed two trees along CR 142 to the south of Van Vleck.

City of Palacios – The City of Palacios had 17 significant events from 1960 to 2014. Three significant events are described below.

- On April 20, 1977, thunderstorm winds were reported at over 78 mph. No injuries, fatalities, or damages were reported.
- On January 19, 1991, Thunderstorm winds were reported in the City at over 71 mph. No injuries, fatalities, or damages were reported.
- On May 26, 2011, thunderstorm winds were reported by local law enforcement at 55 mph. $4,000 in damages were reported.

Matagorda County- Matagorda County Unincorporated Areas had 66 significant events from 1960 to 2014. Three significant events are described below.

- On July 7, 2005, a couple of vehicle awnings were blown down in Matagorda County.
- On July 23, 2014, a severe thunderstorm downed two trees along CR 142 to the south of Van Vleck.
- On April 29, 2013, thunderstorm winds downed trees and damaged a number of roofs on Chinquapin Road.

TABLE 14-3.
WIND POWER CLASS AND SPEED

Rank	Wind Power Class	Wind Power Density at 50 meters (W/m^2)	Wind Speed at 50 meters (mph)
Poor	1	0-200	0-12.5
Marginal	2	200-300	12.5-14.3
Fair	3	300-400	14.3-15.7
Good	4	400-500	15.7-16.8
Excellent	5	500-600	16.8-17.9
Outstanding	6	600-800	17.9-19.7
Superb	7	800-2000	19.7-26.6

Source: National Renewable Energy Laboratory Wind Energy Resource Atlas of the United States
mph Miles per hour
W/m^2 Watts per square meter

Historical severe weather data from the National Climatic Data Center Storm Events Database lists thunderstorm wind events in Matagorda County and participating communities between 1955 and

December 2014, as shown in Table 14-4. This table was supplemented with local knowledge and news articles of events effecting the participating communities.

The National Climatic Data Center database as well as locally available datasets lists no dust devil or dust storm events for the participating communities. There were several documented tornadoes in Matagorda County and participating communities in the 1950 to 2014 time period. These tornadoes are discussed in Chapter 15. Events listed as Matagorda County, Countywide, County or Matagorda in Table 14-4 affected large portions of the HMP update area. Large systems may have effected additional jurisdictions.

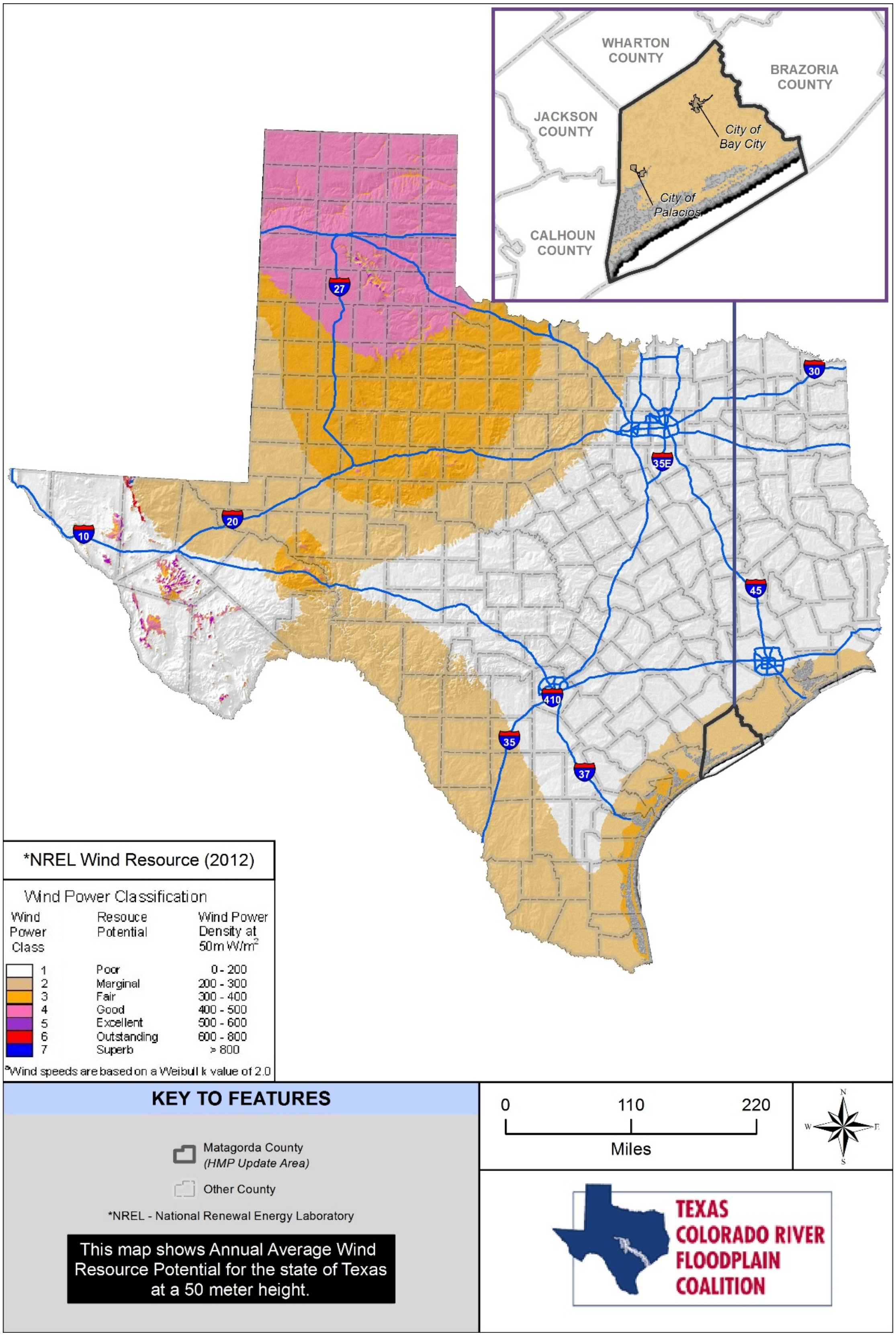


Figure 14-9. Texas Wind Power

**TABLE 14-4.
HISTORIC WIND-RELATED EVENTS IN MATAGORDA COUNTY AND PARTICIPATING COMMUNITIES (1950-2014)**

Location	Date	Peak Wind Speed (knots)	Estimated Damage Cost		Injuries	Deaths
			Property	Crops		
Matagorda County	10/15/1957	67	$0	$0	0	0
Matagorda County	05/29/1962	55	$0	$0	0	0
Matagorda County	04/30/1963	50	$0	$0	0	0
Matagorda County	06/24/1963	52	$0	$0	0	0
Matagorda County	06/05/1965	50	$0	$0	0	0
Matagorda County	02/14/1969	87	$0	$0	0	0
Matagorda County	04/26/1973	55	$0	$0	0	0
Matagorda County	05/30/1975	55	$0	$0	0	0
Matagorda County	04/16/1977	60	$0	$0	0	0
Matagorda County	04/20/1977	68	$0	$0	0	0
Matagorda County	05/30/1979	52	$0	$0	0	0
Matagorda County	05/16/1980	50	$0	$0	0	0
Matagorda County	05/18/1980	55	$0	$0	0	0
Matagorda County	05/18/1980	62	$0	$0	0	0
Matagorda County	05/17/1986	50	$0	$0	0	0
Matagorda County	05/17/1986	61	$0	$0	0	0
Matagorda County	11/16/1987	95	$0	$0	0	1
Matagorda County	03/29/1990	50	$0	$0	0	0
Matagorda County	10/17/1990	52	$0	$0	0	0
Matagorda County	01/14/1991	62	$0	$0	0	0
Matagorda County	04/05/1991	50	$0	$0	0	0
Matagorda County	04/05/1991	52	$0	$0	0	0
Matagorda County	04/05/1991	52	$0	$0	0	0
Matagorda County	05/31/1994	80	$0	$0	0	0
Matagorda County	04/04/1995	65	$1,000	$0	0	0
Matagorda County	04/04/1995	70	$2,000	$0	0	0
Palacios	09/21/1996	50	$0	$0	0	0
Palacios	12/23/2002	52	$150,000	$0	1	0
Matagorda (Zone)	07/14/2003	NM	$716,300	$0	0	0
Bay City	05/01/2004	50	$3,000	$0	0	0
Bay City	05/29/2005	59	$5,000	$0	0	0

**TABLE 14-4.
HISTORIC WIND-RELATED EVENTS IN MATAGORDA COUNTY AND PARTICIPATING COMMUNITIES (1950-2014)**

Location	Date	Peak Wind Speed (knots)	Estimated Damage Cost		Injuries	Deaths
			Property	Crops		
Bay City	07/07/2005	52	$0	$0	0	0
Markham	07/07/2005	53	$8,000	$0	0	0
Bay City	04/21/2006	60	$15,000	$0	0	0
Matagorda (Zone)	09/12/2008	NM	$6,000,000	$0	0	0
Palacios Municipal Airport	05/26/2011	55	$4,000	$0	0	0
Matagorda	05/10/2012	56	$5,000	$5,000	0	0
Lake Austin	04/29/2013	65	$200,000	$0	0	0
Bay City	05/10/2013	52	$0	$0	0	0
Bay City Municipal Airport	07/23/2014	51	$0	$0	0	0

NM Not measured

Source: http://www.ncdc.noaa.gov

Table may list more events than are shown on related figures since some recorded events do not include specific geographic (GIS- enabled data) coordinates for precise graphical representation.

14.2.2 Location

Severe weather events have the potential to happen anywhere in the planning area. Figure 6-6 shows the distribution of average precipitation over the planning area.

Thunderstorms and Lightning

The entire extent of Matagorda County and participating communities are exposed to some degree of lightning hazard, though exposed points of high elevation have significantly higher frequency of occurrence. Since lightning can occur at any location, all of the communities could experience lightning events throughout their respective jurisdictions. There was only 1 recorded lightning damage event recorded by the NOAA National Climatic Data Center from 1993 to 2014 in the HMP update area. This event was located near the City of Matagorda (Figure 14-10). The City of Bay City, the City of Palacios did not have any lightning events recorded by the NOAA National Climatic Data Center during this period. There were no new lightning-related data from local sources for the 1993 to 2014 time period.

Hail

The entire extent of Matagorda County and participating communities are exposed to the hailstorm hazard. Previous instances of hail events in the county are shown in Figure 14-11. Figure 14-11 does not show all hail events shown on Table 14-2 because not all tabular data had geographic locations. Only events listed with GIS data were mapped. Non-GIS supported events were included in the table to provide more data for participating communities.

Winds

The entire extent of Matagorda County and participating communities are exposed to high winds. They have the ability to cause damage over 100 miles from the center of storm activity. Wind events are most damaging to areas that are heavily wooded. Winds impacting walls, doors, windows, and roofs, may cause structural components to fail. Previous occurrences of damaging high winds and their respective locations are shown in Figure 14-12. Figure 14-12 does not show all wind events on Table 14-4 because not all tabular data had geographic coordinates. Only events listed with GIS data were mapped. Non-GIS supported events were included in the table to provide more data for participating communities.

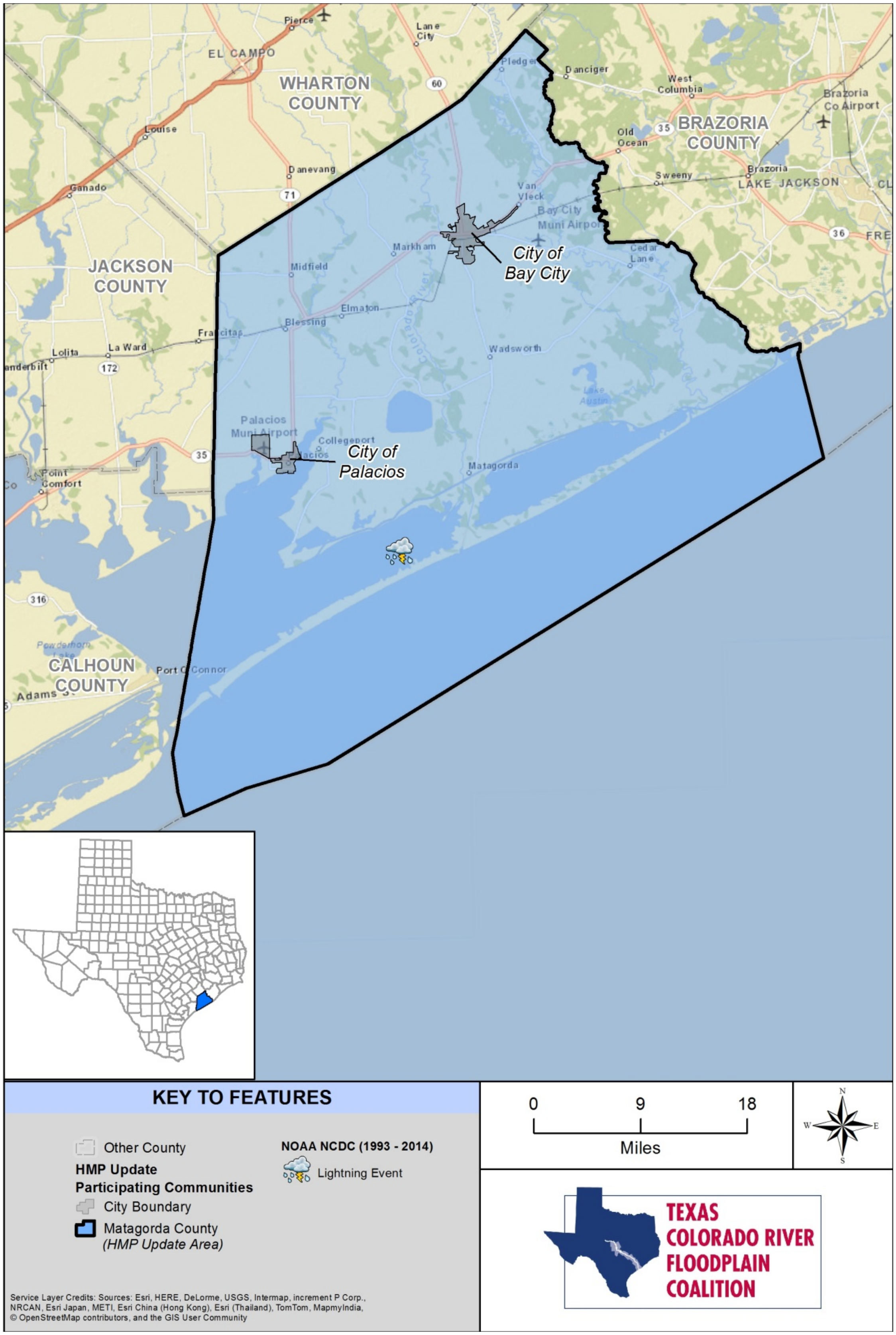


Figure 14-10. Lightning Events in Matagorda County (1993-2014)

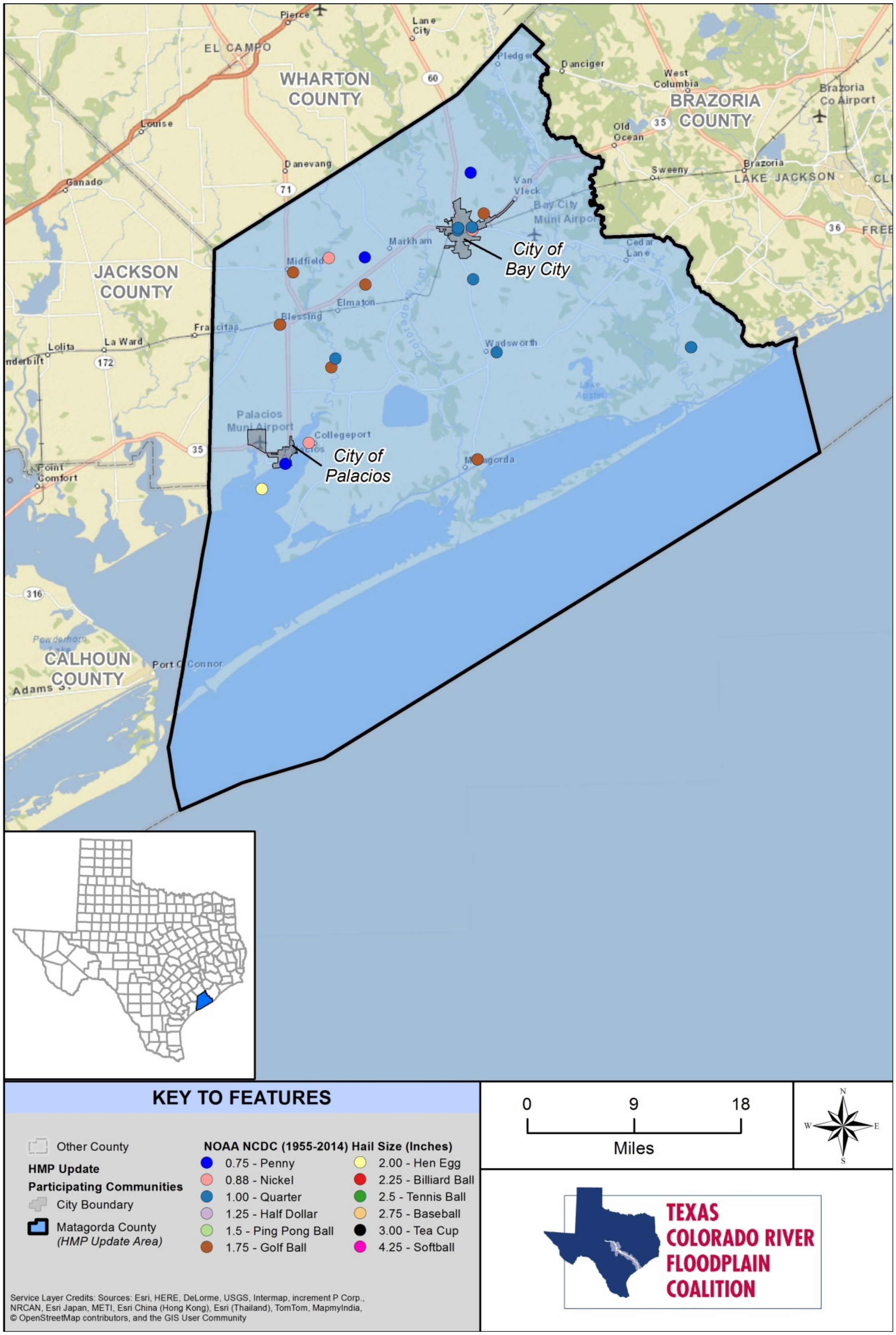


Figure 14-11. Hail Events in Matagorda County (1955-2014)

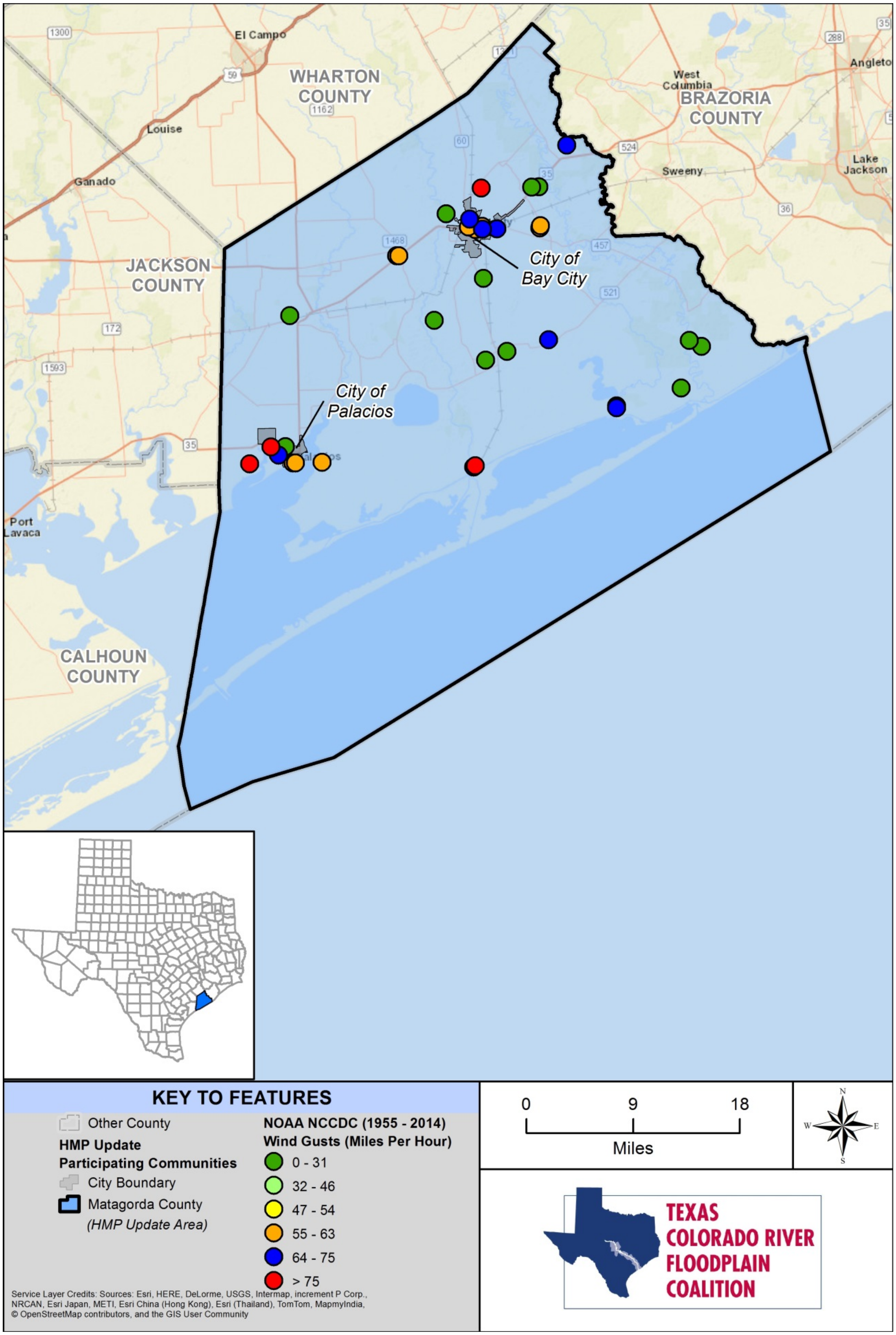


Figure 14-12. Damaging Wind Events in Matagorda County (1955-2014)

14.2.3 Frequency

Lightning

To date, there has been only one reported lightning strike resulting in injury in Matagorda County and all participating communities. However, Texas ranks as one of the highest in lightning fatalities in the nation. Matagorda County has approximately 9 to 15 lightning flashes per square mile per year and a thunderstorm lightning event is considered likely, with a recurrence interval of 10 years or more. This frequency statistics applies to all Matagorda County and participating communities.

Hail

Based on a record of 19 hailstorm events over a 64-year period, significant hail occurs approximately once every three years. Since hail events can happen anywhere throughout the HMP update area, each participating community has the same frequency and probability for future events (once every three years on average). Based on previous events, the City of Bay City can expect hail up to 1.75" in diameter for future events. The City of Palacios can expect hail up to 2.00" in diameter for future events. Matagorda County Unincorporated Area can expect hail up to 17.5" in diameter for future events (see Table 14-2 and Figure 14-11). Future events for all participating communities can be expected once every three years.

Winds

Based on 40 events in 59 years, a damaging high-wind event occurs approximately once every one to two years on average in Matagorda County and is considered likely. Since wind events can happen anywhere throughout the HMP update area, each participating community has the same frequency and probability for future events (approximately once every one to two years).

14.2.4 Severity

Lightning

Based on the information in this hazard profile, the magnitude/severity of lightning is limited and the risk of a damaging lightning event in Matagorda County and participating communities are low. The number of reported injuries from lightning is likely to be low and county infrastructure losses are expected to be limited each year.

Hail

Severe hailstorms can be quite destructive. In recent years within the United States, hail causes more than $1.3 billion in damage to property and crops each year representing between 1 and 2% of the annual crop value.

Insurance claims resulting from hailstorm damage increased 84% nationwide in 2012 from their 2010 level according to the National Insurance Crime Bureau. In 2010, there were 467,602 hail damage claims filed in the U.S. That number increased to 689,267 in 2011 and 861,597 in 2012. The property damage can be as minimal as a few broken shingles to the total destruction of buildings.

Over 2 million hail damage claims were processed from January 1, 2010, to December 31, 2012, with Texas ranking first in overall claims. The top five states generating hail damage claims were Texas (320,823 claims); Missouri (138,857 claims); Kansas (126,490 claims); Colorado (118,118 claims) and Oklahoma (114,168 claims). Much of the damage inflicted by hail is to crops. Even relatively small hail can shred plants to ribbons in a matter of minutes. Vehicles, roofs of buildings and homes, and landscaping are the other things most commonly damaged by hail. Hail has been known to cause injury to humans and occasionally has been fatal.

Based on the information in this hazard profile, the severity of hail storms is limited and the overall significance is low. The economy of Matagorda County and participating communities will be affected usually by less than a day to not more than 1 week. Additionally, up to 25% of people and property can be affected.

High Winds

High winds, often accompanying severe thunderstorms, can cause significant property and crop damage, threaten public safety, and have adverse economic impacts from business closures and power loss. Wind storms in Matagorda County and participating communities are rarely life threatening, but do disrupt daily activities, cause damage to buildings, and structures, and increase the potential for other hazards, such as wildfires. Winter winds can result in damage and close highways due to ice and blowing snow. Winds can also cause trees to fall, particularly those killed by insects or wildfire, creating a hazard to property or those outdoors.

Based on the information in this hazard profile, the magnitude/severity of high winds is considered limited. The overall significance of the hazard is considered low, with minimal potential impact. The economy of Matagorda County and participating communities will be affected usually by less than a day to not more than 1 week. Additionally, up to 25% of people and property can be affected.

14.2.5 Warning Time

Meteorologists can often predict the likelihood of a severe storm. This can give several days of warning time. However, meteorologists cannot predict the exact time of onset or severity of the storm. Some storms may come on more quickly and have only a few hours of warning time. Weather forecasts for the planning area are reliable. However, at times, the warning for the onset of severe weather may be limited.

14.3 SECONDARY HAZARDS

The most significant secondary hazards associated with severe local storms are floods, falling and downed trees, landslides, and downed power lines. Rapidly melting snow combined with heavy rain can overwhelm both natural and man-made drainage systems, causing overflow and property destruction. Erosion can occur when the soil on slopes becomes oversaturated and fails. Fires can occur as a result of lightning strikes. Many locations in the region have minimal vegetative ground cover and the high winds can create a large dust storm, which becomes a hazard for travelers and a disruption for local services. High winds in the winter can turn small amount of snow into a complete whiteout and create drifts in roadways. Debris carried by high winds can also result in injury or damage to property. A wildland fire can be accelerated and rendered unpredictable by high winds, which creates a dangerous environment for firefighters.

14.4 CLIMATE CHANGE IMPACTS

Climate change presents a significant challenge for risk management associated with severe weather. The frequency of severe weather events has increased steadily over the last century. The number of weather-related disasters during the 1990s was four times that of the 1950s, and cost 14 times as much in economic losses. Historical data shows that the probability for severe weather events increases in a warmer climate (see Figure 14-13). The changing hydrograph caused by climate change could have a significant impact on the intensity, duration, and frequency of storm events. All of these impacts could have significant economic consequences.

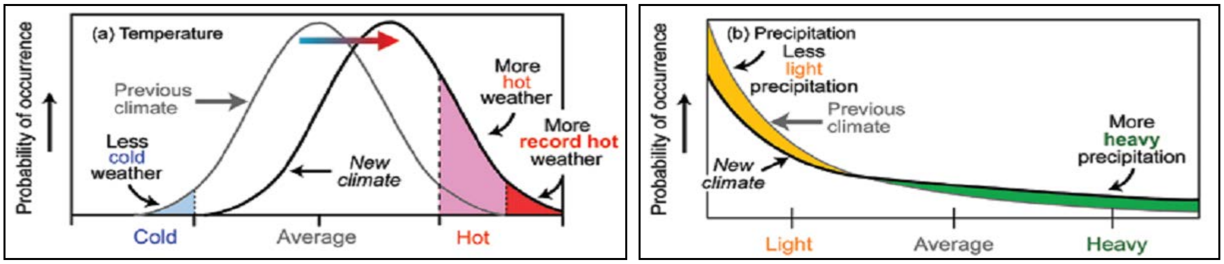


Figure 14-13. Severe Weather Probabilities in Warmer Climates

14.5 EXPOSURE

The primary data source was the HAZUS 2.2 inventory data (updated with 2010 Census Data and 2014 RS Means Square Foot Costs), augmented with state and federal data sets, NOAA National Climatic Data Center Storm Event Database, as well as data from local sources.

14.5.1 Population

It can be assumed that the entire planning area is exposed to some extent to thunderstorm, lightning, high wind, and hail events. Certain areas are more exposed due to geographic location and local weather patterns. Populations with large stands of trees or overhead power lines may be more susceptible to wind damage and black out, while populations in low-lying areas are at risk for possible flooding. It is not uncommon for residents living in more remote areas of the county to be isolated after such events. Table 14-6 lists the vulnerable population for the participating communities.

14.5.2 Property

According to the Matagorda County HAZUS 2.2 inventory data (updated with 2010 U.S. Census Data and 2014 RS Means Square Foot Costs), there are 16,635 buildings within the census blocks that define the planning area with an asset replaceable value of over $4 million (excluding contents). About 98.5% of these buildings (and 83.4% of the building value) are associated with residential housing. Within the participating communities in the HMP update area, there are an estimated 14,544 buildings (residential, commercial, and other) with a total asset inventory (excluding contents) value of over $3.6 million. Other types of buildings in this report include agricultural, education, religious, and governmental structures. See Table 14-5 below for specific participating community exposure values.

It is estimated that most of the residential structures were built without the influence of a structure building code with provisions for wind loads. Wind pressure can create a direct and frontal assault on a structure, pushing walls, doors, and windows inward. Conversely, passing currents can create lift and suction forces that act to pull building components and surfaces outward. The effects of winds are magnified in the upper levels of multi-story structures. As positive and negative forces impact the building’s protective envelope (doors, windows, and walls), the result can be roof or building component failures and considerable structural damage.

All of these buildings are considered to be exposed to the lightning, wind, and hail hazards, but structures in poor condition or in particularly vulnerable locations (located on hilltops or exposed open areas) may risk the most damage. The frequency and degree of damage will depend on specific locations.

TABLE 14-5
EXPOSED STRUCTURES AND POPULATION

Jurisdiction	Residential	Commercial	Other *	**Total Structures**	**Total Population**
Unincorporated Area	5,744	121	35	5,900	17,631
City of Bay City	1,785	17	10	1,812	4,718
City of Palacios	6,787	29	16	6,832	10,028
Matagorda County Total	14,316	167	61	14,544	32,377

*Other includes industrial, agricultural, religious, governmental, and educational classifications.

14.5.3 Critical Facilities and Infrastructure

All critical facilities within the planning area are exposed to lightning, high winds, and hail.. Those facilities within the floodplain (Chapter 12) are exposed to flooding associated with thunderstorms. Additional facilities on higher ground may be particularly exposed to wind damage, lightning, or damage from falling trees. The most common problems associated with these weather events are loss of utilities. Downed power lines can cause blackouts, leaving large areas isolated. Phone, water, and sewer systems may not function. Roads may become impassable due to secondary hazards such as flooding.

14.5.4 Environment

The environment is highly exposed to lightning, high winds, and hail. Natural habitats such as streams and trees risk major damage and destruction. Prolonged rains can saturate soils and lead to slope failure. Flooding events can produce river channel migration or damage riparian habitat. Lightning can start wildfires, particularly during a drought.

14.6 VULNERABILITY

Because lightning, hail, and wind cannot be directly modeled in HAZUS, annualized losses were estimated using GIS-based analysis, historical data analysis, and statistical risk assessment methodology. Event frequency, severity indicators, expert opinions, and historical local knowledge of the region were used for this assessment.

14.6.1 Population

Vulnerable populations are the elderly, low income or linguistically isolated populations, people with life-threatening illnesses, and residents living in areas that are isolated from major roads. Power outages can be life threatening to those dependent on electricity for life support. Isolation of these populations is a significant concern. These populations face isolation and exposure during thunderstorm, wind, and hail events and could suffer more secondary effects of the hazard. Outdoor recreational users in the area may also be more vulnerable to severe weather events. Table 14-6 shows vulnerable populations per participating jurisdiction.

TABLE 14-6
MOST VULNERABLE POPULATION

Jurisdiction	Youth Population (< 16)	% of Total Population	Elderly Population (> 65)	% of Total Population	Economically Disadvantage (Income < $20,000)	% of Total Population
Unincorporated Area	4,912	27.86	2,146	12.17	1,749	9.92
City of Bay City	1,441	30.54	623	13.20	549	11.64
City of Palacios	2,192	21.86	1,829	18.24	527	5.26
Matagorda County Total	8,545	26.39	4,598	14.20	2,825	8.73

14.6.2 Property

All property is vulnerable during thunderstorm, lightning, wind, and hail events, but properties in poor condition or in particularly vulnerable locations may risk the most damage. Generally, damage is minimal and goes unreported. Those on hillsides and ridges may be more prone to wind damage. Those that are located under or near overhead lines or near large trees may be damaged in the event of a collapse.

Loss estimations for the lightning, wind, and hail hazards are not based on damage functions, because no such damage functions have been generated. Instead, loss estimates were developed representing projected damages (annualized loss) on reported damages and exposed values. Historical events, statistical analysis and probability factors were applied to the county's and communities' reported damages and exposed values to create an annualized loss. Table 14-7 through Table 14-9 lists the property loss estimates for lightning, hail, and wind events. Annualized losses of 'negligible' are less than $50 annually. Negligible loss hazards are still included despite minimal annualized losses because of the potential for a high value damaging event.

TABLE 14-7.
LOSS ESTIMATES FOR HAIL EVENTS

Jurisdiction	Exposed Value	Annualized Loss	Annualized Loss Percentage
Unincorporated Area	$2,558,729,176	16,471	<0.01
City of Bay City	$2,649,736,203	135	<0.01
City of Palacios	$669,865,421	Negligible	<0.01
Matagorda County Total	**$5,878,330,801**	**$16,625**	**<0.01**

TABLE 14-8.
LOSS ESTIMATES FOR LIGHTNING EVENTS

Jurisdiction	Exposed Value	Annualized Loss	Annualized Loss Percentage
Unincorporated Area	$2,558,729,176	Negligible	<0.01
City of Bay City	$2,649,736,203	Negligible	<0.01
City of Palacios	$669,865,421	Negligible	<0.01
Matagorda County Total	**$5,878,330,801**	**Negligible**	**<0.01**

TABLE 14-9.
LOSS ESTIMATES FOR WIND EVENTS

Jurisdiction	Exposed Value	Annualized Loss	Annualized Loss Percentage
Unincorporated Area	$2,558,729,176	$1,142,415	0.04
City of Bay City	$2,649,736,203	$9,347	<0.01
City of Palacios	$669,865,421	$1,336	<0.01
Matagorda County Total	**$5,878,330,801**	**$1,153,098**	**<0.01**

Vulnerability Narrative

All participating communities are equally at risk to either lightning, hail, or wind. Table 14-6 lists the vulnerable population per community. Table 14-7 to Table 14-9 lists the estimated annualized losses in dollars for each participating community. All participating communities are vulnerable to communication problems. This applies to both residents of the communities, such as Early Warning Systems, and between emergency personal. Resources such as the implementation of Emergency Notification Systems and NOAA "All Hazard" Radios would decrease the vulnerability of each jurisdiction.

City of Bay City-

- *Lightning* – Properties with thick vegetation and large trees or those built under no or insufficient building codes are more susceptible to the negative impacts of a lightning event. Structures without alternative sources of power supply, such as generators, increase these risks.
- *Hail* – The maximum hail size recorded for the City was 1.75 inches (golf ball size hail). This hail size can cause damage to windows and glass roofs as well as the body work of vehicles and aircrafts. Mobile homes and older residential areas are more prone to damages from an event.

These buildings are not built to as stringent building codes and are more susceptible to hail damage.

- *Wind* – Based on historical events, significant wind events have been recorded within the City of Bay City at between 64-75 mph. Approximately 13**%** of the City's housing is manufactured homes. Older residential areas as well as manufactured home subdivisions, houses, and structures not securely anchored to foundations are most vulnerable to wind damages. Furthermore, areas with dead trees and vegetation that are not regularly cleared are more prone to wind damages. Both of these (loose structures and dead vegetation) can become flying/falling hazards in a wind event. Furthermore, areas with dead trees and vegetation that are not regularly cleared are more prone to wind damages. Both of these (Loose structures and dead vegetation) can become flying/falling hazards in a wind event.

Community Perception of Vulnerability in the City of Bay City

See front page of current chapter for a summary of hazard rankings for the City of Bay City. Chapter 19 gives a detailed description of this rankings and Chapter 20 addresses mitigations actions for this hazard vulnerability.

City of Palacios -

- *Lightning* – Properties built without sufficient building codes or with large trees or thick brush are more vulnerable to a damaging lightning event. Facilities without alternative sources for power supply, such as a generator, are more vulnerable in the event of an outage.
- *Hail* – Hen egg size hail (2 in) was recorded just southeast of the City of Palacios. This hail size can cause damage to windows and glass roofs as well as the body work of vehicles. Older homes may experience more damages as they have been exposed to the elements longer and may not have been built with as stringent building codes. Manufactured homes are less resilient to natural disasters, such as hail, and are more vulnerable to feeling the effects of a damaging hail event. Cars left in the open are subject to damages from hail events as well.
- *Wind* – Based on historical events, the most significant wind events recorded for the City of Palacios was over 75 mph. Approximately 17 **%** of the City's housing is manufactured homes. Older residential areas as well as manufactured home subdivisions, houses, and structures not securely anchored to foundations are most vulnerable to wind damages. Furthermore, areas with dead trees and vegetation that are not regularly cleared are more prone to wind damages. Both of these (loose structures and dead vegetation) can become flying/falling hazards in a wind event. Residents unaware the meaning of severe weather alerts or how to properly prepare their homes and property against structural damage from wind increase their vulnerability.

Community Perception of Vulnerability in the City of Palacios

See front page of current chapter for a summary of hazard rankings for the City of Palacios. Chapter 19 gives a detailed description of this rankings and Chapter 20 addresses mitigations actions for this hazard vulnerability.

Matagorda County (Unincorporated Area) -

- *Lightning* – Emergency service facilities and infrastructure such as area schools, wastewater treatment plants, police and fire departments and government buildings are vulnerable to lightning strikes. A power outage at one of these facilities could negatively impact residents and increase and complicate emergency response efforts. Rural areas are at a greater risk of this as they are a greater distance from emergency responders and face longer response times. Properties with large trees and underbrush are also more vulnerable to lightning strikes and fires.

- *Hail* – The maximum hail size recorded for the Unincorporated Areas of Matagorda County was 1.75 inches (golf ball size hail). This hail size can cause damage to windows and glass roofs as well as the body work of vehicles. Older homes may experience more damages as they have been exposed to the elements longer.
- *Wind* – Based on historical events, the most significant wind events recorded for the Unincorporated Areas of Matagorda County were over 75 mph. Approximately 20**%** of the HMP update area's housing is manufactured homes. Matagorda rural areas may experience longer emergency response times if an event were to occur due to their distance from services. Older residential areas as well as manufactured home subdivisions, houses, and structures not securely anchored to foundations are most vulnerable to wind damages. Furthermore, areas with dead trees and vegetation that are not regularly cleared are more prone to wind damages. Both of these (loose structures and dead vegetation) can become flying/falling hazards in a wind event.

Community Perception of Vulnerability in the Unincorporated Areas of Matagorda County

See front page of current chapter for a summary of hazard rankings for the Unincorporated Areas of Matagorda County. Chapter 19 gives a detailed description of these rankings and Chapter 20 addresses mitigations actions for this hazard vulnerability.

14.6.3 Critical Facilities and Infrastructure

Incapacity and loss of roads are the primary transportation failures resulting from lightning, wind, and hail and are mostly associated with secondary hazards. Erosion caused by heavy prolonged rains can block roads. High winds can cause significant damage to trees and power lines, blocking roads with debris, incapacitating transportation, isolating population, and disrupting ingress and egress. Of particular concern are roads providing access to isolated areas and to the elderly. Prolonged obstruction of major routes due to debris or floodwaters can disrupt the shipment of goods and other commerce. Large, prolonged storms can have negative economic impacts for an entire region. Severe windstorms and downed trees can create serious impacts on power and above-ground communication lines. Loss of electricity and phone connection would leave certain populations isolated because residents would be unable to call for assistance. Lightning events in the participating communities can have destructive effects on power and information systems. Failure of these systems would have cascading effects throughout the county and could possible disrupt critical facility functions.

14.6.4 Environment

The vulnerability of the environment to severe weather is the same as the exposure, discussed in Section 14.5.4

14.7 FUTURE TRENDS IN DEVELOPMENT

All future development will be affected by severe storms. The ability to withstand impacts lies in sound land use practices and consistent enforcement of codes and regulations for new construction. The planning partners have already adopted the International Building Code for construction within this region. This code is equipped to deal with the impacts of severe weather events. Land use policies identified in master plans and enforced through zoning code and the permitting process also address many of the secondary impacts of the severe weather hazard. With these tools, the planning partnership is well equipped to deal with future growth and the associated impacts of severe weather.

14.8 SCENARIO

Although severe local storms are infrequent, impacts can be significant, particularly when secondary hazards of flood and erosion occur. A worst-case event would involve prolonged high winds, an intense hail event, and a lightning strike at a critical facility (such as an emergency service station) during a thunderstorm. Such an event would have both short-term and longer-term effects. Initially, schools and roads would be closed due to power outages caused by high winds and downed tree obstructions. In more rural areas, some subdivisions could experience limited ingress and egress. Prolonged rain could produce flooding, overtopped culverts with ponded water on roads and landslides on steep slopes. Flooding could further obstruct roads and bridges, further isolating residents.

14.9 ISSUES

Important issues associated with a severe weather in the planning area include the following:

- Older building stock in the planning area is built to low code standards or none at all. These structures could be highly vulnerable to severe weather events such as windstorms.
- Redundancy of power supply must be evaluated.
- The capacity for backup power generation is limited.
- The potential for isolation after a severe storm event is high.
- There is limited information available for local weather forecasts.
- The lack of proper management of trees may exacerbate damage from high winds.

CHAPTER 15.
TORNADO

TORNADO RANKING	
Matagorda County	Medium
City of Bay City	Low
City of Palacios	Low

DEFINITIONS

Tornado — Funnel clouds that generate winds up to 500 mph. They can affect an area up to three-quarters of a mile wide, with a path of varying length. Tornadoes can come from lines of cumulonimbus clouds or from a single storm cloud. They are measured using the Fujita Scale (ranging from F0 to F5), or the Enhanced Fujita Scale.

15.1 GENERAL BACKGROUND

A tornado is a narrow, violently rotating column of air that extends from the base of a cumulonimbus cloud to the ground. The visible sign of a tornado is the dust and debris that is caught in the rotating column made up of water droplets. Tornadoes are the most violent of all atmospheric storms. Tornadoes can be induced by hurricanes. The following are common ingredients for tornado formation:

- Very strong winds in the mid and upper levels of the atmosphere
- Clockwise turning of the wind with height (i.e., from southeast at the surface to west aloft)
- Increasing wind speed in the lowest 10,000 feet of the atmosphere (i.e., 20 mph at the surface and 50 mph at 7,000 feet)
- Very warm, moist air near the ground with unusually cooler air aloft
- A forcing mechanism such as a cold front or leftover weather boundary from previous shower or thunderstorm activity

Tornadoes can form from individual cells within severe thunderstorm squall lines. They also can form from an isolated super-cell thunderstorm. Weak tornadoes can sometimes occur from air that is converging and spinning upward, with little more than a rain shower occurring in the vicinity.

In 2007, NWS began rating tornadoes using the Enhanced Fujita Scale (EF-scale). The EF-scale is a set of wind estimates (not measurements) based on damage. It uses 3-second gusts estimated at the point of damage based on a judgment of 8 levels of damage to the 28 indicators listed in Table 15-1. These estimates vary with height and exposure. Standard measurements are taken by weather stations in openly exposed area. Table 15-2 describes the EF-scale ratings (NOAA 2007).

The U.S. experiences more tornadoes than any other country. In a typical year, approximately 1,000 tornadoes affect the U.S. The peak of the tornado season is April through June, with the highest concentration of tornadoes in the central U.S. Figure 15-1 shows the annual average number of tornadoes between 1991 and 2010. Texas experienced an average of 155 tornado events annually in that period. Texas ranks first among the 50 states in both the frequency of tornadoes and the number of lethal tornadoes. When these statistics are compared to other states by the frequency per 10,000 square miles, Texas ranks tenth in the U.S. “Tornado Alley” is a nickname given to an area in the southern plains of the central United States that consistently experiences a high frequency of tornadoes each year. Tornadoes in this region typically happen in late spring and occasionally the early fall. The Gulf Coast area has a separate tornado region nicknamed "Dixie Alley" with a relatively high frequency of tornadoes occurring in the late fall (October through December).

NOAA’s National Severe Storms Laboratory used historical data to estimate the daily probability of tornado occurrences across the U.S., regardless of tornado magnitude. Figure 15-2 shows the estimates. The density per 25 square miles in the map’s legend indicates the probable number of tornadoes for each 25 square mile cell within the contoured zone that can be expected over a similar period of record. This density number does NOT indicate the number of events that can be expected across the entire zone on the map.

TABLE 15-1.
ENHANCED FUJITA SCALE DAMAGE INDICATORS

No.	Damage Indicator	No.	Damage Indicator
1	Small barns, farm outbuildings	15	School – one-story elementary (interior or exterior halls)
2	One or two-family residences	16	School – junior or senior high school
3	Single-wide mobile home	17	Low-rise (1-4 story) building
4	Double-wide mobile home	18	Mid-rise (5-20) building
5	Apartment, condo, townhouse (3 stories or less)	19	High-rise (over 20 stories) building
6	Motel	20	Institutional building (hospital, government, or university)
7	Masonry apartment or motel	21	Metal building system
8	Small retail building (fast food)	22	Service station canopy
9	Small professional (doctor office, bank)	23	Warehouse (tilt-up walls or heavy timber)
10	Strip mall	24	Transmission line tower
11	Large shopping mall	25	Free-standing tower
12	Large, isolated (big box) retail building	26	Free standing pole (light, flag, luminary)
13	Automobile showroom	27	Tree – hardwood
14	Automobile service building	28	Tree – softwood

TABLE 15-2.
THE FUJITA SCALE AND ENHANCED FUJITA SCALE

Fujita (F) Scale			Derived		Operational Enhanced Fujita (EF) Scale	
F Number	Fastest ¼ mile (mph)	3-second gust (mph)	EF Number	3-second gust (mph)	EF Number	3-second gusts (mph)
0	40-72	45-78	0	65-85	0	65-85
1	73-112	79-117	1	86-109	1	86-110
2	113-157	118-161	2	110-137	2	111-135
3	158-207	162-209	3	138-167	3	136-165
4	208-260	210-261	4	168-199	4	166-200
5	261-318	262-317	5	200-234	5	Over 200

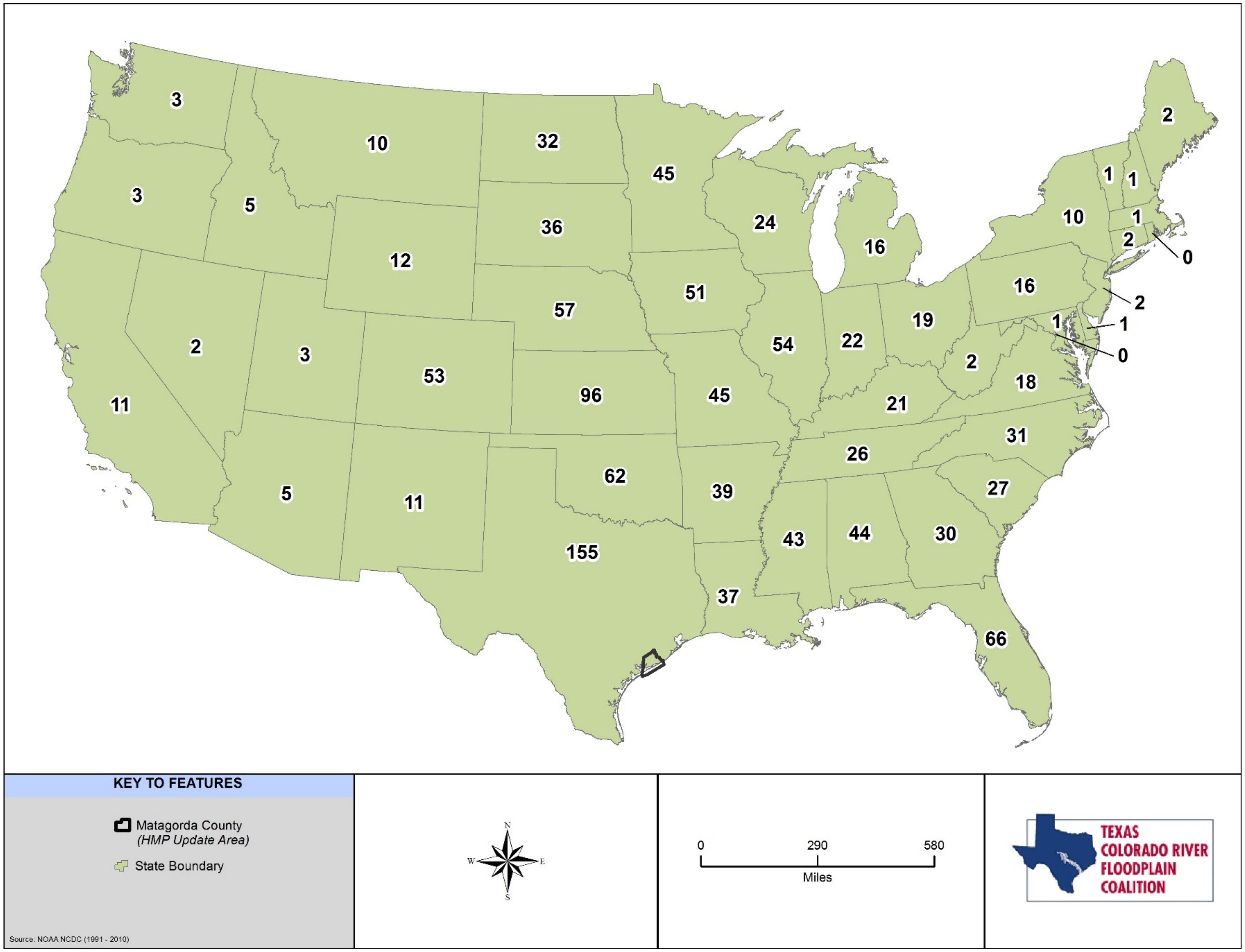


Figure 15-1. Annual Average Number of Tornadoes in the U.S. (1991-2010)

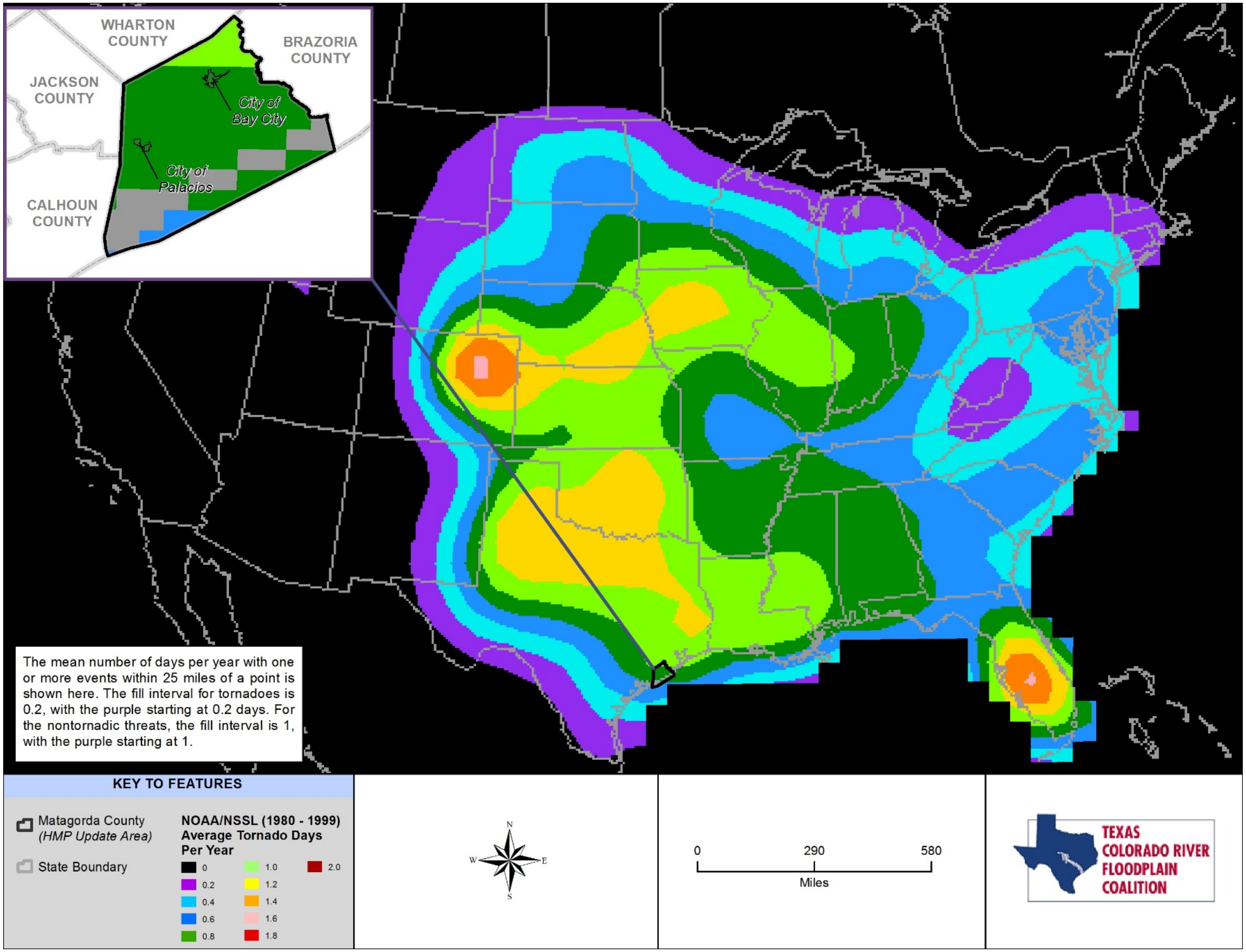


Figure 15-2. Total Annual Threat of Tornado Events in the U.S. (1980-1999)

15.2 HAZARD PROFILE

15.2.1 Past Events

Table 15-3 lists tornadoes in Matagorda County and the participating communities recorded by the NOAA Storm Events Center from 1950 to 2014. Most of the tornadoes caused property damages with a sizeable number rated as F1 tornadoes. Figure 15-4 shows the location of NOAA documented tornado paths between 1950 and 2014. As can be seen from the map, most of the tornadoes occur in the spring season, with a few in the fall.

TABLE 15-3.
HISTORIC TORNADO EVENTS IN MATAGORDA COUNTY AND PARTICIPATING COMMUNITIES (1950-2014)

			Estimated Damage Cost			
Location	**Date**	**Category**	**Property**	**Crops**	**Injuries**	**Deaths**
Matagorda County	4/15/1954	F1	$25,000	$0	0	0
Matagorda County	5/18/1955	F2	$25,000	$0	0	0
Matagorda County	11/1/1956	F0	$0	$0	0	0
Matagorda County	3/31/1957	F1	$2,500	$0	0	0
Matagorda County	9/29/1959	F0	$0	$0	0	0
Matagorda County	9/11/1961	F2	$0	$0	0	0
Matagorda County	9/17/1962	F1	$25,000	$0	0	0
Matagorda County	7/18/1964	F0	$250	$0	0	0
Matagorda County	9/20/1967	F0	$250	$0	0	0
Matagorda County	9/20/1967	F0	$0	$0	0	0
Matagorda County	9/20/1967	F1	$250	$0	0	0
Matagorda County	9/20/1967	F3	$25,000	$0	7	4
Matagorda County	4/11/1969	F0	$0	$0	0	0
Matagorda County	4/11/1969	F0	$0	$0	0	0
Matagorda County	4/11/1969	F3	$2,500,000	$0	13	0
Matagorda County	5/15/1969	F0	$0	$0	0	0
Matagorda County	10/11/1970	F1	$2,500	$0	0	0
Matagorda County	3/20/1972	F1	$25,000	$0	0	0
Matagorda County	3/20/1972	F1	$25,000	$0	0	0
Matagorda County	6/25/1975	F0	$0	$0	0	0
Matagorda County	8/3/1975	F0	$0	$0	0	0
Matagorda County	9/26/1976	F1	$25,000	$0	0	0

**TABLE 15-3.
HISTORIC TORNADO EVENTS IN MATAGORDA COUNTY AND PARTICIPATING COMMUNITIES (1950-2014)**

Location	Date	Category	Estimated Damage Cost: Property	Estimated Damage Cost: Crops	Injuries	Deaths
Matagorda County	4/16/1977	F0	$0	$0	0	0
Matagorda County	9/10/1977	F0	$0	$0	0	0
Matagorda County	5/31/1981	F1	$0	$0	0	0
Matagorda County	12/31/1984	F1	$25,000	$0	0	0
Matagorda County	1/14/1991	F0	$2,500	$0	0	0
Matagorda County	1/18/1991	F0	$2,500	$0	0	0
Matagorda County	4/17/1992	F0	$0	$0	0	0
Matagorda County	4/17/1992	F1	$250,000	$0	0	0
Matagorda County	4/17/1992	F1	$25,000	$0	0	0
Collegeport	3/15/1993	F1	$50,000	$0	0	0
Dayton	5/30/1994	F0	$5,000	$0	0	0
Collegeport	12/17/1995	F0	$100,000	$0	0	0
Markham	12/17/1995	F0	$1,000,000	$0	0	0
Blessing	12/17/1995	F0	$150,000	$0	0	0
Sargent	9/10/1998	F0	$15,000	$0	5	0
Sargent	5/28/2000	N/A	$0	$0	0	0
Palacios	5/13/2001	N/A	$0	$0	0	0
Matagorda	5/25/2001	F0	$10,000	$0	0	0
Van Vleck	9/6/2002	F0	$60,000	$0	0	0
Wadsworth	6/14/2003	F0	$0	$0	0	0
Markham	6/14/2003	F0	$0	$0	0	0
Palacios	7/15/2003	F1	$150,000	$0	0	0
Wadsworth	9/14/2003	N/A	$0	$0	0	0
Clemville	11/17/2003	F0	$30,000	$0	0	0
Bay City	3/15/2004	N/A	$0	$0	0	0
Bay City	3/16/2004	N/A	$0	$0	0	0
Collegeport	6/1/2006	N/A	$0	$0	0	0
Bay City	8/19/2006	N/A	$0	$0	0	0
Wadsworth	5/25/2007	N/A	$0	$0	0	0

TABLE 15-3.
HISTORIC TORNADO EVENTS IN MATAGORDA COUNTY AND PARTICIPATING COMMUNITIES (1950-2014)

			Estimated Damage Cost			
Location	**Date**	**Category**	**Property**	**Crops**	**Injuries**	**Deaths**
Matagorda	7/23/2008	N/A	$0	$0	0	0
Matagorda	7/23/2008	N/A	$0	$0	0	0
Wadsworth	6/30/2010	EF0	$0	$5,000	0	0
Matagorda County	10/6/2014	N/A	$0	$0	0	0

http://www.ncdc.noaa.gov

Table may list more events than are shown on related figures since some recorded events do not include specific geographic coordinates (GIS-enabled data) for precise graphical representation.

15.2.2 Location

Recorded tornadoes in the planning area are typically average size and short-lived. They can occur anywhere in Matagorda County and participating communities. Figure 15-4 shows tornado activity documented by NOAA from 1980-1999. Figure 15-5 shows the location of previous tornado events in Matagorda County and participating communities.

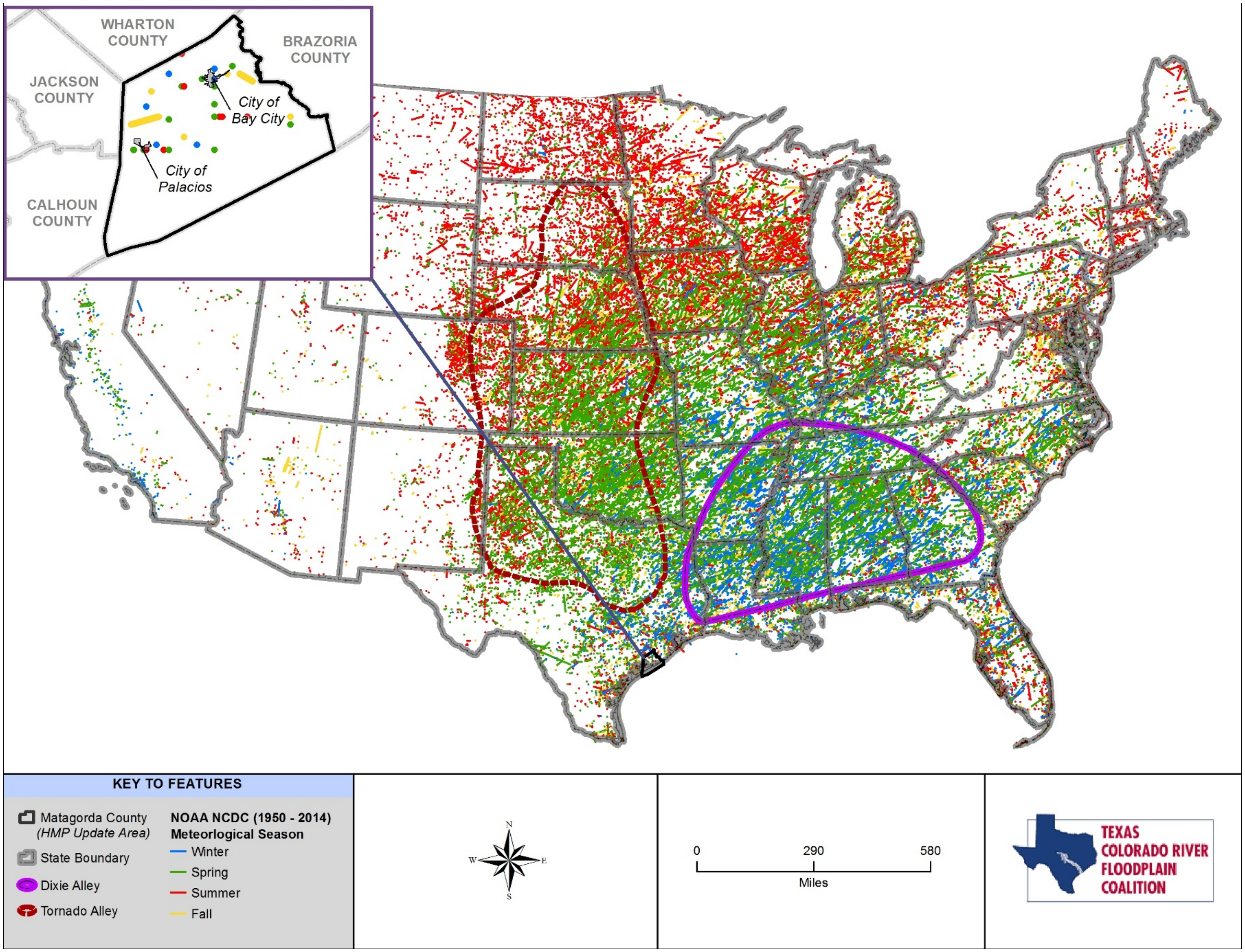


Figure 15-3. Tornado Paths in the U.S. (1950-2014)

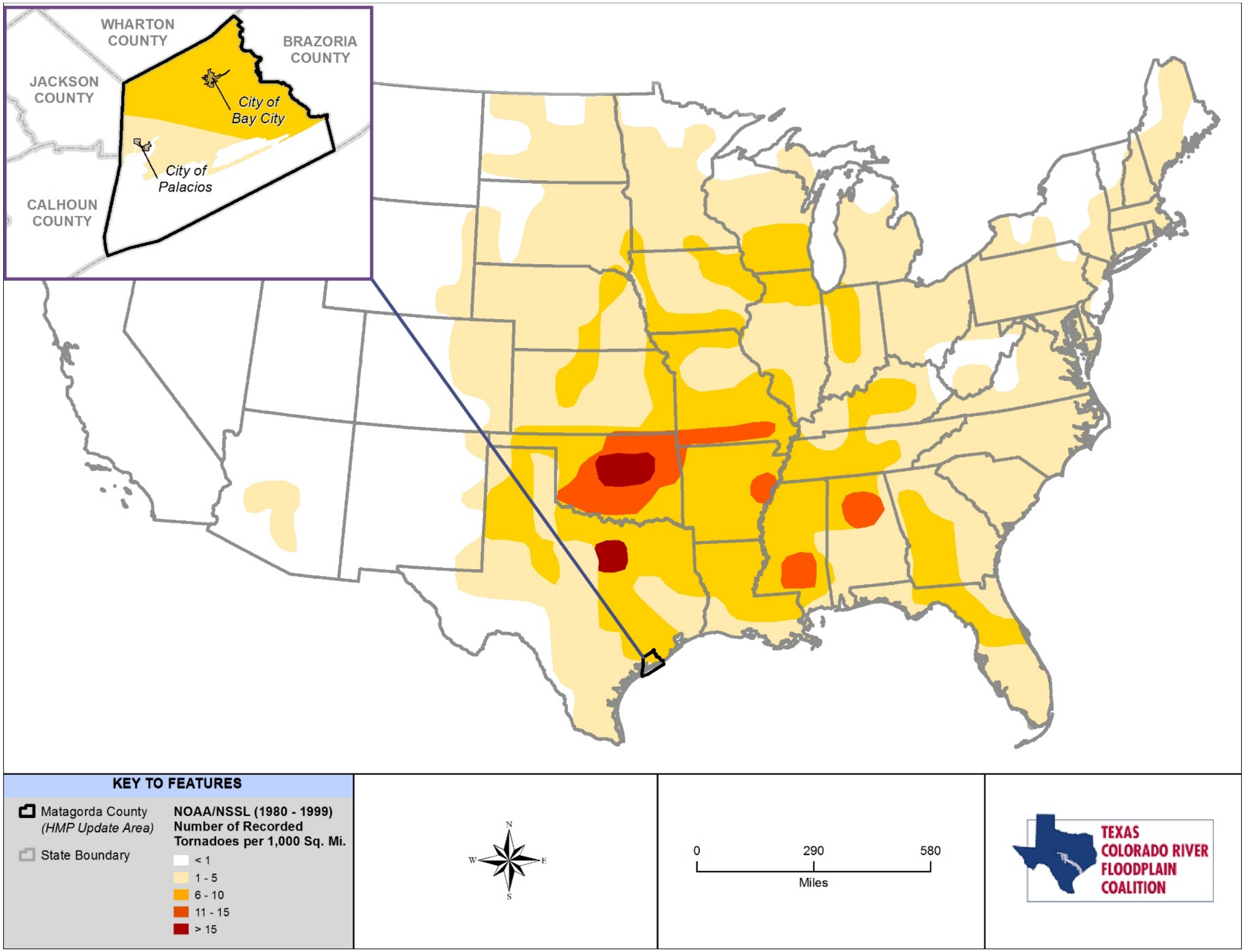


Figure 15-4. Tornado Activity in the U.S. (1980-1999)

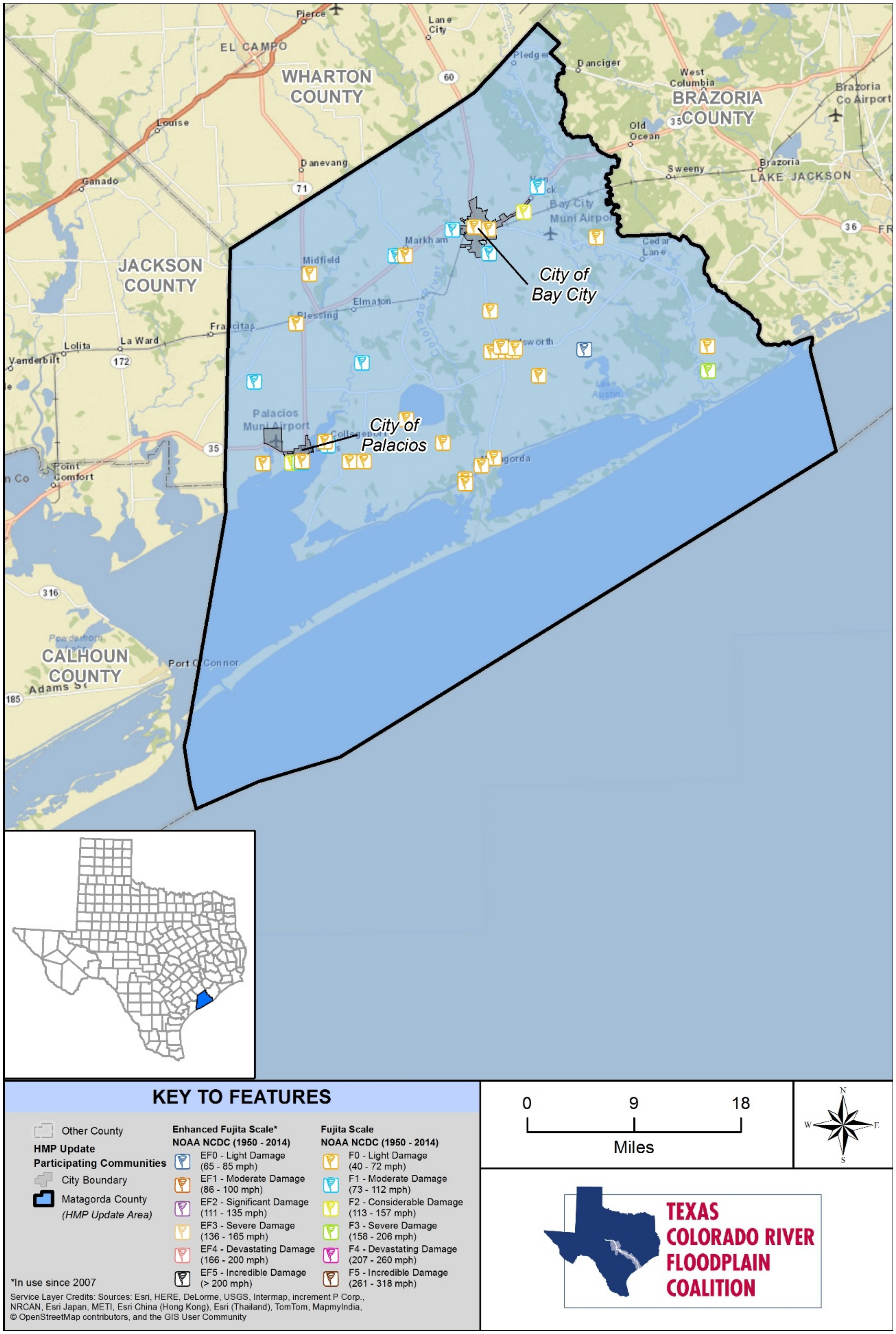


Figure 15-5. Tornado Events in Matagorda County (1950-2014)

15.2.3 Frequency

Tornadoes may occur in any month and at any hour of the day, but they occur with the greatest frequency during the late spring and early summer months, and between the hours of 4 p.m. and 8 p.m. In the period of 1951 to 2011, nearly 62.7% of all Texas tornadoes occurred within the three-month period of April, May, and June, with almost one-third of the total tornadoes occurring in May.

Table 15-3 lists 18 recorded tornadoes rated F1 or higher between 1950 and 2014. Therefore, on average, a significant tornado occurs in the county once every 3 to 4 years for each participating community (as tornado events are random, and can occur anywhere). Since tornado events can occur anywhere throughout the HMP update area, each participating community has the same frequency and probability of future events (once every 3 to 4 years future events). Tornados up to category F3 can be expected for future events (see Table 15-3) for all participating communities.

15.2.4 Severity

Tornadoes are potentially the most dangerous of local storms. If a major tornado were to strike within the populated areas of Matagorda County and the participating communities, damage could be widespread. Businesses could be forced to close for an extended period or permanently, fatalities could be high, many people could be homeless for an extended period, and routine services such as telephone or power could be disrupted. Buildings may be damaged or destroyed. Historically, tornadoes have not typically been severe or caused damage in the planning area.

15.2.5 Warning Time

The NOAA Storm Prediction Center issues tornado watches and warnings for Matagorda County. Watches and warnings are described below:

- Tornado Watch - Tornadoes are possible. Remain alert for approaching storms. Watch the sky and stay tuned to NOAA Weather Radio, commercial radio, or television for information.
- Tornado Warning - A tornado has been sighted or indicated by weather radar. Take shelter immediately.

Once a warning has been issued, residents may have only a matter of seconds or minutes to seek shelter.

15.3 SECONDARY HAZARDS

Tornadoes may cause loss of power if utility service is disrupted. Additionally, fires may result from damages to natural gas infrastructure. Hazardous materials may be released if a structure is damaged that houses such materials or if such a material is in transport.

15.4 CLIMATE CHANGE IMPACTS

Climate change impacts on the frequency and severity of tornadoes are unclear. According to the Center for Climate Change and Energy Solutions, "Researchers are working to better understand how the building blocks for tornadoes – atmospheric instability and wind shear – will respond to global warming. It is likely that a warmer, moister world would allow for more frequent instability. However, it is also likely that a warmer world would lessen chances for wind shear. Recent trends for these quantities in the Midwest during the spring are inconclusive. It is also possible that these changes could shift the timing of tornadoes or regions that are most likely to be hit" (Center for Climate and Energy Solutions no date).

15.5 EXPOSURE

Because tornadoes cannot be directly modeled in HAZUS, annualized losses were estimated using GIS-based analysis, historical data analysis, and statistical risk assessment methodology. Event frequency, severity indicators, expert opinions, and historical knowledge of the region were used for this assessment.

The primary data source was the updated HAZUS inventory data (updated with 2010 U.S. Census Data and 2014 RS Means Square Foot Costs) augmented with state and federal data sets as well as the NOAA National Climatic Data Center Storm Event Database.

15.5.1 Population

It can be assumed that the entire planning area is exposed to tornadoes to some extent. Certain areas are more exposed due to geographic location (rural areas of the county) and local weather patterns.

15.5.2 Property

According to the Matagorda County HAZUS 2.2 inventory data (updated with 2010 U.S. Census Data and 2014 RS Means Square Foot Costs), there are 16,635 buildings within the census blocks that define the planning area with an asset replaceable value of over $4 million (excluding contents). About 98.5% of these buildings (and 83.4% of the building value) are associated with residential housing. Within the participating communities in the HMP update area, there are an estimated 14,544 buildings (residential, commercial, and other) with a total asset inventory (excluding contents) value of over $3.6 million. Other types of buildings in this report include agricultural, education, religious, and governmental structures. See hazard loss tables for community-specific total assessed numbers (e.g. Table 15-6). Properties at lower elevations are more likely to be exposed to tornadoes. Table 15-4 list the exposed structures and population for each participating community.

TABLE 15-4
EXPOSED STRUCTURES AND POPULATION

Jurisdiction	Residential	Commercial	Other *	**Total Structures**	**Total Population**
Unincorporated Area	5,744	121	35	5,900	17,631
City of Bay City	1,785	17	10	1,812	4,718
City of Palacios	6,787	29	16	6,832	10,028
Matagorda County Total	14,316	167	61	14,544	32,377

*Other includes industrial, agricultural, religious, governmental, and educational classifications.

15.5.3 Critical Facilities and Infrastructure

All critical facilities (see Figure 6-8 and Figure 6-9) are likely vulnerable to tornadoes. The most common problems associated with this hazard are utility losses. Downed power lines can cause blackouts, leaving large areas isolated. Phone, water, and sewer systems may not function. Roads may become impassable due to downed trees or other debris.

15.5.4 Environment

Environmental features are exposed to tornado risk, although damages are generally localized to the path of the tornado.

15.6 VULNERABILITY

15.6.1 Population

Vulnerable populations are the elderly, low income, or linguistically isolated populations, people with life-threatening illnesses, and residents living in areas that are isolated from major roads. Power outages can be life threatening to those dependent on electricity for life support. Isolation of these populations is a significant concern. These populations face isolation and exposure after tornado events and could suffer more secondary effects of the hazard.

Individuals caught in the path of a tornado who are unable to seek appropriate shelter are especially vulnerable. This may include individuals who are out in the open, in cars, or who do not have access to basements, cellars, or safe rooms. See Table 15-5 for population most vulnerable to tornado events per jurisdiction.

TABLE 15-5
MOST VULNERABLE POPULATION

Jurisdiction	Youth Population (< 16)	% of Total Population	Elderly Population (> 65)	% of Total Population	Economically Disadvantage (Income < $20,000)	% of Total Population
Unincorporated Area	4,912	27.86	2,146	12.17	1,749	9.92
City of Bay City	1,441	30.54	623	13.20	549	11.64
City of Palacios	2,192	21.86	1,829	18.24	527	5.26
Matagorda County Total	8,545	26.39	4,598	14.20	2,825	8.73

15.6.2 Property

All property is vulnerable during tornado events, but properties in poor condition or in particularly vulnerable locations (rural areas) may risk the most damage.

Loss estimations for tornadoes are not based on damage functions, because no such damage functions have been generated. Instead, loss estimates were developed representing projected damages (annualized loss) on historical events, statistical analysis, and probability factors. These were applied to the exposed value of the county and communities to create an annualized loss. Table 15-6 lists the loss estimates.

TABLE 15-6.
LOSS ESTIMATES FOR TORNADO EVENTS

Jurisdiction	Exposed Value	Annualized Loss	Annualized Loss Percentage
Unincorporated Area	$2,558,729,176	$696,694	0.03
City of Bay City	$2,649,736,203	$5,700	<0.01

TABLE 15-6.
LOSS ESTIMATES FOR TORNADO EVENTS

Jurisdiction	Exposed Value	Annualized Loss	Annualized Loss Percentage
City of Palacios	$669,865,421	$815	<0.01
Matagorda County Total	**$5,878,330,801**	**$703,209**	**0.01**

Vulnerability Narrative

Annualized losses of “negligible” are less than $50 per year. The vulnerability of tornado events per jurisdiction are described below.

- **City of Bay City -** Approximately 13**%** of the City of Bay City’s housing is manufactured homes. This type of housing is more vulnerable to a tornado event. Loose structures and non-secured objects (such as dead trees and thick underbrush) can become flying projectiles in an event. If an event were to impact critical facilities, such as police stations or government facilities, emergency services could be greatly limited and residents would be negatively impacted. Facilities without alternative power supply sources increase this risk as they will be unable to respond to residents. Homes built without the use of building codes are more structurally vulnerable as well.
- **City of Palacios -** Approximately 17**%** of the City of Palacios’ housing is manufactured homes. Tornadoes can easily destroy poorly constructed buildings and mobile homes. Loose structures and non-secured objects (such as vehicles, dead trees and thick underbrush) can become flying projectiles in an event. Older homes constructed without the use of building codes are vulnerable as well. If an event were to strike emergency service centers or key transportation routes (such as the local police and fire stations or TX 35) emergency response times would be limited. Facilities without secured utility lines or alternate sources of power increase this risk. Residents who are unaware of the meaning of alerts or of emergency evacuation routes are increasingly vulnerable as well.
- **Matagorda County (Unincorporated Area)** - Approximately 20% of Matagorda County’s Unincorporated Area’s housing is manufactured homes. Tornadoes can easily destroy poorly constructed buildings and mobile homes. Response times to rural communities and residents would be greater if major thoroughfares (such as TX 71 or TX 35) as well as emergency response facilities (such as police and fire departments) were impacted by an event. Facilities without generators or another means of power supply increase these risks. Dead trees, branches, and non-secured structures can become flying projectiles during a tornado, placing people and property at a greater risk. Communities who do not provide shelter for vulnerable residents increase vulnerability. Residents who are unaware of the risks and hazards associated with tornadoes are more vulnerable as they will be less able to effectively protect themselves and prepare for an event.

Community Perception of Vulnerability

See front page of current chapter for a summary of hazard rankings for Matagorda County and participating communities in this HMP update. Chapter 19 gives a detailed description of this rankings and Chapter 20 addresses mitigations actions for this hazard vulnerability.

15.6.3 Critical Facilities and Infrastructure

Tornadoes can cause significant damage to trees and power lines, block roads with debris, incapacitate transportation, isolate populations, and disrupt ingress and egress. Of particular concern are roads providing access to isolated areas and to the elderly. Any facility that is in the path of a tornado is likely to sustain damage.

15.6.4 Environment

Environmental vulnerability will typically be the same as exposure (discussed in Section 15.5.4); however, if tornadoes impact facilities that store hazardous material, areas impacted by material releases may be especially vulnerable.

15.7 FUTURE TRENDS IN DEVELOPMENT

All future development will be affected by tornadoes, particularly development that occurs at lower elevations. Development regulations that require safe rooms, basements, or other structures that reduce risk to people would decrease vulnerability. Tornadoes that cause damage are uncommon in the county, so mandatory regulations may not be cost-effective.

15.8 SCENARIO

If an F3 or higher tornado were to hit populated areas of the county, substantial damage to property and loss of life could result. Likelihood of injuries and fatalities would increase if warning time was limited before the event or if residents were unable to find adequate shelter. Damage to critical facilities and infrastructure would likely include loss of power, water, sewer, gas and communications. Roads and bridges could be blocked by debris or otherwise damaged. The most serious damage would be seen in the direct path of the tornado, but secondary effects could impact the rest of the county through loss of government services and interruptions in the transportation network. Debris from the tornado would need to be collected and properly disposed. Such an event would likely have substantial negative effects on the local economy.

15.9 ISSUES

Important issues associated with a tornado in the planning area include the following:

- Older building stock in the planning area is built to low code standards or none at all. These structures could be highly vulnerable to tornadoes.
- Redundancy of power supply must be evaluated.
- The capacity for backup power generation is limited.
- Roads and bridges blocked by debris or otherwise damaged might isolate populations.
- Warning time may not be adequate for residents to seek appropriate shelter or such shelter may not be widespread throughout the planning area.
- The impacts of climate change on the frequency and severity of tornadoes are not well understood.
- Building codes may need to be updated so buildings can withstand strong wind loads or provisions may be added for tornado shelters in high risk areas.

CHAPTER 16.
WILDFIRE

16.1 GENERAL BACKGROUND

According to the 2000 National Fire Plan, the wildland fire risk is now considered by authorities as "the most significant fire service problem of the Century."

A wildfire is any uncontrolled fire occurring on undeveloped land that requires fire suppression. Wildfires can be ignited by lightning or by human activity such as smoking, campfires, equipment use, and arson.

Fire hazards present a considerable risk to vegetation and wildlife habitats. Short-term loss caused by a wildfire can include the destruction of timber, wildlife habitat, scenic vistas, and watersheds. Long-term effects include smaller timber harvests, reduced access to affected recreational areas, and destruction of cultural and economic resources and community infrastructure. Vulnerability to flooding increases due to the destruction of watersheds. The potential for significant damage to life and property exists in areas designated as wildland urban interface (WUI) areas, where development is adjacent to densely vegetated areas.

DEFINITIONS

Conflagration — A fire that grows beyond its original source area to engulf adjoining regions. Wind, extremely dry or hazardous weather conditions, excessive fuel buildup, and explosions are usually the elements behind a wildfire conflagration.

Interface Area — An area susceptible to wildfires and where wildland vegetation and urban or suburban development occur together. An example would be smaller urban areas and dispersed rural housing in forested areas.

Wildfire — Fires that result in uncontrolled destruction of forests, brush, field crops, grasslands, and real and personal property in non-urban areas. Because of their distance from firefighting resources, they can be difficult to contain and can cause a great deal of destruction.

WILDFIRE RANKING	
Matagorda County	Low
City of Bay City	Low
City of Palacios	No Exposure

Texas has seen a huge increase in the number of wildfires in the past 30 years. From January 2005 to mid-September 2006, the Texas Forest Service (TFS) responded to 4,370 wildfires that burned 1.6 million acres. More and more people are placing their homes in woodland settings in or near forests, rural areas, or remote mountain sites. Many of these homes are nestled along ridgelines, cliff-edges, and other classic fire-interface hazard zones. There, homeowners enjoy the beauty of the environment but they also face the very real danger of wildfire.

Years of fire suppression has significantly disturbed natural fire occurrences—nature's renewal process. The result has been the gradual accumulation of understory and canopy fuels to levels of density that can feed high-energy, intense wildfires and further increase hazards from and exposure to interface problems.

Fire Protection in Matagorda County

Fire protection in Matagorda County is divided between volunteer fire departments, TFS, Bureau of Land Management, and the U.S. Forest Service (USFS). More information about these divisions is provided in Table 16-1. The TFS administers the Community Wildfire Protection Plan (CWPP) to reduce related risks to life, property, and the environment. Its Fire Control Department provides leadership in wildland fire protection for state and private lands in Texas.

**TABLE 16-1.
FIRE PROTECTION SERVICES IN MATAGORDA COUNTY AND PARTICIPATING COMMUNITIES**

Fire Protection Service	Unincorporated Area	City of Bay City	City of Palacios
Local Volunteer Fire Department	Yes *	Yes	Yes
National Park Service	Yes	No	No
Bureau of Land Management	Yes	No	No
Texas Commission on Environmental Quality	Yes	Yes	Yes
Texas Forest Service	Yes	Yes	Yes
AgriLife	Yes	Yes	Yes
Texas Parks and Wildlife Department	Yes	Yes	Yes
Texas Interagency Coordination Center	Yes	Yes	Yes
U.S. Fish and Wildlife Service	Yes	No	No
U.S. Forest Service	Yes	No	No

** Fire protection available in areas of high population*

Vegetation Classes in Matagorda County

General vegetation for Matagorda County and participating communities are described in Table 16-2 and in Figure 16-1. The most common vegetation classes in the county are grassland, comprising almost 70% of the acreage in the county, and evergreen forest.

**TABLE 16-2.
VEGETATION CLASSES IN MATAGORDA COUNTY AND PARTICIPATING COMMUNITIES**

Class	Acres	% of Area
Barren Land (Rock/Sand/Clay)	7,759	1.07
Deciduous Forest	26,625	3.69
Developed Land	34,143	4.73
Evergreen Forest	17,247	2.39
Grassland	451,902	62.59
Marshland	145,812	20.20
Mixed Forest	15,137	2.10
Water	23,380	3.24
Total	**722,006**	**100**

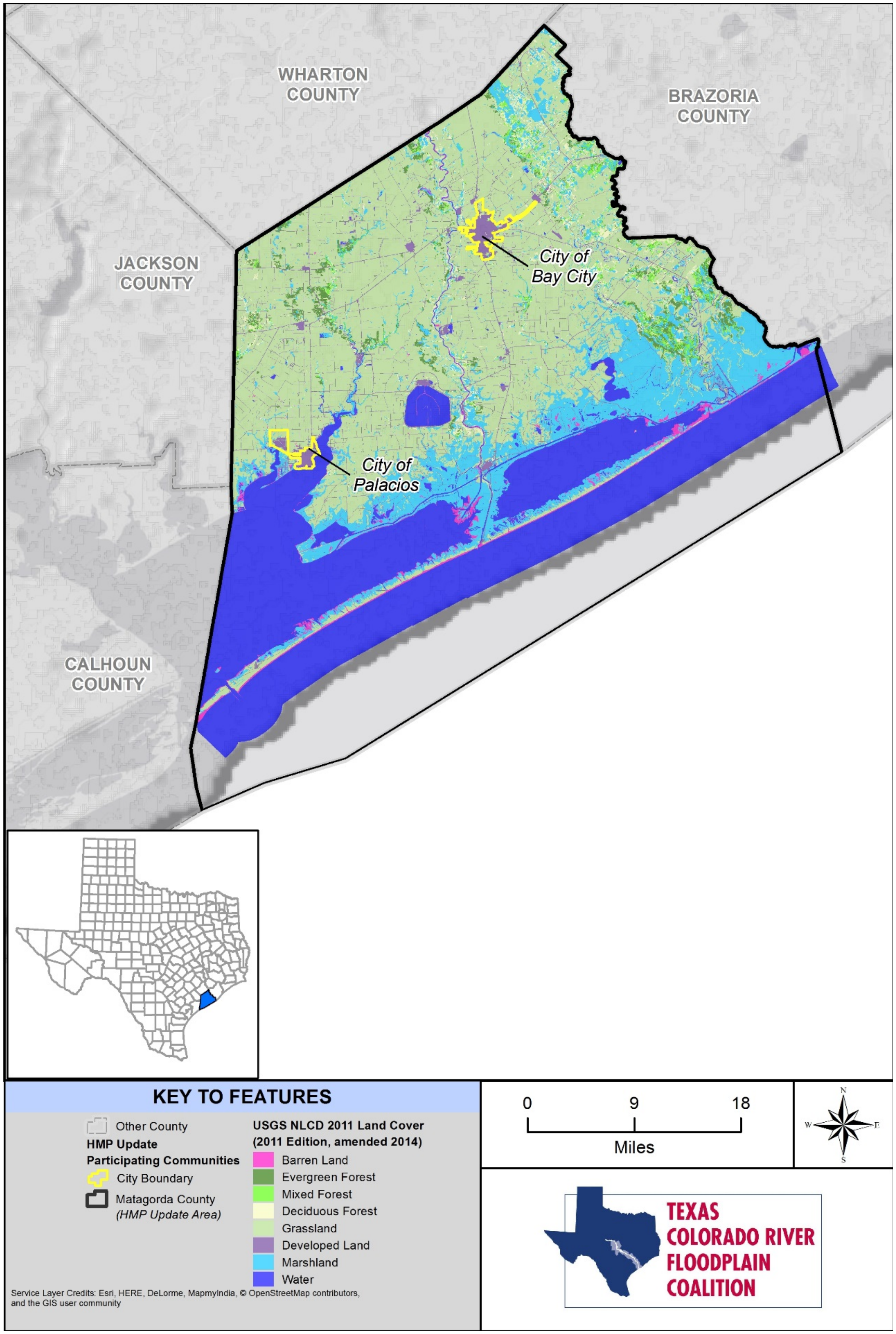


Figure 16-1. Vegetation Types in Matagorda County

16.2 HAZARD PROFILE

16.2.1 Past Events

Figure 16-2 shows the locations of federally reported wildfires in Matagorda County and participating communities, documented by federal and state agencies from 1980 through 2014. Recent fires larger than fifty acres are listed in Table 16-3. The locations of past wildfires in each partner community are shown on Figure 16-3 through Figure 16-4. No detailed descriptions of the wildfire events in Matagorda County were available.

TABLE 16-3.
HISTORIC WILDFIRE EVENTS IN MATAGORDA COUNTY AND PARTICIPATING COMMUNITIES (50+ ACRES) (1980-2014)

Fire ID	Name	Cause	Start Date	Acres
1992215412144	SMITHMARSH	Human	8/25/1992	1,700
369924	FLATRIDGE	Miscellaneous	1/25/1993	531
369964	LEWIS	Arson	10/30/1993	535
371090	SARGENT01	Lightning	7/17/1995	315
1995215412167	LEWIS	Natural	9/17/1995	100
371725	SMITH1	Arson	1/16/1996	50
371724	SMITH2	Arson	1/19/1996	100
1996215422396	ELECTRIC	Human	6/1/1996	50
371732	BOTTLE	Miscellaneous	7/13/1996	350
374088	CACTUS	Lightning	8/25/1999	1,319
374145	LAPORT	Debris Burning	11/10/1999	190
2000215412502	RADOTOWER	Human	3/26/2000	165
105683	SWIFT FARMS	Debris burning	1/5/2007	1,200
105689	PIERCE	Debris burning	9/17/2007	50
105691	SLOAN	Debris burning	10/12/2007	200
115944	CHICKEN FARM RD	Equipment use	1/1/2008	150
124893	FM 1862	Debris burning	2/13/2008	120
129240	CR 365	Debris burning	2/27/2008	100
132141	RAILROAD AVE	Debris burning	3/21/2008	80
63407	SMITH MARSH 2008	Lightning	6/21/2008	1,765
201121541F0P1	CEDAR LAKE CREEK	Human	2/17/2011	100
201409266	6/4/1901	Smoking	3/11/2011	130
201550232	SMITH MARSH 2012	Lightning	5/9/2012	64

Source: TxWRAP (https://www.texaswildfirerisk.com/), USGS (http://wildfire.cr.usgs.gov/firehistory/data.html), USDA (http://www.fs.usda.gov/rds/archive/Product/RDS-2013-0009.2/)

Table may list more events than are shown on related figures since some recorded events do not include specific geographic coordinates (GIS-enabled data) for precise graphical representation.

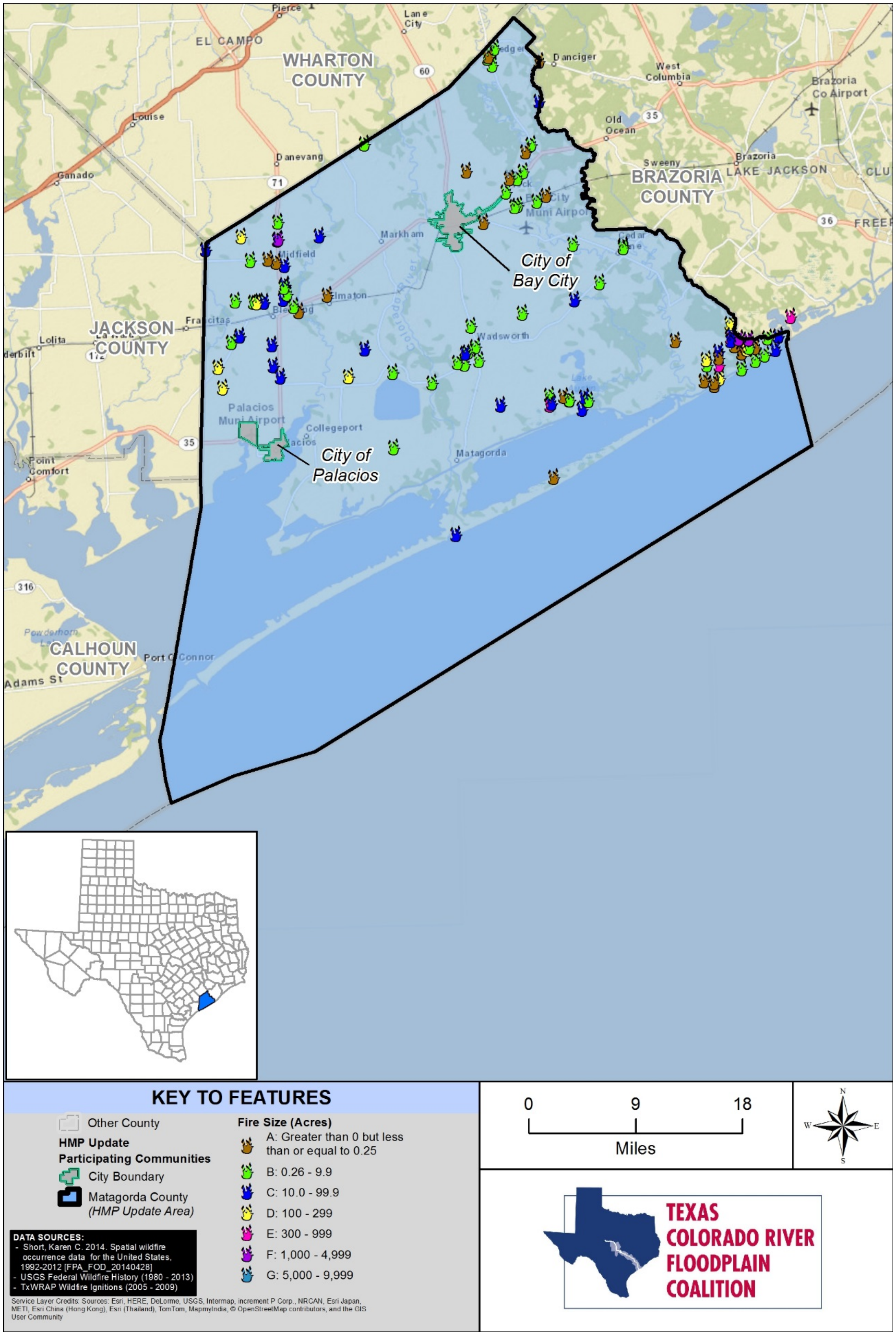


Figure 16-2. Wildfires in Matagorda County and Participating Communities (1980-2014)

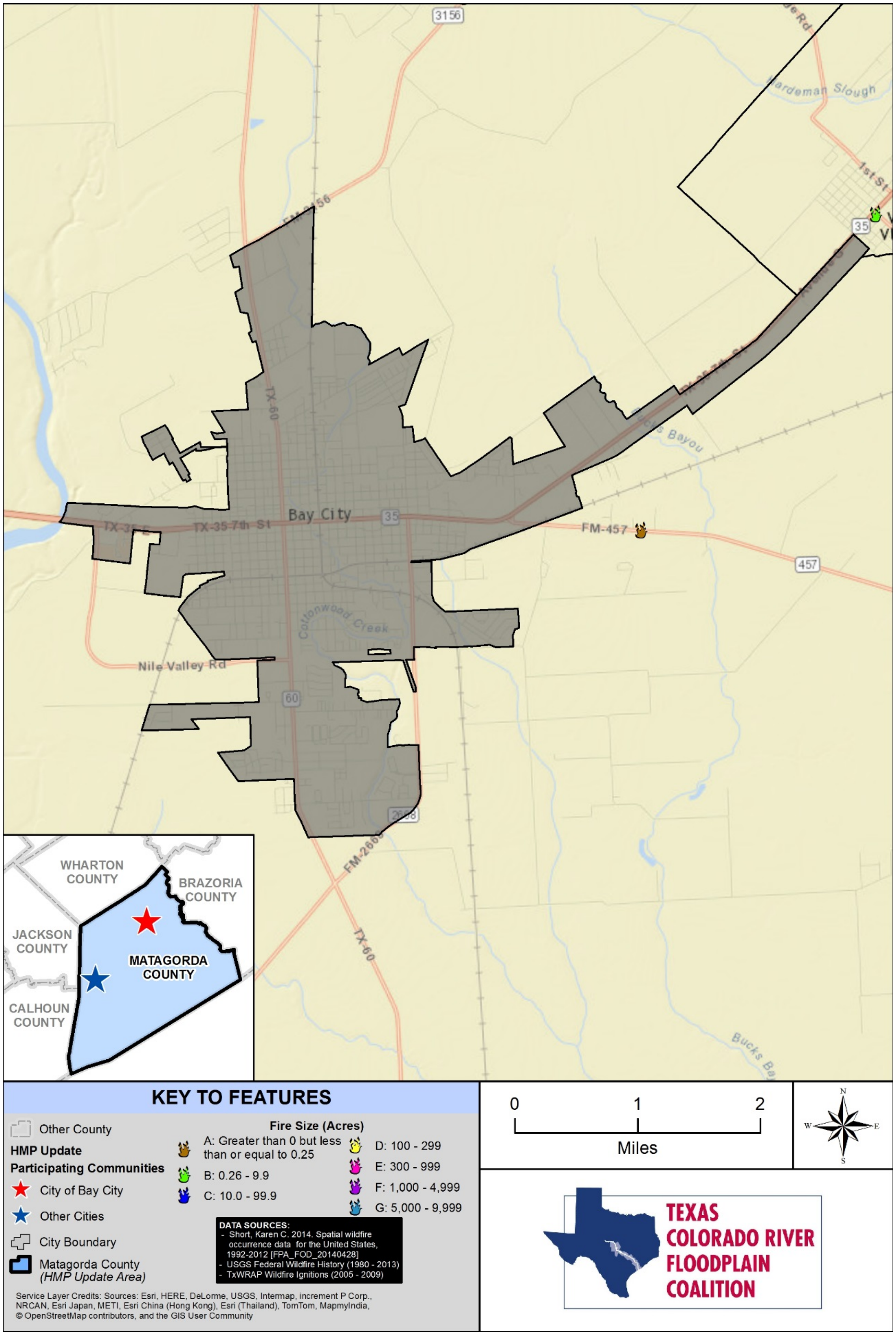


Figure 16-3. Wildfires in the City of Bay City County (1980-2014)

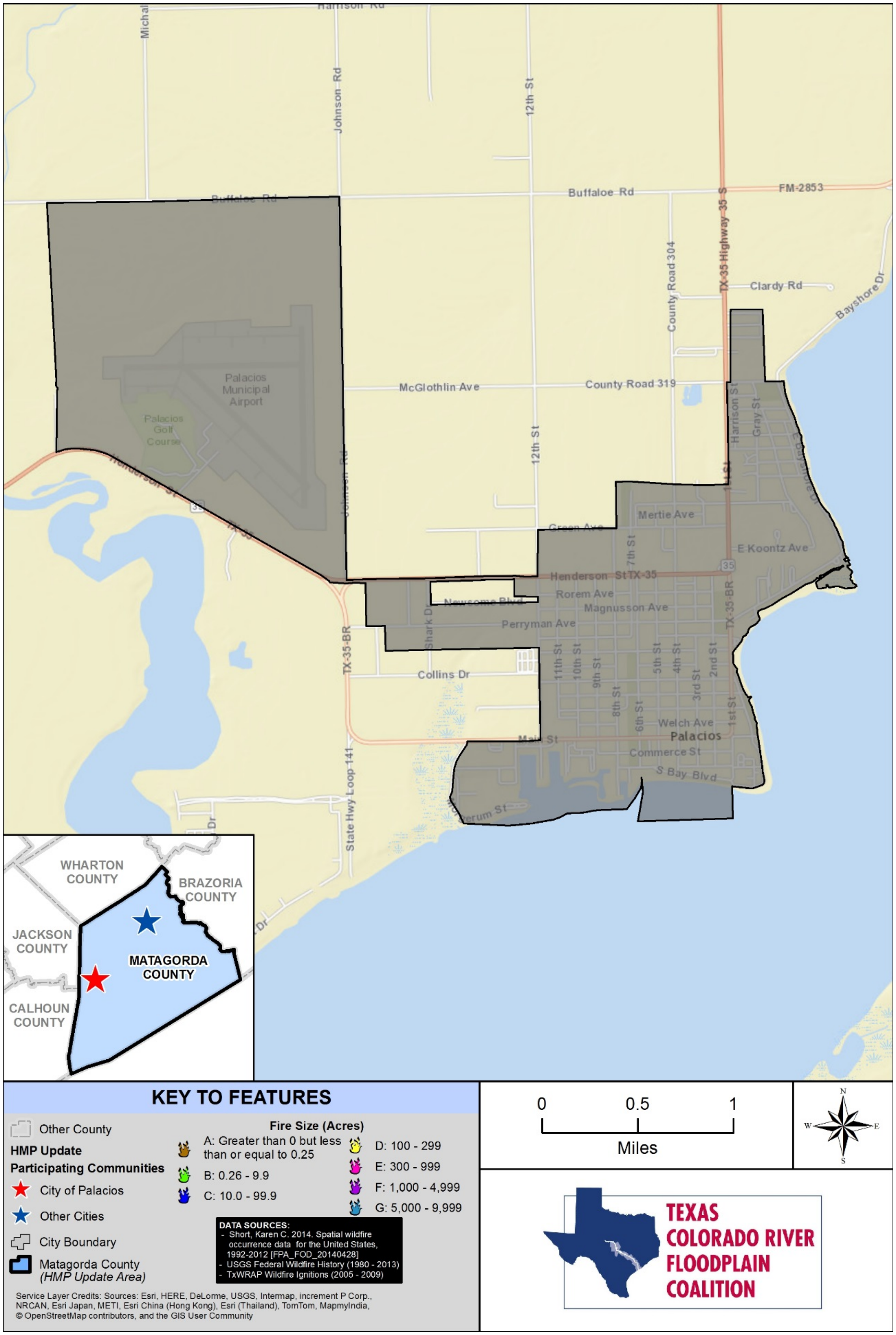


Figure 16-4. Wildfires in the City of Palacios (1980-2014)

16.2.2 Location

According to the TFS CWPP, nearly 85% of wildfires in Texas occur within two miles of a community. These wildfires pose a threat to life and property. There are approximately 14,000 communities in Texas that have been identified as “at risk” for potentially devastating fires. Figure 16-5 shows the distribution of wildfire ignitions in the Matagorda County and the participating communities.

Texas is one of the fastest growing states in the nation. Much of this growth is occurring in the WUI area, where structures and other human improvements meet and mix with undeveloped wildland or vegetative fuels. Population growth within the WUI substantially increases the risk from wildfires. For Matagorda County, the Texas State Wildfire Risk Assessment Program (TxWRAP) estimated that 21,319 people or 58% of the total project area population (36,980) live within the WUI. The WUI layer reflects housing density depicting where humans and their structures meet or intermix with wildland fuels. Figure 16-6 shows the Matagorda County housing density within the WUI.

The TxWRAP report for Matagorda County and the participating communities maps the WUI Response Index, which is a rating of the potential impact of a wildfire on people and their homes. The key input, WUI, reflects housing density (houses per acre) consistent with Federal Register National standards (Figure 16-6). The TxWRAP report states that the location of people living in the WUI and rural areas is essential for defining potential wildfire impacts to people and homes. Figure 16-7 shows the WUI Response Index for Matagorda County.

According to the TxWRAP report for Matagorda County, wildfire Values Response Index (VRI) layer reflects a rating of the potential impact of a wildfire on values or assets. The VRI is an overall rating that combines the impact ratings for WUI (housing density) and Pine Plantations (pine age) into a single measure. VRI combines the likelihood of a fire occurring (threat) with those areas of most concern that are adversely impacted by fire to derive a single overall measure of wildfire risk. Figure 16-8 shows the VRI for Matagorda County and the participating communities.

The TxWRAP report for Matagorda County and the participating communities maps the Community Protection Zones (CPZ), which represent those areas considered highest priority for mitigation planning activities. CPZs are based on an analysis of the “Where People Live” housing density data and surrounding fire behavior potential. “Rate of Spread” data is used to determine the areas of concern around populated areas that are within a 2-hour fire spread distance. Figure 16-9 shows the demarcation of CPZs in Matagorda County and the participating communities.

Finally, wildfire threat or Wildfire Hazard Potential (WHP) is the likelihood of a wildfire occurring or burning into an area. Threat is calculated by combining multiple landscape characteristics including surface and canopy fuels, fire behavior, historical fire occurrences, weather observations, terrain conditions, and other factors. Figure 16-10 through Figure 16-12 maps the WHP for Matagorda County and each partner community as identified in the 2014 USDA Forest Service, Fire Modeling Institute WHP using data from 1992 to 2012. On its own, WHP is not an explicit map of wildfire threat or risk, but when paired with spatial data depicting highly valued resources and assets such as structures or power lines, it can approximate relative wildfire risk to those specific resources and assets. WHP is also not a forecast or wildfire outlook for any particular season, as it does not include any information on current or forecasted weather or fuel moisture conditions. It is instead intended for long-term strategic fuels management and appropriate for regional, county, or local protection mitigation or prevention planning.

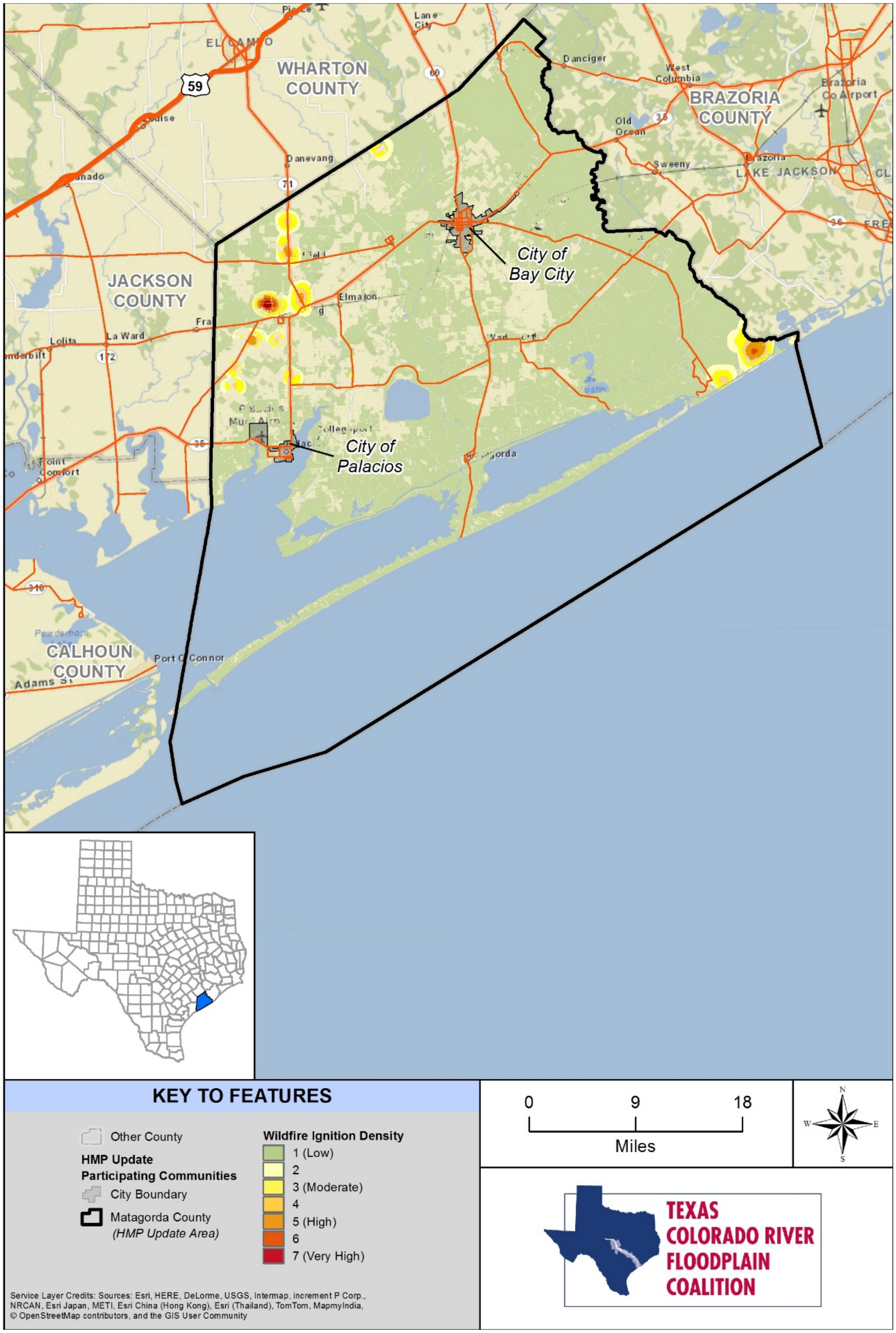


Figure 16-5. Matagorda County and Participating Communities Wildfire Ignitions Distribution

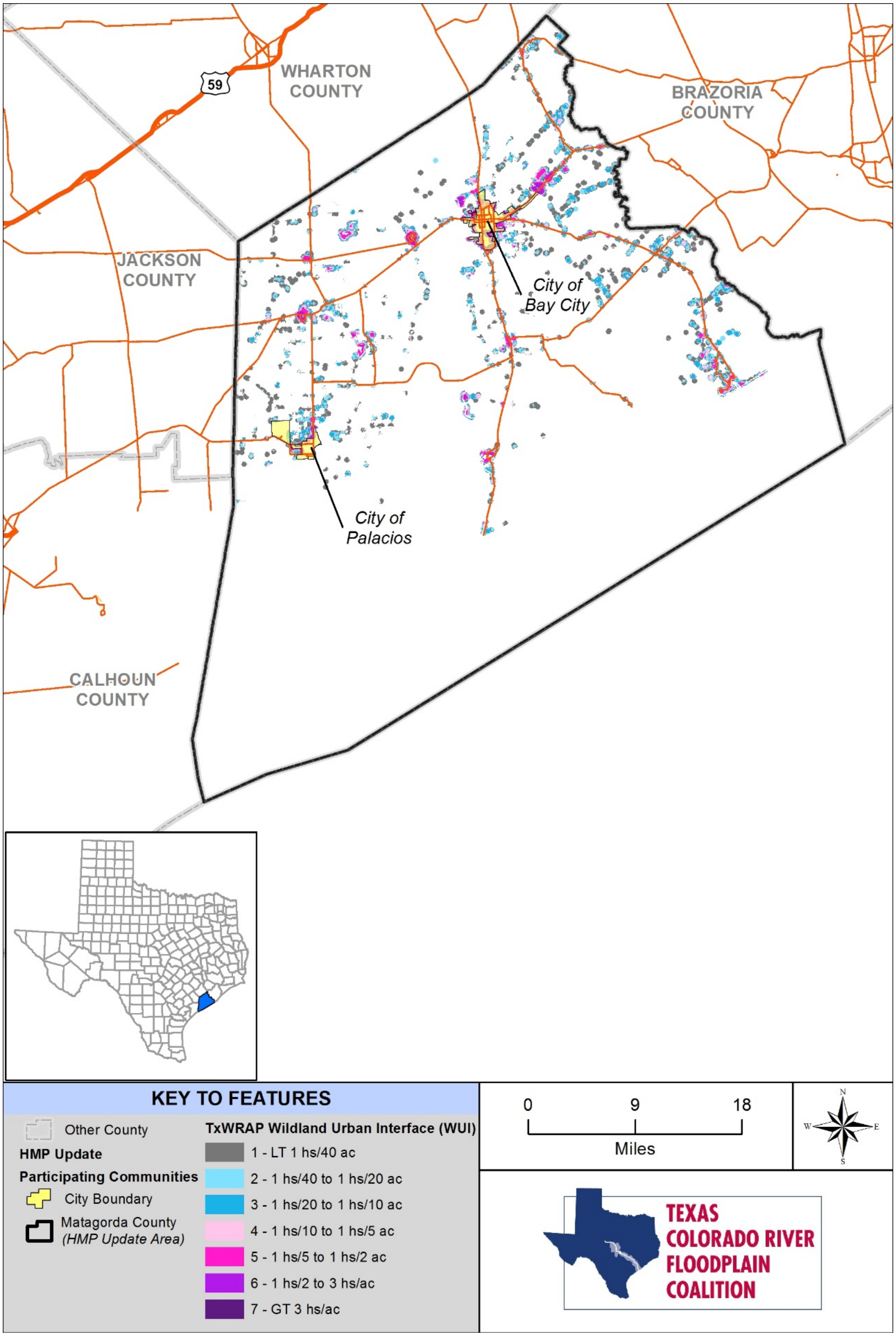


Figure 16-6. Matagorda County and Participating Communities Wildland Urban Interface

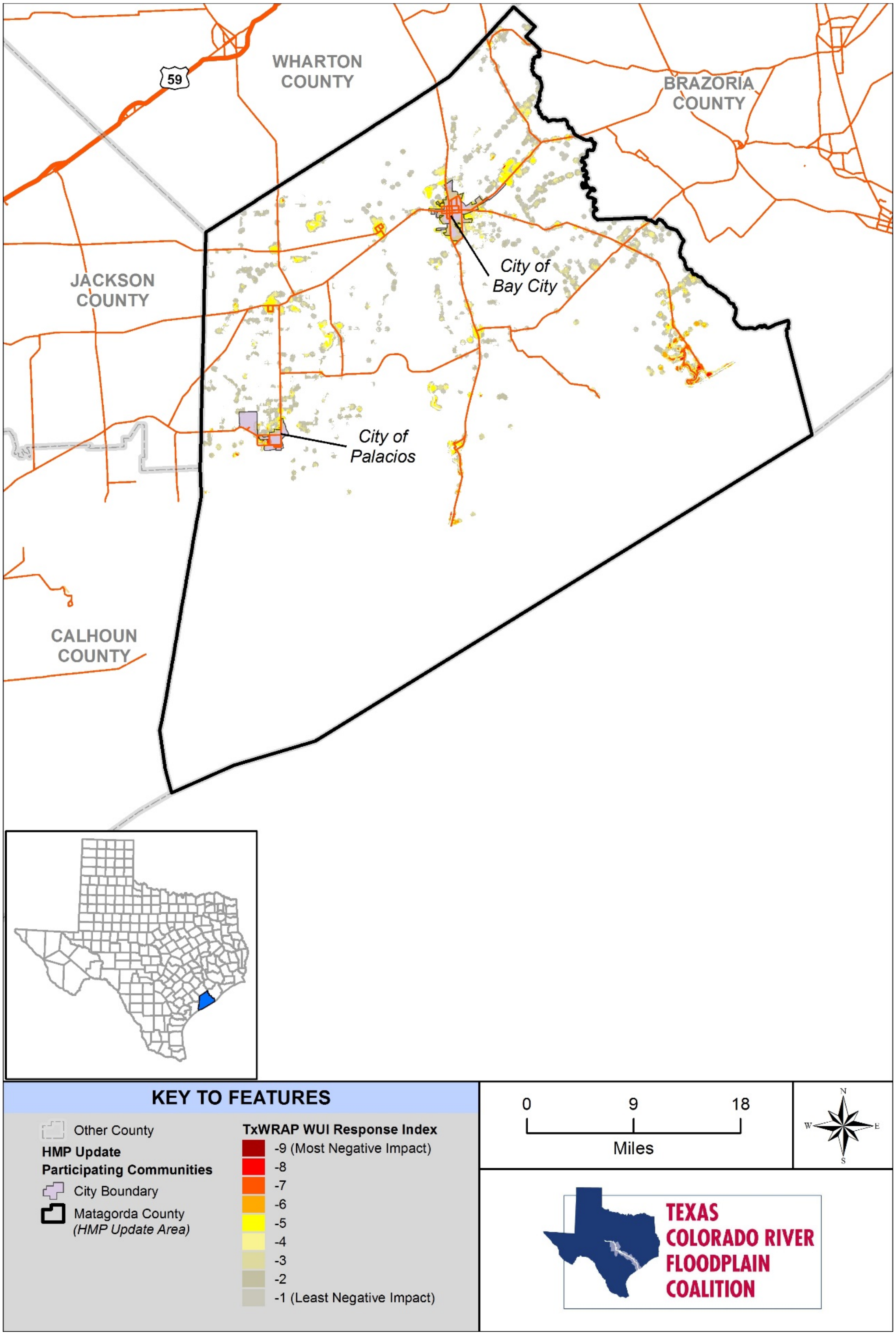


Figure 16-7. Matagorda County and Participating Communities Wildland Urban Interface Response Index

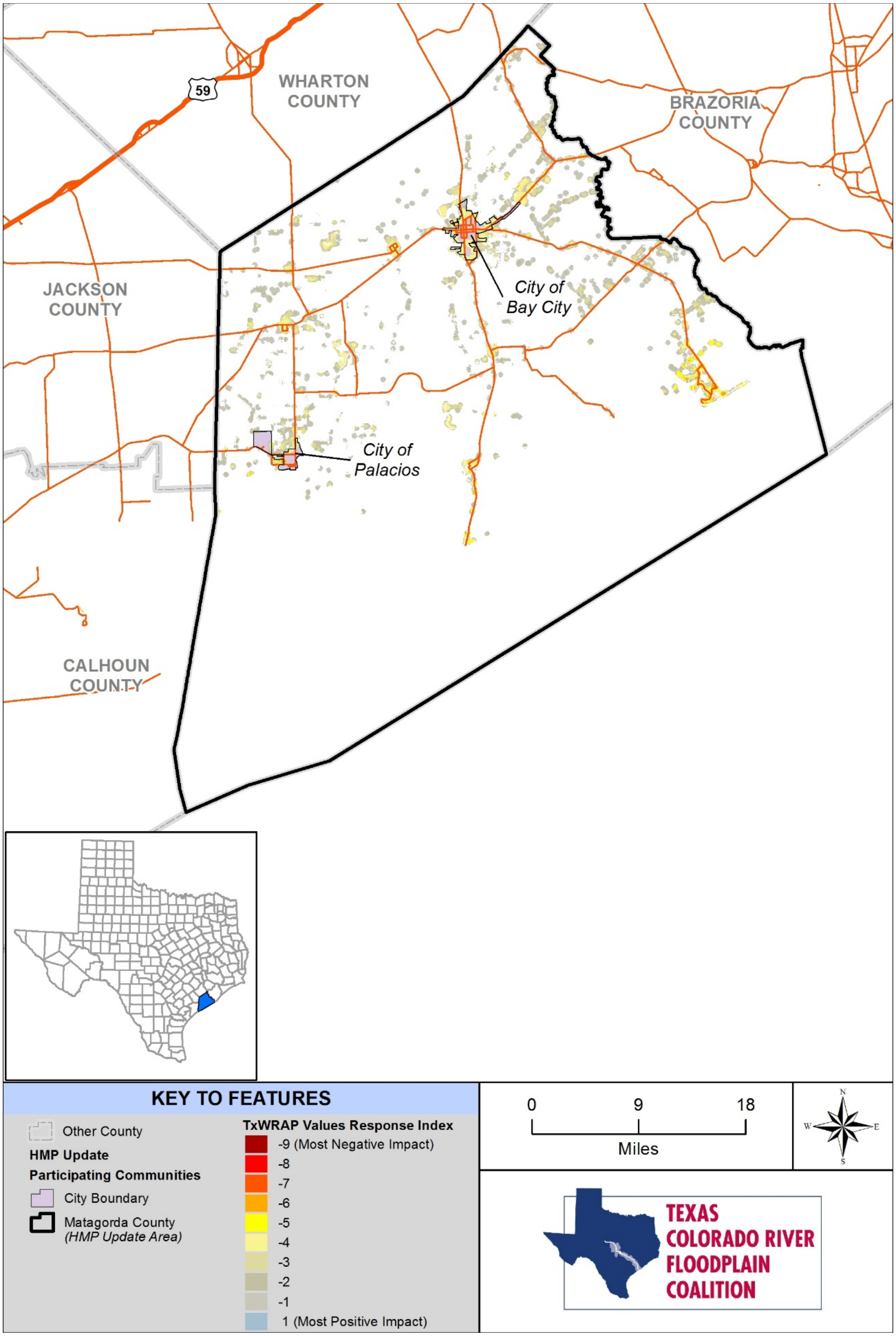


Figure 16-8. Matagorda County and Participating Communities Wildfire Values Response Index

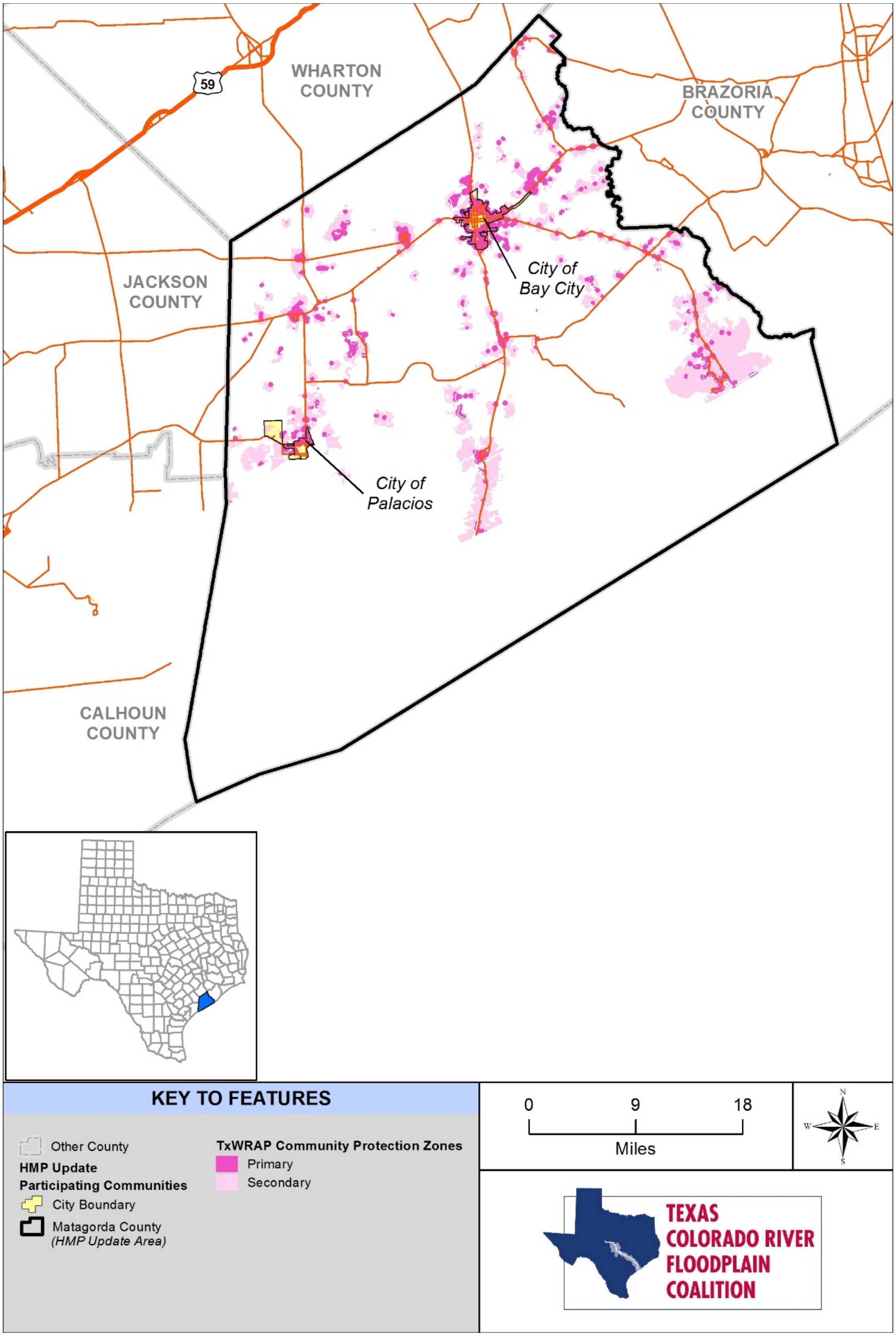


Figure 16-9. Matagorda County and Participating Communities Wildfire Community Protection Zones

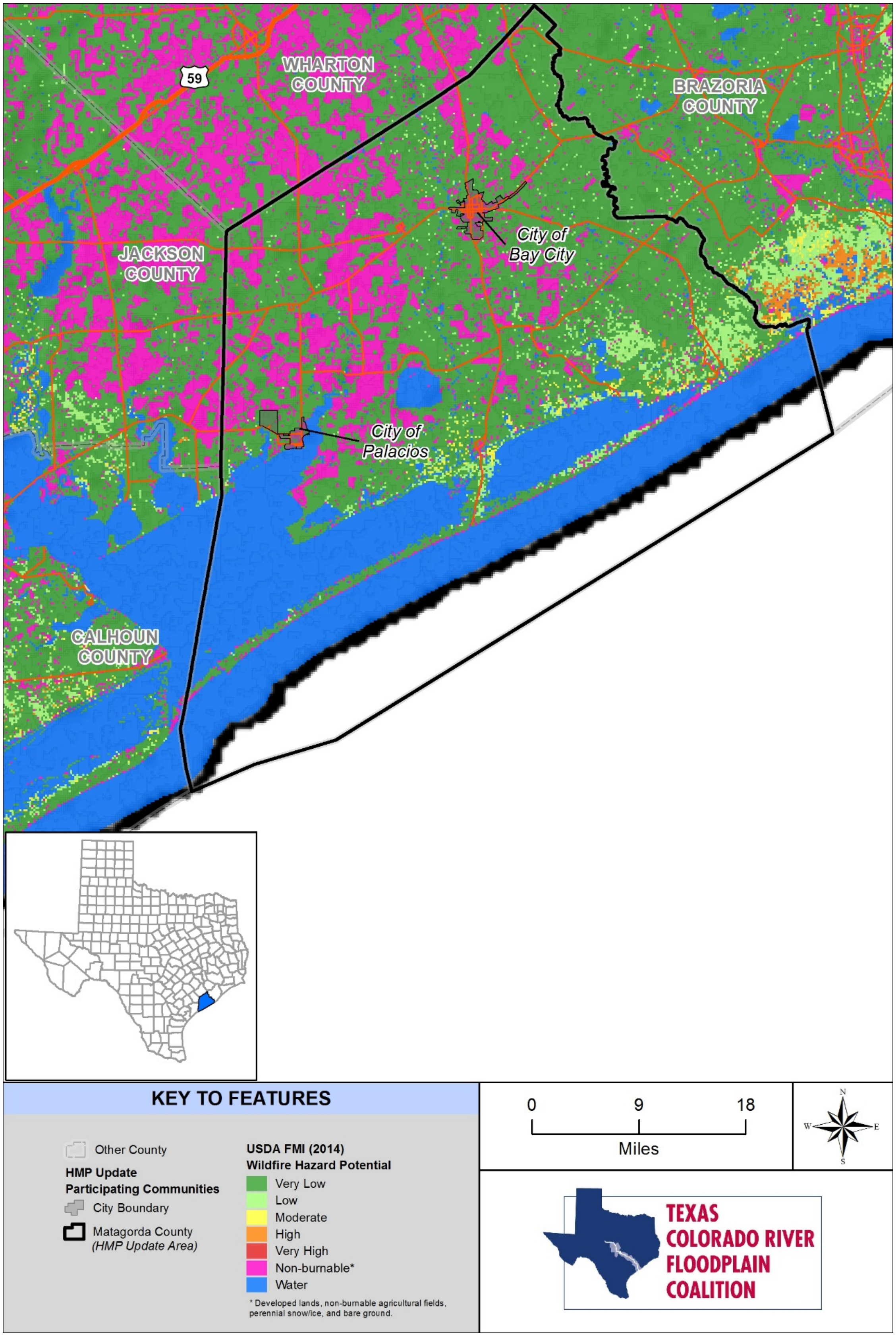


Figure 16-10. Matagorda County and Participating Communities Wildfire Hazard Potential

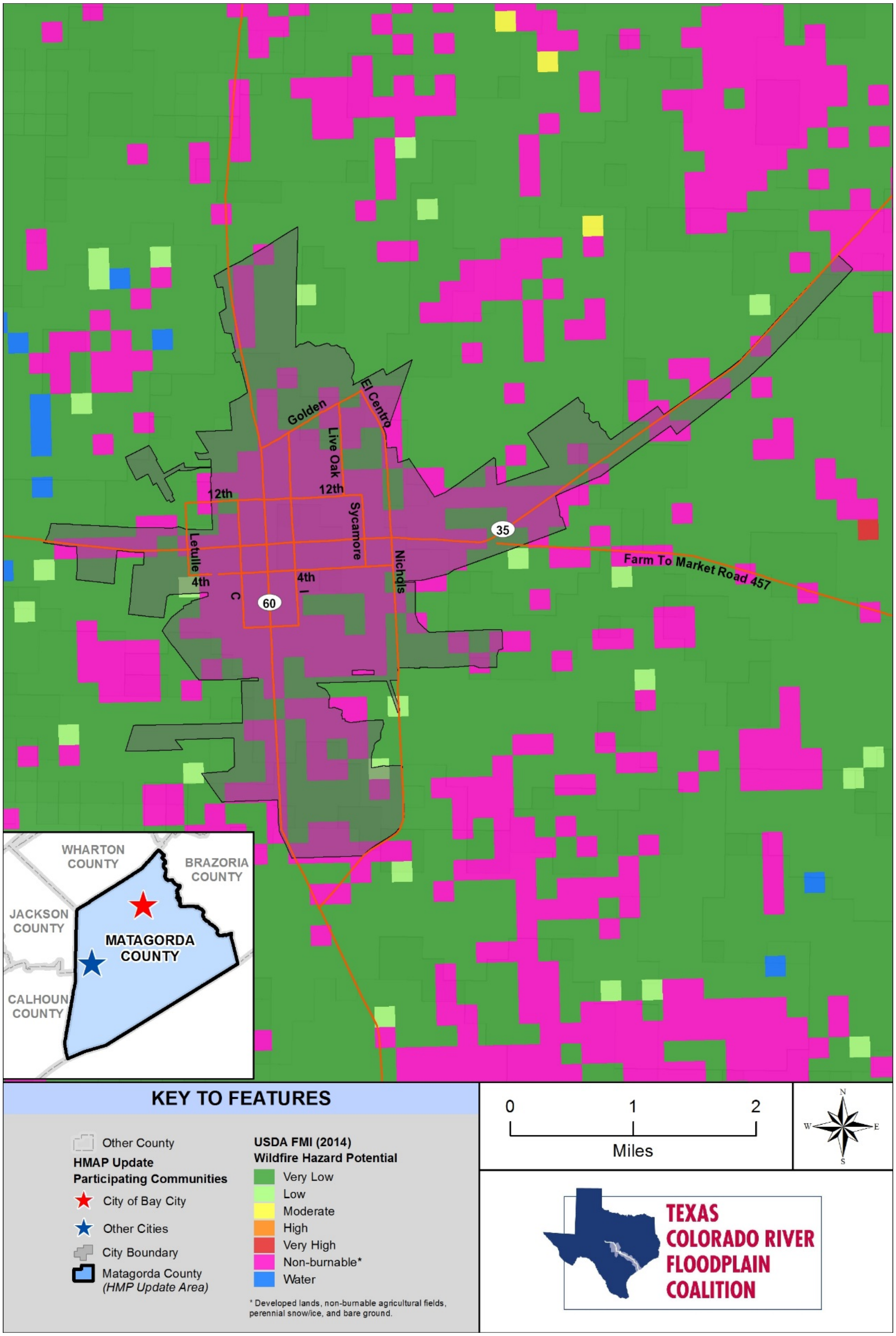


Figure 16-11. City of Bay City Wildfire Hazard Potential

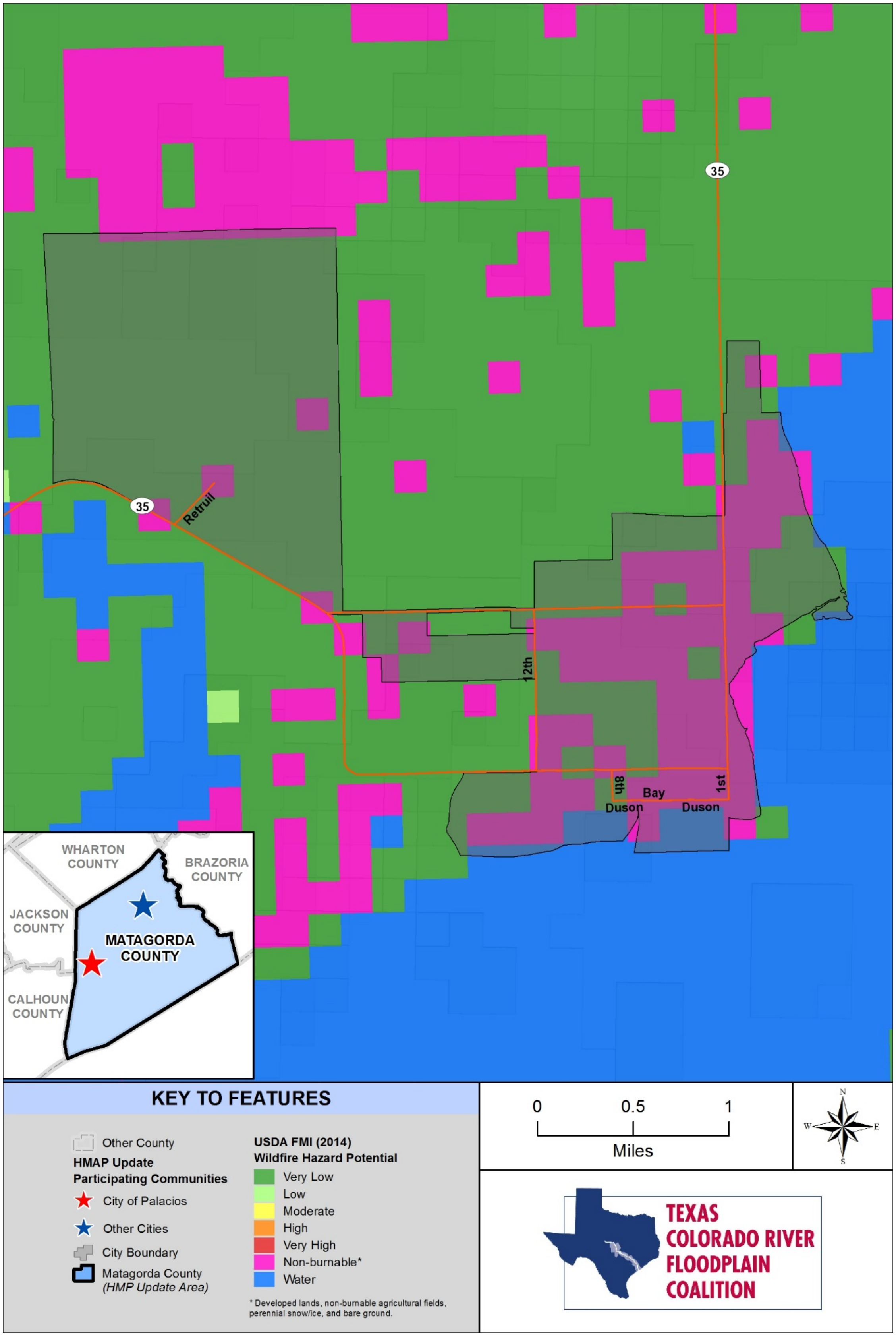


Figure 16-12. City of Palacios Wildfire Hazard Potential

16.2.3 Frequency

Based on previous events and historical records, there is 73% chance of an event occurring in Matagorda County unincorporated areas. There is a <1% chance of an event occurring in the City of Bay City and the City of Palacios. Wildfires occur throughout the year and these fires are expected to be greater than 50 acres in size. The probability of future events are the same for the respective participating communities. Future events are expected to be similar in size (greater than 50 acres) and strength to previous events. Previous events are listed in Table 16-3 and displayed on Figure 16-2 and Figure 16-5.

16.2.4 Severity

The overall significance of the hazard for Matagorda County is considered high (event possible in the next year). The City of Bay City and the City of Palacios have an overall significance of an unlikely (event possible in the next 10 years). Based on the information in this hazard profile, and the widespread impacts, the magnitude/severity of severe wildfires is considered moderate; that is, few deaths or injuries and limited property damage, interruption of essential facilities and services, or economic impact. The overall significance of the hazard is considered low for Matagorda County and the participating communities.

16.2.5 Warning Time

Wildfires are often caused by humans, intentionally or accidentally. There is no way to predict when one might break out. Because fireworks often cause brush fires, extra diligence is warranted around the Fourth of July when the use of fireworks is highest. Dry seasons and droughts are factors that greatly increase fire likelihood. Dry lightning may trigger wildfires. Severe weather can be predicted, so special attention can be paid during weather events that may include lightning. Reliable NWS lightning warnings are available on average 24 to 48 hours before a significant electrical storm.

If a fire does break out and spreads rapidly, residents may need to evacuate within days or hours. A fire's peak burning period generally is between 1 p.m. and 6 p.m. Once a fire has started, fire alerting is reasonably rapid in most cases. The rapid spread of cellular and two-way radio communications in recent years has further contributed to a significant improvement in warning time.

16.3 SECONDARY HAZARDS

Wildfires can generate a range of secondary effects, which in some cases may cause more widespread and prolonged damage than the fire itself. Fires can cause direct economic losses in the reduction of harvestable timber and indirect economic losses in reduced tourism. Wildfires cause the contamination of reservoirs, destroy transmission lines, and contribute to flooding. They strip slopes of vegetation, exposing them to greater amounts of runoff. This in turn can weaken soils and cause failures on slopes. Major landslides can occur several years after a wildfire. Most wildfires burn hot and for long durations that can bake soils, especially those high in clay content, increasing the imperviousness of the ground. This increases the runoff generated by storm events, thus increasing the chance of flooding.

16.4 CLIMATE CHANGE IMPACTS

Fire in western ecosystems is affected by climate variability, local topography, and human intervention. Climate change has the potential to affect multiple elements of the wildfire system: fire behavior, ignitions, fire management, and vegetation fuels. Hot, dry spells create the highest fire risk. Increased temperatures may intensify wildfire danger by warming and drying out vegetation. When climate alters fuel loads and fuel moisture, forest susceptibility to wildfires changes. Climate change also may increase winds that spread fires. Faster fires are harder to contain, and thus are more likely to expand into residential neighborhoods.

Historically, drought patterns in the West and Midwest are related to large-scale climate patterns in the Pacific and Atlantic Oceans. The El Niño–Southern Oscillation in the Pacific varies on a 5- to 7-year cycle, the Pacific Decadal Oscillation varies on a 20- to 30-year cycle, and the Atlantic Multidecadal Oscillation varies on a 65- to 80-year cycle. As these large-scale ocean climate patterns vary in relation to each other, drought conditions in the U.S. shift from region to region.

Climate scenarios project summer temperature increases between 2 and 5 degrees Celsius (35.6 to 41°F) and precipitation decreases of up to 15% by 2100. Such conditions would exacerbate summer drought and further promote wildfires, releasing stores of carbon and further contributing to the buildup of greenhouse gases. Forest response to increased atmospheric carbon dioxide – the so-called “fertilization effect” – could also contribute to more tree growth and thus more fuel for fires, but the effects of carbon dioxide on mature forests are still largely unknown. High carbon dioxide levels should enhance tree recovery after fire and young forest regrowth, as long as sufficient nutrients and soil moisture are available, although the latter is in question for many parts of the western United States because of climate change.

16.5 EXPOSURE

Since wildfire cannot be directly modeled in HAZUS, annualized losses were estimated using GIS-based analysis, historical data analysis, and statistical risk assessment methodology. Event frequency, severity indicators, expert opinions, and historical knowledge of the region were used for this assessment. The primary data source was the updated HAZUS inventory data (updated with 2010 U.S. Census Data and 2014 RS Means Square Foot Costs) augmented with state and federal data sets as well as TxWRAP, USGS Federal Wildfire History, Fire Program Analysis Fire-Occurrence Database (FPA-FOD), CWPP, and the USDA Wildfire Hazard Potential Data. Information for the exposure analyses provided in the sections below was based on data sources above.

16.5.1 Population

Population estimates within the wildfire hazard potential areas are shown in Table 16-4.

TABLE 16-4.
POPULATION WITHIN WILDFIRE RISK AREAS

Jurisdiction	Non-Burnable*	Very Low	Low	Moderate	High	Very High	**Total**
Unincorporated Area	2,132	7,146	336	43	26	0	**9,683**
City of Bay City	12,652	4,904	48	0	0	0	**17,604**
City of Palacios	3,112	1,496	0	0	0	0	**4,608**
Matagorda County Total	**17,896**	**13,546**	**384**	**43**	**26**	**0**	**31,895**

* Non-Burnable classification includes developed lands, non-burnable agricultural fields, perennial snow or ice, bare ground, and permanent water areas

16.5.2 Property

Property damage from wildfires can be severe and can significantly alter entire communities. Table 16-5 through Table 16-9 display the number of structures in the various wildfire hazard zones within the planning area and their values. For all tables, property data are from the HAZUS 2014 data inventory (updated with 2010 U.S. Census Data and 2014 RS Means Square Foot Costs).

TABLE 16-5.
EXPOSURE AND VALUE OF STRUCTURES IN VERY LOW WILDFIRE RISK AREAS

Jurisdiction	Exposed Buildings	Value Exposed ($)			% of Total Assessed Value
		Structure	Contents	Total	
Unincorporated Area	4,274	1,051,097,131	611,093,601	**1,662,190,732**	64.96
City of Bay City	1,475	429,553,424	254,816,908	**684,370,332**	25.83
City of Palacios	523	122,531,321	79,067,195	**201,598,515**	30.1%
Matagorda County Total	**6,272**	**1,603,181,876**	**944,977,703**	**2,548,159,579**	**43.35**

TABLE 16-6.
EXPOSURE AND VALUE OF STRUCTURES IN LOW WILDFIRE RISK AREAS

Jurisdiction	Exposed Buildings	Value Exposed ($)			% of Total Assessed Value
		Structure	Contents	Total	
Unincorporated Area	413	88,134,772	47,946,653	**136,081,425**	5.32
City of Bay City	15	3,380,457	2,212,202	**5,592,659**	0.21
City of Palacios	0	0	0	**0**	0.00
Matagorda County Total	**428**	**91,515,229**	**50,158,855**	**141,674,084**	**2.41**

TABLE 16-7.
EXPOSURE AND VALUE OF STRUCTURES IN MODERATE WILDFIRE RISK AREAS

Jurisdiction	Exposed Buildings	Value Exposed ($)			% of Total Assessed Value
		Structure	Contents	Total	
Unincorporated Area	78	15,536,996	8,105,779	23,642,775	0.92
City of Bay City	0	0	0	0	0.00
City of Palacios	0	0	0	0	0.00
Matagorda County Total	**78**	**15,536,996**	**8,105,779**	**23,642,775**	**0.40**

TABLE 16-8.
EXPOSURE AND VALUE OF STRUCTURES IN HIGH WILDFIRE RISK AREAS

Jurisdiction	Exposed Buildings	Value Exposed ($)			% of Total Assessed Value
		Structure	Contents	Total	
Unincorporated Area	38	7,348,012	3,725,010	11,073,022	0.43
City of Bay City	0	0	0	0	0.00
City of Palacios	0	0	0	0	0.00
Matagorda County Total	**38**	**7,348,012**	**3,725,010**	**11,073,022**	**0.19**

TABLE 16-9.
EXPOSURE AND VALUE OF STRUCTURES IN VERY HIGH WILDFIRE RISK AREAS

Jurisdiction	Exposed Buildings	Value Exposed ($)			% of Total Assessed Value
		Structure	Contents	Total	
Unincorporated Area	1	14,779	7,421	22,200	**<0.01**
City of Bay City	0	0	0	0	**0.00**
City of Palacios	0	0	0	0	**0.00**
Matagorda County Total	**1**	**14,779**	**7,421**	**22,200**	**<0.01**

Present Land Use

Present land use for each wildfire risk area is described in Table 16-10.

**TABLE 16-10.
WILDFIRE RISK AREAS IN PRESENT LAND COVERAGE FOR MATAGORDA COUNTY**

	Wildfire Risk Class & Area (acres)				
Present Land Cover Class	Very Low	Low	Moderate	High	Very High
Barren Land (Rock/Sand/Clay)	2,252	508	190	4	0
Deciduous Forest	23,943	924	32	28	0
Developed Land	20,444	680	70	27	0
Evergreen Forest	16,100	581	8	6	0
Grassland	311,725	6,832	439	425	18
Marshland	99,624	25,235	5,375	1,079	0
Mixed Forest	14,205	492	30	8	0
Open Water	3,926	808	332	26	0

16.5.3 Critical Facilities and Infrastructure

Table 16-11 identifies critical facilities exposed to the wildfire hazard in the county.

**TABLE 16-11.
CRITICAL FACILITIES AND INFRASTRUCTURE PER WILDFIRE RISK CLASS**

	Critical Facilities and Infrastructure per Wildfire Risk Class				
	Very Low	Low	Moderate	High	Very High
Medical and Health	0	0	0	0	0
Government Functions	1	0	0	0	0
Protective Functions	1	0	0	0	0
Schools	5	1	0	0	0
Hazardous Materials	9	0	0	0	0
Bridges	87	6	0	0	0
Wastewater	6	0	0	0	0
Power	4	1	0	0	0

TABLE 16-11.
CRITICAL FACILITIES AND INFRASTRUCTURE PER WILDFIRE RISK CLASS

	Critical Facilities and Infrastructure per Wildfire Risk Class				
	Very Low	Low	Moderate	High	Very High
Communications	3	1	0	0	0
Transportation	4	1	0	0	0
Water Storage	1	0	0	0	0
Dams	9	0	0	0	0

16.5.4 Environment

Fire is a natural and critical ecosystem process in most terrestrial ecosystems, dictating in part the types, structure, and spatial extent of native vegetation. However, wildfires can cause severe environmental impacts:

- **Soil Erosion** – The protective covering provided by foliage and dead organic matter is removed, leaving the soil fully exposed to wind and water erosion. Accelerated soil erosion occurs, causing landslides and threatening aquatic habitats.
- **Spread of Invasive Plant Species** – Non-native woody plant species frequently invade burned areas. When weeds become established, they can dominate the plant cover over broad landscapes, and become difficult and costly to control.
- **Disease and Insect Infestations** – Unless diseased or insect-infested trees are swiftly removed, infestations and disease can spread to healthy forests and private lands. Timely active management actions are needed to remove diseased or infested trees.
- **Destroyed Endangered Species Habitat** – Catastrophic fires can have devastating consequences for endangered species.
- **Soil Sterilization** – Topsoil exposed to extreme heat can become water repellant, and soil nutrients may be lost. It can take decades or even centuries for ecosystems to recover from a fire. Some fires burn so hot that they can sterilize the soil.

Many ecosystems are adapted to historical patterns of fire occurrence. These patterns, called “fire regimes,” include temporal attributes (e.g., frequency and seasonality), spatial attributes (e.g., size and spatial complexity), and magnitude attributes (e.g., intensity and severity), each of which have ranges of natural variability. Ecosystem stability is threatened when any of the attributes for a given fire regime diverge from its range of natural variability.

16.6 VULNERABILITY

Structures, aboveground infrastructure, critical facilities, agricultural area (crops and structures), and natural environments are all vulnerable to the wildfire hazard. There is currently no validated damage function available to support wildfire mitigation planning. Except as discussed in this section, vulnerable populations, property, infrastructure, and environment are assumed to be the same as described in the section on exposure.

16.6.1 Population

Smoke and air pollution from wildfires can be a severe health hazard, especially for sensitive populations, including children, the elderly, and those with respiratory and cardiovascular diseases. Smoke generated by wildfire consists of visible and invisible emissions that contain particulate matter (soot, tar, water vapor, and minerals), gases (carbon monoxide, carbon dioxide, nitrogen oxides), and toxics (formaldehyde, benzene). Emissions from wildfires depend on the type of fuel, the moisture content of the fuel, the efficiency (or temperature) of combustion, and the weather. Public health impacts associated with wildfire include difficulty in breathing, odor, and reduction in visibility.

Wildfire may also threaten the health and safety of those fighting the fires. First responders are exposed to the dangers from the initial incident and after-effects from smoke inhalation and heat stroke.

The increasing demand for outdoor recreation places more people outside and in higher wildfire risk areas during holidays, weekends, and vacation periods. Table 16-4 contains more detailed information.

16.6.2 Property

Loss estimations for wildfire hazard are not based on damage functions, because no such damage functions have been generated. Instead, loss estimates were developed representing projected damages (annualized loss) on historical events, statistical analysis and probability factors. These were applied to the exposed values of the county and communities to create an annualized loss. Table 16-12 lists the loss estimates for the general building stock for jurisdictions that have an exposure to a wildfire risk category.

Community Perception of Vulnerability

See front page of current chapter for a summary of hazard rankings for Matagorda County and participating communities in this HMP update. Chapter 19 gives a detailed description of this rankings and Chapter 20 addresses mitigations actions for this hazard vulnerability.

TABLE 16-12.
LOSS ESTIMATES FOR WILDFIRE EVENTS

Jurisdiction	Exposed Value	Annualized Loss	Annualized Loss Percentage
Unincorporated Area	$7,402,969	Negligible	<0.01
City of Bay City	$2,015,985	Negligible	<0.01
City of Palacios	$43,654,412	Negligible	<0.01
Matagorda County Total	**$53,073,366**	**Negligible**	**<0.01**

16.6.3 Critical Facilities and Infrastructure

Critical facilities of wood frame construction are especially vulnerable during wildfire events. In the event of wildfire, there would likely be little damage to most infrastructure. Most roads and railroads would be without damage except in the worst scenarios. Power lines are the most at risk from wildfire because most poles are made of wood and susceptible to burning. Fires can create conditions that block or prevent access and can isolate residents and emergency service providers. Wildfire typically does not have a major direct impact on bridges, but it can create conditions in which bridges are obstructed. Many bridges in areas of high to moderate fire risk are important because they provide the only ingress and egress to large areas and in some cases to isolated neighborhoods.

16.6.4 Environment

Environmental vulnerability will typically be the same as exposure (as discussed in Section 16.5).

16.7 FUTURE TRENDS IN DEVELOPMENT

The threat of wildfire is a constant in Texas. From the East Texas Piney Woods to the Davis Mountains of West Texas, wildfires burn thousands, if not millions, of acres each year. Wildfires become especially dangerous when wildland vegetation begins to intermix with homes.

With more and more people living in the WUI, it is increasingly important for local officials to plan and prepare for wildfires. CWPPs are a proven strategy for reducing the risk of catastrophic wildfires and protecting lives and property.

TFS encourages Texas counties and communities to develop and adopt CWPPs to better prepare their region and citizens for wildfires. Planning for wildfires should take place long before a community is threatened. Once a wildfire ignites, the only option available to firefighters is to attempt to suppress the fire before it reaches a community. A CWPP is unique in that it empowers communities to share the responsibility of determining the best strategies for protection against wildfire.

The Texas CWPP calls for communities to:

- Know their environment (WUI), assets at risk, fire occurrence and behavior, and overall wildfire risks
- Adopt mitigation strategies from wildfire preventions to fuels reduction to capacity building
- Create and adopt recovery plan strategies

16.8 SCENARIO

A major conflagration in the planning area might begin with a wet spring, adding to fuels already present on the forest floor. Flash fuels would build throughout the spring. The summer could see the onset of insect infestation. A dry summer could follow the wet spring, exacerbated by dry hot winds. Carelessness with combustible materials or a tossed lit cigarette, or a sudden lightning storm could trigger a multitude of small isolated fires.

The embers from these smaller fires could be carried miles by hot, dry winds. The deposition zone for these embers would be deep in the forests and interface zones. Fires that start in flat areas move slower, but wind still pushes them. It is not unusual for a wildfire pushed by wind to burn the ground fuel and later climb into the crown and reverse its track. This is one of many ways that fires can escape containment, typically during periods when response capabilities are overwhelmed. These new small fires would most likely merge. Suppression resources would be redirected from protecting the natural resources to saving more remote subdivisions.

The worst-case scenario would include an active fire season throughout Texas, spreading resources thin. Firefighting teams would be exhausted or unavailable. Many federal assets would be responding to other fires that started earlier in the season. While local fire districts would be extremely useful in the urban interface areas, they have limited wildfire capabilities or experience, and they would have a difficult time responding to the ignition zones. Even though the existence and spread of the fire is known, it may not be possible to respond to it adequately, so an initially manageable fire can become out of control before resources are dispatched.

To further complicate the problem, heavy rains could follow, causing flooding and landslides, and releasing tons of sediment into the Colorado River, Tres Palacios River, and other creeks. This in turn could permanently change floodplains and damage sensitive habitat and riparian areas. Such a fire followed by rain could release millions of cubic yards of sediment into streams for years, creating new floodplains and changing existing ones. With the forests removed from the watershed, stream flows could easily double. Floods that could be expected every 50 years may occur every couple of years. With the streambeds unable to carry the increased discharge because of increased sediment, the floodplains and floodplain elevations would increase.

16.9 ISSUES

The major issues for wildfire are the following:

- Public education and outreach to people living in or near the fire hazard zones should include information about and assistance with mitigation activities such as defensible space, and advance identification of evacuation routes and safe zones.
- Wildfires could cause landslides as a secondary natural hazard.
- Climate change could affect the wildfire hazard.
- Future growth into interface areas should continue to be managed.
- Area fire districts need to continue to train on WUI events.
- Vegetation management activities should be enhanced.
- Regional consistency of higher building code standards such as residential sprinkler requirements and prohibitive combustible roof standards.
- Fire department water supply in high risk wildfire areas.
- Expand certifications and qualifications for fire department personnel. Ensure that all firefighters are trained in basic wildfire behavior, basic fire weather, and that all company officers and chief level officers are trained in the wildland command and strike team leader level.
- Both the natural and man-made conditions that contribute to the wildland fire hazard are tending to exacerbate through time.
- Conservative forestry management practices have resulted in congested forests prone to fire and disease.
- The continued migration of inhabitants to remote areas of the county increases the probability of human-caused ignitions from vehicles, grills, campfires, and electrical devices.

CHAPTER 17.
WINTER WEATHER

WINTER WEATHER RANKING	
Matagorda County	Medium
City of Bay City	Low
City of Palacios	Low

DEFINITIONS

Freezing Rain — The result of rain occurring when the temperature is below the freezing point. The rain freezes on impact, resulting in a layer of glaze ice up to an inch thick. In a severe ice storm, an evergreen tree 60 feet high and 30 feet wide can be burdened with up to 6 tons of ice, creating a threat to power and telephone lines and transportation routes.

Severe Local Storm — Small-scale atmospheric systems, including tornadoes, thunderstorms, windstorms, ice storms, and snowstorms. These storms may cause a great deal of destruction and even death, but their impact is generally confined to a small area. Typical impacts are on transportation infrastructure and utilities.

Winter Storm — A storm having significant snowfall, ice, or freezing rain; the quantity of precipitation varies by elevation.

17.1 GENERAL BACKGROUND

Winter storms can include heavy snow, ice, and blizzard conditions. Heavy snow can immobilize a region, stranding commuters, stopping the flow of supplies, and disrupting emergency and medical services. Accumulations of snow can collapse roofs and knock down trees and power lines. In rural areas, homes and farms may be isolated for days, and unprotected livestock may be lost. The cost of snow removal, damage repair, and business losses can have a tremendous impact on cities and towns.

Heavy accumulations of ice can bring down trees, electrical wires, telephone poles and lines, and communication towers. Communications and power can be disrupted for days until damage can be repaired. Even small accumulations of ice may cause extreme hazards to motorists and pedestrians.

Some winter storms are accompanied by strong winds, creating blizzard conditions with blinding wind-driven snow, severe drifting, and dangerous wind chills. Strong winds with these intense storms and cold fronts can knock down trees, utility poles, and power lines. Blowing snow can reduce visibilities to only a few feet in areas where there are no trees or buildings. Serious vehicle accidents can result in injuries and deaths.

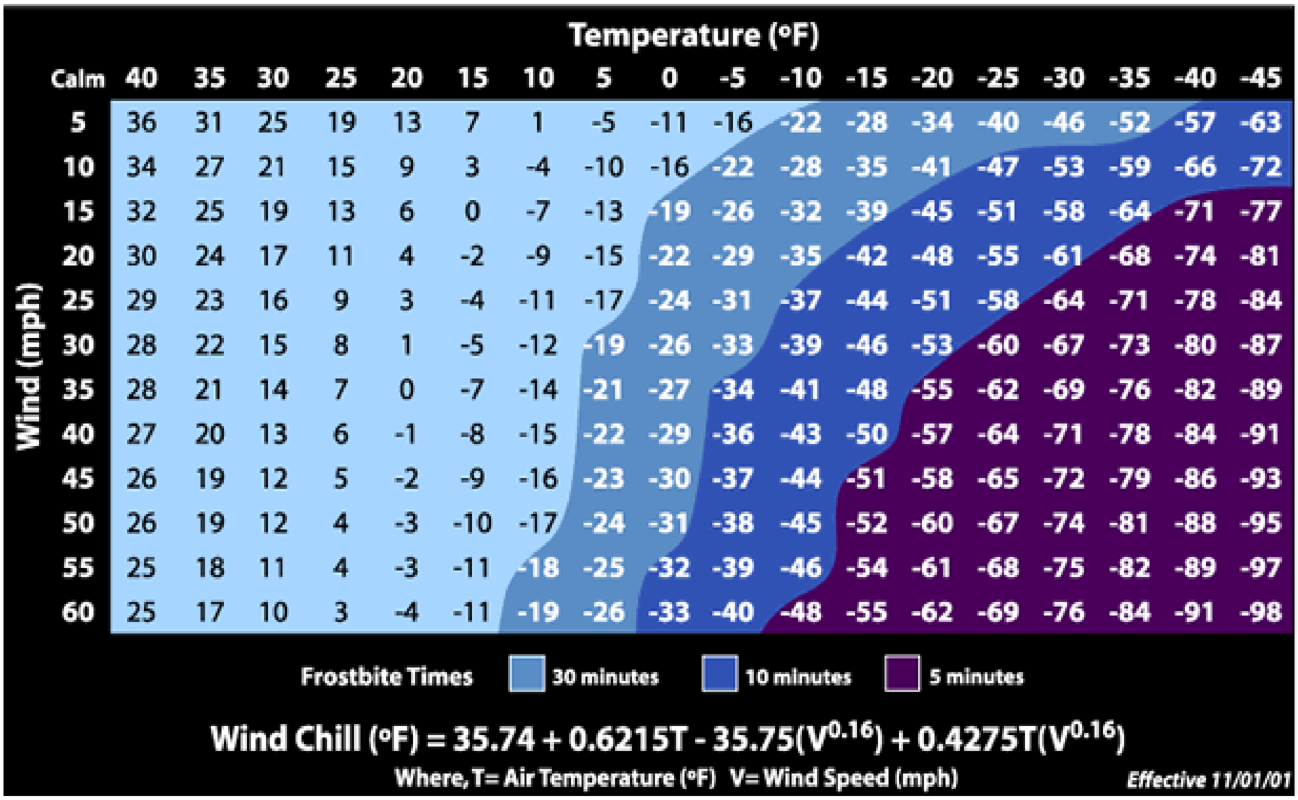
Winter storms in Matagorda County, including strong winds and ice conditions, can result in property damage, localized power and phone outages and closures of streets, highways, schools, businesses, and nonessential government operations. People can also become isolated from essential services in their homes and vehicles. A winter storm can escalate, creating life threatening situations when emergency response is limited by severe winter conditions. Other issues associated with severe winter weather include hypothermia and the threat of physical overexertion that may lead to heart attacks or strokes. Snow and ice prevention as well as removal costs can impact budgets significantly.

17.1.1 Extreme Cold

Extreme cold often accompanies a winter storm or is left in its wake. It is most likely to occur in the winter months of December, January, and February. Prolonged exposure to the cold can cause frostbite or hypothermia and can become life-threatening. Infants and the elderly are most susceptible. Pipes may freeze and burst in homes or buildings that are poorly insulated or without heat. Extreme cold can disrupt or impair communications facilities.

In 2001, the NWS implemented an updated wind chill temperature index (see Figure 17-1). This index describes the relative discomfort or danger resulting from the combination of wind and temperature. Wind chill is based on the rate of heat loss from exposed skin caused by wind and cold. As the wind increases, it draws heat from the body, driving down skin temperature and eventually the internal body temperature.

Source: NOAA, NWS



Temperature (°F)

Wind (mph) / Calm	40	35	30	25	20	15	10	5	0	-5	-10	-15	-20	-25	-30	-35	-40	-45
5	36	31	25	19	13	7	1	-5	-11	-16	-22	-28	-34	-40	-46	-52	-57	-63
10	34	27	21	15	9	3	-4	-10	-16	-22	-28	-35	-41	-47	-53	-59	-66	-72
15	32	25	19	13	6	0	-7	-13	-19	-26	-32	-39	-45	-51	-58	-64	-71	-77
20	30	24	17	11	4	-2	-9	-15	-22	-29	-35	-42	-48	-55	-61	-68	-74	-81
25	29	23	16	9	3	-4	-11	-17	-24	-31	-37	-44	-51	-58	-64	-71	-78	-84
30	28	22	15	8	1	-5	-12	-19	-26	-33	-39	-46	-53	-60	-67	-73	-80	-87
35	28	21	14	7	0	-7	-14	-21	-27	-34	-41	-48	-55	-62	-69	-76	-82	-89
40	27	20	13	6	-1	-8	-15	-22	-29	-36	-43	-50	-57	-64	-71	-78	-84	-91
45	26	19	12	5	-2	-9	-16	-23	-30	-37	-44	-51	-58	-65	-72	-79	-86	-93
50	26	19	12	4	-3	-10	-17	-24	-31	-38	-45	-52	-60	-67	-74	-81	-88	-95
55	25	18	11	4	-3	-11	-18	-25	-32	-39	-46	-54	-61	-68	-75	-82	-89	-97
60	25	17	10	3	-4	-11	-19	-26	-33	-40	-48	-55	-62	-69	-76	-84	-91	-98

Frostbite Times: 30 minutes, 10 minutes, 5 minutes

$$\text{Wind Chill (°F)} = 35.74 + 0.6215T - 35.75(V^{0.16}) + 0.4275T(V^{0.16})$$

Where, T = Air Temperature (°F) V = Wind Speed (mph)

Effective 11/01/01

Figure 17-1. National Weather Service Wind Chill Chart

A wind chill watch is issued by the NWS when wind chill warning criteria are possible in the next 12 to 36 hours. A wind chill warning is issued for wind chills of at least -25°F on plains and -35°F in mountains and foothills.

Table 17-1 contains a summary of temperature data related to extreme cold for the station. These temperatures apply to all of Matagorda County and participating communities.

TABLE 17-1.
TEMPERATURE DATA FROM CITY OF MATAGORDA STATION

Statistic	Years	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec
High Annual Minimum	1928-2014	40	40	47	58	64	73	77	75	72	57	48	42
Low Annual Minimum	1928-2014	11	13	23	35	44	55	61	55	45	32	26	9
Average Annual Minimum	1915-2014	27.2	31.2	35.8	44.7	56.5	66.3	71.3	69.8	59.5	46.9	35.8	29.9

TABLE 17-1.
TEMPERATURE DATA FROM CITY OF MATAGORDA STATION

Statistic	Years	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec
Average Days Annually with Minimum Below 32	1910-2012	3.1	1.4	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	1.8
All temperatures are in degrees Fahrenheit.													

Few areas of Texas escape freezing weather in any winter. Matagorda County and the participating communities receives little to no snow accumulations. More often than not, snow falling in the southern half of the state melts and does not stick to the surface; snow stays on the ground only once or twice every decade. Snowfall occurs at least once every winter in the northern half of Texas.

17.2 HAZARD PROFILE

17.2.1 Past Events

The National Climatic Data Center lists 4 winter weather events that impacted Matagorda County and the participating communities between 1996 and 2014. These events and estimated damage costs are outlined in Table 17-2. Matagorda County and the participating communities do not experience severe winter weather events consistently, but winter storms can affect HMP update area..

TABLE 17-2.
HISTORIC WINTER WEATHER EVENTS IN MATAGORDA COUNTY AND PARTICIPATING COMMUNITIES (1996-2014)

Location	Date	Event Type	Estimated Damage Cost			
			Property	Crops	Injuries	Deaths
Matagorda County	01/12/1997	Ice Storm	$0	$0	0	3
Matagorda County	12/24/2004	Heavy Snow	$0	$0	0	0
Matagorda County	12/04/2009	Winter Storm	$0	$0	0	0
Matagorda County	02/03/2011	Ice Storm	$0	$0	0	0
Source: http://www.ncdc.noaa.gov/						

17.2.2 Location

Matagorda County and the participating communities are susceptible to severe winter storms; although severe winter weather or blizzard conditions are primarily in the form of freezing rain, sleet, or ice. Ice accumulation becomes a hazard by creating dangerous travel conditions. State Highways 35, 60, and 71 are important corridors to move people, supplies, and equipment into the region and to reach medical facilities outside of the counties. An accident on these roads can cause a major disruption in the flow of goods and services to the area.

The record lows for Texas occur during October through March. According to data recorded by NWS between 1897 and 2014, the planning area experiences an average of 10 freezing days. The average first freeze in HMP update area usually occurs late November to early December and the last freeze occurs in late February to early March. In January 1940, Matagorda County and the participating communities experienced the coldest month on record with mean temperature of about 42.6°F. The coldest recorded winter for the area was in 1979, with a mean temperature of about 46.2°F. Figure 6-4 shows the annual average minimum temperature distribution in Texas.

17.2.3 Frequency

Table 17-2 lists 4 winter storms from 1996 to 2014. Therefore, on average a winter storm occurs in the county and participating communities once every 4 to 5 years. In this region, the first autumn freeze ordinarily occurs in mid-December, and the last freeze in spring takes place in mid-February. There is an average of 10 to 15 days of freezes in south Texas. Since winter events are usually zonal events and affect a large area, each participating community has the same frequency and probability of future events (once every 4 to 5 years). Future events size and strength is expected to be in line with previous events as listed in Table 17-2 and Table 17-1 for all participating communities.

17.2.4 Severity

The magnitude and severity of severe winter weather in Matagorda County and the participating communities is low, resulting in minor injuries and illnesses; minimal property damage that does not severely threaten structural stability; or interruption of essential facilities and services for less than 48 hours.

17.2.5 Warning Time

Meteorologists can often predict the likelihood of a severe winter storm. When forecasts are available, they can give several days of warning time. However, meteorologists cannot predict the exact time of onset or severity of the storm. Some storms may come on more quickly and have only a few hours of warning time.

17.3 SECONDARY HAZARDS

The most significant secondary hazards associated with severe local storms are falling and downed trees, landslides, and downed power lines. Heavy rain and icy conditions can overwhelm both natural and man-made drainage systems, causing overflow and property destruction. Landslides occur when the soil on slopes becomes oversaturated and fails. Additionally, the storms may result in closed highways and blocked roads. It is not unusual for motorists and residents to become stranded. Annually, icy conditions and frozen pipes cause damage to residences and businesses. Late season winter events will typically cause some plant and crop damage.

17.4 CLIMATE CHANGE IMPACTS

Climate change presents a significant challenge for risk management associated with severe weather. The frequency of severe weather events has increased steadily over the last century. Nationally, the number of weather-related disasters during the 1990s was four times that of the 1950s, and cost 14 times as much in economic losses. Historical data shows that the probability for severe weather events increases in a warmer climate (see Figure 14-13). The changing hydrograph caused by climate change could have a significant impact on the intensity, duration and frequency of storm events. All of these impacts could have significant economic consequences.

17.5 EXPOSURE

Because winter weather cannot be directly modeled in HAZUS, annualized losses were estimated using GIS-based analysis, historical data analysis, and statistical risk assessment methodology. Event frequency, severity indicators, expert opinions, and historical knowledge of the region were used for this assessment. The primary data source was the updated HAZUS inventory data (updated with 2010 U.S. Census Data and

2014 RS Means Square Foot Costs) augmented with state and federal data sets as well as the NOAA National Climatic Data Center Storm Event Database. .

17.5.1 Population

Although the entire population within the planning area could be affected, certain areas are more exposed due to geographic location and local weather patterns.

17.5.2 Property

According to the Matagorda County HAZUS 2.2 inventory data (updated with 2010 U.S. Census Data and 2014 RS Means Square Foot Costs), there are 16,635 buildings within the census blocks that define the planning area with an asset replaceable value of over $4 million (excluding contents). About 98.5% of these buildings (and 83.4% of the building value) are associated with residential housing. Within the participating communities in the HMP update area, there are an estimated 14,544 buildings (residential, commercial, and other) with a total asset inventory (excluding contents) value of over $3.6 million. Other types of buildings in this report include agricultural, education, religious, and governmental structures. See hazard loss tables for community-specific total assessed numbers (e.g. Table 15-6). Table 17-3 lists the exposed structures and population for the participating communities. Although the entire population within the planning area could be affected, certain areas are more exposed due to geographic location and local weather patterns.

Residents within a city or municipality are governed by building codes and ordinances. Buildings and land in unincorporated areas of the county are not governed by building codes. Because of the less stringent regulations, all of these buildings are considered to be exposed to severe winter weather, but structures in poor condition or in particularly vulnerable locations (located on hilltops or exposed open areas) may risk the most damage. The frequency and degree of damage to a building will depend on specific locations.

TABLE 17-3
EXPOSED STRUCTURES AND POPULATION

Jurisdiction	Residential	Commercial	Other *	**Total Structures**	**Total Population**
Unincorporated Area	5,744	121	35	5,900	17,631
City of Bay City	1,785	17	10	1,812	4,718
City of Palacios	6,787	29	16	6,832	10,028
Matagorda County Total	14,316	167	61	14,544	32,377

*Other includes industrial, agricultural, religious, governmental, and educational classifications.

17.5.3 Critical Facilities and Infrastructure

All critical facilities are likely exposed to winter weather events. The most common problems associated with this hazard are utility losses. Downed power lines can cause blackouts, leaving large areas isolated. Phone, water, and sewer systems may not function. Roads may become impassable due to ice or snow. Ice accumulation on roadways can create dangerous driving conditions. There are several county roads that are available to move people and supplies throughout the region.

17.5.4 Environment

The environment is highly exposed to severe weather events. Natural habitats such as streams and trees risk major damage and destruction. Flooding events caused by snowmelt can produce river channel migration or damage riparian habitat.

17.6 VULNERABILITY

Although winter storm is a slow onset hazard with generally six to twelve hours of warning time, utility disruptions from winter storms can severely impact the delivery of services. Water pipes can freeze and crack in sub-freezing temperatures. Ice can build up on power lines and cause them to break under the weight or ice on trees can cause tree limbs to fall on the lines. These events can disrupt electric service for long periods.

Economic impact may be felt by increased consumption of heating fuel which can lead to energy shortages and higher prices. House fires and resulting deaths tend to occur more frequently from increased and improper use of alternate heating sources. Fires during winter storms also present a greater danger because water supplies may freeze and impede firefighting efforts.

Certain properties and population are more exposed due to geographic location and local weather patterns. People and animals are subject to health risks from extended exposure to cold air. Elderly people and economically disadvantaged populations in the planning area are at greater risk of death from hypothermia during these events. According to the U.S. Center for Disease Control, every year hypothermia kills about 600 Americans, half of whom are 65 years of age or older.

17.6.1 Population

Vulnerable populations are the elderly, low income, linguistically isolated populations, people with life-threatening illnesses, and residents living in areas that are isolated from major roads. Power outages can be life threatening to those dependent on electricity for life support. Isolation of these populations is a significant concern. These populations face isolation and exposure during severe winter weather events and could suffer more secondary effects of the hazard. Commuters who are caught in storms may be particularly vulnerable. Stranded commuters may be vulnerable to carbon monoxide poisoning or hypothermia. Additionally, individuals engaged in outdoor recreation during a severe winter event may be difficult to locate and rescue. Table 17-3 and Table 17-4 contain more specific jurisdictional information.

TABLE 17-4
MOST VULNERABLE POPULATION

Jurisdiction	Youth Population (< 16)	% of Total Population	Elderly Population (> 65)	% of Total Population	Economically Disadvantage (Income < $20,000)	% of Total Population
Unincorporated Area	4,912	27.86	2,146	12.17	1,749	9.92
City of Bay City	1,441	30.54	623	13.20	549	11.64
City of Palacios	2,192	21.86	1,829	18.24	527	5.26

Matagorda County Total	8,545	26.39	4,598	14.20	2,825	8.73

17.6.2 Property

All property is vulnerable during severe winter weather events, but properties in poor condition or in particularly vulnerable locations may risk the most damage. Those that are located under or near overhead lines or near large trees may be vulnerable to falling ice or may be damaged in the event of a collapse.

Loss estimations for severe winter weather are not based on damage functions, because no such damage functions have been generated. Instead, loss estimates were developed representing projected damages (annualized loss) on historical events, statistical analysis, and probability factors. These were applied to the participating communities reported event damages and exposed values to create an annualized loss. The annualized loss estimated for winter storm events is shown in Table 17-5.

TABLE 17-5.
LOSS ESTIMATES FOR WINTER STORM EVENTS

	Exposed Value	Annualized Loss	Annualized Loss Percentage
Unincorporated Area	$2,558,729,176	Negligible	<0.01
City of Bay City	$2,649,736,203	Negligible	<0.01
City of Palacios	$669,865,421	Negligible	<0.01
Matagorda County Total	**$5,878,330,801**	Negligible	**0.02**

Vulnerability Narrative

Each communities vulnerability to winter weather events are described below.

- **City of Bay City -** Winter storms in the City of Bay City would expose the residents to high utility bills, affecting especially those who are economically disadvantaged. Roads become dangerous to travel on because of icy conditions. This can lead to schools and businesses being shut down for a day or two. Homes built without proper building codes could suffer from a lack of insulation and may experience deteriorating infrastructure, physical harm and property damage.
- **City of Palacios** – The City of Palacios is rated “Low” as the probability of a winter weather occurrence is minimal, local knowledge, and few historical events (none listed on Table 17-2).
- **Matagorda County (Unincorporated Area) -** Matagorda County Unincorporated Areas are at a greater risk of rolling blackouts during a winter weather event due to high usage from other areas of the electrical grid. The more rural areas of the HMP update area could experience longer wait times for emergency response actions. This could expose them to hazards such as prolonged periods of cold without heating. Also, this would have a greater effect on the young, elderly and economically disadvantaged that may not have the means to respond to such an event. Residents unaware of the hazards associated with extreme winter weather are more vulnerable to its effects. Winter weather can impact critical facility structures negatively impacting residents. Facilities that are not equipped with alternate sources of power supply in the event of an outage, such as generators, increase these risks.

Community Perception of Vulnerability

See front page of current chapter for a summary of hazard rankings for Matagorda County and participating communities in this HMP update. Chapter 19 gives a detailed description of this rankings and Chapter 20 addresses mitigations actions for this hazard vulnerability.

17.6.3 Critical Facilities and Infrastructure

Incapacity and loss of roads are the primary transportation failures resulting from winter weather, mostly associated with secondary hazards. Snowstorms can significantly impact the transportation system and the availability of public safety services. Of particular concern are roads providing access to isolated areas and to the elderly. Prolonged obstruction of major routes can disrupt the shipment of goods and other commerce. Large, prolonged storms can have negative economic impacts for an entire region.

Severe windstorms, downed trees, and ice can create serious impacts on power and above-ground communication lines. Freezing of power and communication lines can cause them to break, disrupting electricity and communication. Loss of electricity and phone connection would leave certain populations isolated because residents would be unable to call for assistance.

17.6.4 Environment

The vulnerability of the environment to winter weather is the same as the exposure, discussed in Section 17.5.4.

17.7 FUTURE TRENDS IN DEVELOPMENT

All future development will be affected by winter storms. The vulnerability of community assets to severe winter storms is increasing through time as more people enter the planning area. The ability to withstand impacts lies in sound land use practices and consistent enforcement of codes and regulations for new construction. The planning partners have adopted the International Building Code. This code is equipped to deal with the impacts of severe weather events. Land use policies identified in general plans within the planning area also address many of the secondary impacts (flood and landslide) of the severe weather hazard. With these tools, the planning partnership is well equipped to deal with future growth and the associated impacts of severe weather.

17.8 SCENARIO

Although severe local storms are infrequent, impacts can be significant, particularly when secondary hazards, such as flood or erosion occur. A worst-case event would involve prolonged high winds during a winter storm accompanied by thunderstorms. Such an event would have both short-term and longer-term effects. Initially, schools and roads would be closed due to power outages caused by high winds and downed tree obstructions. In more rural areas, some subdivisions could experience limited ingress and egress. Prolonged rain could produce flooding, overtopped culverts with ponded water on roads, and erosion on steep slopes. Flooding and landslides could further obstruct roads and bridges, further isolating residents.

17.9 ISSUES

Important issues associated with a winter storm in the planning area include the following:

- Older building stock in the planning area is built to low code standards or none at all. These structures could be highly vulnerable to winter weather, particularly freezing temperatures, high winds, and ice.
- Redundancy of power supply must be evaluated.
- The capacity for backup power generation is limited.

- Future efforts should be made to identify populations at risk and determine special needs during winter storm event

CHAPTER 18.COASTAL EROSION

COASTAL EROSION RANKING	
Jurisdiction	**Coastal Erosion**
Matagorda County	High
City of Bay City	No Exposure
City of Palacios	Low

DEFINITIONS

Ground Subsidence — Ground subsidence is the sinking of land over human-caused or natural underground voids and the settlement of native low density soils.

Soil Erosion — Soil erosion is the removal and simultaneous transportation of earth materials from one location to another by water, wind, waves, or moving ice.

Deposition — Deposition is the placing of eroded material in a new location.

18.1 GENERAL BACKGROUND

The General Land Office (GLO) of Texas defines coastal erosion as "the loss of shoreline, beach and/or dune sediments and is caused by the lack of sediment delivered to the coast to balance the impacts ranging from man-made actions such as the damming of rivers, land subsidence from groundwater withdrawal, construction of seawalls, groins and jetties, diversion of rivers and streams, fast-moving motor craft and ship-generated wakes and many other factors to natural processes such as wave action from storms, tidal surges, wind, and loss of wetlands."

The Texas Coastline stretches approximately 367 miles along the Gulf of Mexico. This coastline will lose, on average, 2.3 feet per year of beaches due to coastal erosion. Furthermore, according to the GLO, 64% of the Texas coast is eroding at a higher rate of approximately 6 feet per year, with some locations losing over 30 feet per year. The specific erosion rates for the Texas Coast are shown in Figure 18-1. This figure shows the shoreline change rates due to erosion in feet per year from 1950 to 2012.

Figure 18-1. Coastal Change/Erosion Rates for the Texas Coast

18.2 HAZARD PROFILE

18.2.1 Past Events

Coastal erosion is a problem along the Texas Coast. Matagorda County is a coastal county on the Texas Gulf Coast and is exposed to coastal shoreline erosion, as is the City of Palacios. Inland communities, such as the City of Bay City, are not directly affected by coastal erosion.

Texas has a variety of shoreline types along its coastal bays and open Gulf of Mexico Coast that are constantly shifting and mostly retreating landward. This retreat results in loss of private and public property and important natural habitats, such as beaches, dunes, and marshes. To address this problem, the Texas Legislature passed the Coastal Erosion Planning and Response Act in 1999. This act authorized the Texas General Land Office (GLO) to conduct a coastal erosion response program. In support of the program, coastal researchers are identifying and studying eroding areas along the Gulf of Mexico and coastal bay shorelines of Texas, quantifying data gleaned from research and creating a comprehensive, digital database of historical shoreline positions and average annual rates of shoreline change. These data are being made available to the public through the internet. Figure 18-2 shows the Texas Bureau of Economic Geology Storm Susceptibility Index (SSI) Map for the Texas Coast which indicates susceptibility to storm flooding, and erosion resistance, and recoverability. SSI indicates the predicted protection level from storms at recurrence intervals of 1 to 200 years.

Figure 18-2. Storm Susceptibility Index for the Texas Coast

18.2.2 Location

Coastal Erosion

Coastal erosion is located primarily along the Texas Coast (Gulf of Mexico). Coastal erosion issues will affect both the Gulf and Bay side of barrier islands along the coast. Matagorda County unincorporated area (including Matagorda Peninsula, Island, and ship channel) and the City of Palacios are affected by coastal shoreline erosion because of its coastal geography. Inland areas, including parts of the unincorporated area and the City of Bay City are not exposed, vulnerable, or effected by coastal erosion. Natural and human activities also cause seasonal soil erosion and deposition throughout the county. Figure 18-1 and Figure 18-2 show the location of coastal erosion along Matagorda County and participating communities.

Matagorda County Unincorporated area has approximately 61 miles of Gulf of Mexico shoreline and 403 miles of bay shoreline. The City of Palacios has approximately 8 miles of bay shoreline.

18.2.3 Frequency

According to the Texas General Land office and a study by the University of Texas at Austin's Bureau of Economic Geology (BEG) Coastal Studies Group, for Calhoun, Jackson, Matagorda and Victoria Counties, about 58 miles of the region's 97 miles of Gulf shoreline are critically eroding, most of it along the Matagorda Peninsula and Matagorda Island. As mentioned above, this region is home to the highest rate of erosion recorded along the Texas Gulf Coast – 46.2 feet a year along a 2.5-mile-long section of Matagorda Island just south of the Matagorda Ship Channel. The average coastal change of the entire studied Matagorda Coastline (Gulf of Mexico side) is 6.58 feet. This same average will be used for the bay side of Matagorda County coastline.

Future Probability

The Texas GLO and BEG Coastal Study, analyzing shoreline changes (as shown in Figure 18-1.) only assessed the Gulf of Mexico shoreline change rates. Bay side changes were not analyzed. The average rate of change according to the 2013 Hazard Mitigation Plan was 6 feet per year, for the majority of the state. This same average will be used for the bay side of Matagorda County coastline. Future trends of 6 feet per year (Bay side) to 46.2 feet (Matagorda Island and ship land) loss can be expected.

18.2.4 Severity

According to the Texas Coastwide Erosion Response Plan (2013 Update), coastal erosion remains a continuing threat to the Texas Gulf and bay shorelines. Whether the erosion is caused by the lack of sediments to balance the long-term losses within the coastal compartments, or the episodic erosion brought on by storms or human activities, planning and implementation of erosion response and sediment management practices is essential to the sustainability of the shoreline and public beaches.

The severity of coastal erosion soils are largely related to the extent and location of areas that are impacted. Such events can cause property damage as well as loss of life. Since the coastline is home to many residential and commercial property, as well as significant landscapes (such as wetlands) there is the potential for significant impact to people or property.

Structures exposed to erosion hazard areas may be undermined, resulting in damages. This may also result in the condemnation of a structure. Additionally, physical loss land area may occur as a result of erosion. This applies to coastal land and structures for the unincorporated area of the county and the City of Palacios. The City of Bay City is an inland community and is not effected by coastal erosion. Matagorda County Unincorporated area near the Matagorda Ship Channel and Matagorda Island is home to the highest rate of erosion recorded along the Texas Gulf Coast – 46.2 feet a year along a 2.5-mile-long section of Matagorda Island just south of the Matagorda Ship Channel. According to the State of Texas 2013 Hazard Mitigation Plan, Matagorda County has a total of 34 miles of critical erosion caused by coastal erosion.

18.2.5 Warning Time

Meteorologists can often predict the likelihood of weather events which can impact shoreline communities, and ultimately the shoreline. NOAA's National Weather Service monitors potential events, and provides forecasts and information, in advance of a storm through multiple means varying in system characteristics and time issued. The National Weather Service provides early notification through its Hazardous Weather Outlook, which is a narrative statement produced and issued on a routine basis, to provide information regarding the potential of significant weather expected during the next 1 to 5 days (NWS, 2009). Additionally, for nor'easters the National Weather Service issues Coastal Flood Advisories when minor flooding is possible; Coastal Flood Watches when flooding with significant impacts is possible; or Coastal Flood Warnings when flooding that will pose a serious threat to life and property is occurring, imminent or highly likely (NWS, 2009). For tropical, subtropical, or post-tropical systems the National Weather Service will issue a Hurricane or Tropical Storm Warning 36 hours in advance of the anticipated onset of tropical-storm-force winds or a Hurricane or Tropical Storm Watch 48 hours in advance of the anticipated onset of tropical-storm-force winds (NWS, 2013). The National Weather Service uses common terms like minor, moderate, major, and severe to categorize the severity of forecasted beach erosion in statements, advisories, watches, and warnings. Although commonly used, no formal definition exists within the National Weather Service Glossary for these descriptors. With shore structures and population increasing along the coastline, the shoreline becomes increasingly modified. Impact from weather incidents will continue to influence the Matagorda County and participating communities coastal areas, intensifying and exacerbating the situation.

18.3 SECONDARY HAZARDS

Windstorm events can blow beach and dune sand overland into adjacent low-lying marshes, upland habitats, inland bays, and communities. Flooding from extreme rainfall events can scour and erode dunes as inland floodwaters return through the dunes and beach face into the ocean. Shore protection structures such as seawalls and revetments often are built to attempt to stabilize the upland property. However, typically, they eliminate natural wave run-up and sand deposition processes and can increase reflected wave action and currents at the waterline. Increase wave action can cause localized scour in front of structures and prevent settlement of suspended sediment.

18.4 CLIMATE CHANGE IMPACTS

According to the Environmental Protection Agency, coastal shores change constantly due to wind, waves, tides, sea level fluctuation, seasonal and climatic variation, human alteration, and other factors that influence the movement of sand and material within a shoreline system. Climatic trends can change a beach from naturally accreting to eroding due to increased episodic erosion events caused by waves from an above-average number of storms and high tides, or the long-term effects of fluctuations in sea or lake level. The coastal zone is being severely impacted by erosion and flooding due in part to climate change and sea-level rise. It is likely that the impact will increase in the future as sea levels continue to rise at the current rate or rises at an accelerated rate. Impacts of climate change can lead to shoreline erosion, coastal flooding, and water pollution, affecting man-made coastal infrastructure and coastal ecosystems. Coastal areas may be impacted by climate change in different ways. Coastal areas are sensitive to sea level rise, changes in the frequency and intensity of storms, increase in precipitation, and warmer ocean temperatures. Additionally, oceans are absorbing more carbon dioxide, due to the rising atmospheric concentrations of the gas, and the oceans are becoming more acidic. This could have significant impacts on coastal and marine ecosystems

18.5 EXPOSURE

The coastal communities (including people, structures, economy, culture and property) are effected by coastal erosion, shoreline change, and sea-live rise. Healthy dunes, beaches and banks are vital to these communities as they serve as a natural buffer against hurricanes, tropical storms, and tropical depressions. Events such as those previously listed can cause shoreline erosion or accretion.

18.5.1 Population

It can be assumed that the coastal areas along the planning area are exposed to some extent to coastal erosion. Certain areas are more exposed due to geographic location and local weather patterns.

In the future, increasing population may result in costal erosion problems in metropolitan areas where damage from erosion will be great. These events may damage infrastructure and result in loss of life. Current growth trends could cause more county residents to be exposed to coastal erosion. Table 18-1 lists the exposed population.

18.5.2 Property

According to the Matagorda County HAZUS 2.2 inventory data (updated with 2010 U.S. Census Data and 2014 RS Means Square Foot Costs), there are 16,635 buildings within the census blocks that define the planning area with an asset replaceable value of over $4 million (excluding contents). About 98.5% of these buildings (and 83.4% of the building value) are associated with residential housing. Within the participating communities in the HMP update area, there are an estimated 14,544 buildings (residential, commercial, and other) with a total asset inventory (excluding contents) value of over $3.6 million. Other types of buildings in this report include agricultural, education, religious, and governmental structures.. See hazard loss tables for community-specific total assessed numbers (e.g. Table 18-2).

Structures and other improvements located in areas along the coast are most exposed to risk from this hazards. Additionally, deposition may result in damage to structures and property. Table 18-1 describes the vulnerable structures and population per participating community.

TABLE 18-1
EXPOSED STRUCTURES AND POPULATION

Jurisdiction	Residential	Commercial	Other *	**Total Structures**	**Total Population**
Unincorporated Area	3,001	5	1	**3,007**	**2,006**
City of Bay City	0	0	0	**0**	**0**
City of Palacios	1,389	9	7	**1,405**	**3,472**
Matagorda County Total	**4,390**	**14**	**8**	**4,412**	**5,478**

*Other includes industrial, agricultural, religious, governmental, and educational classifications.

18.5.3 Critical Facilities and Infrastructure

Any critical facilities or infrastructure that are located on or near the coast are exposed to risk from the hazard. Deposition may result in additional exposure. Critical Facilities and Infrastructure located closer to the coast are more exposed.

18.5.4 Environment

Coastal erosion is a naturally occurring processes, but can still cause damage to the natural environment. These processes and events can alter the natural environment where they occur.

18.6 VULNERABILITY

18.6.1 Population

The risk of injury or fatalities as a result of these hazards are limited, but possible. Since the changes caused by coastal erosion are gradual, coastal erosion is not generally considered and imminent threat to the public. Spontaneous collapse is rare, but still may occur resulting in death or injury to any people in the area at the time. It is likely that any such injuries would be highly localized to the area directly impacted by an event. Such drastic changes to the coast can be cause by an extreme event, such as hurricane or tropical storm. The population exposed is considered vulnerable to this hazard. Please see Table 18-1.

18.6.2 Property

Property exposed to coastal erosion can sustain minor damages or can result in complete destruction. Structures may be condemned as a result of coastal erosion damage resulting in large losses. Additionally, physical loss land area may occur as a result of erosion. All coastal property is vulnerable, but properties closer to the coast are in more immediate risk.

Instead, loss estimates were developed representing projected damages (annualized loss) on historical events, statistical analysis, and probability factors. These were applied to the exposed value of the county and communities to create an annualized loss. lists the loss estimates.

TABLE 18-2.
LOSS ESTIMATES FOR COASTAL EROSION

	Exposed Value	Annualized Loss	Annualized Loss Percentage
Unincorporated Area	$970,444	Negligible	<0.01
City of Bay City	$0	Negligible	0.00
City of Palacios	$503,759	Negligible	<0.01
Matagorda County Total	**1,474,203**	**Negligible**	**<0.01**

Vulnerability Narrative

The coastal communities are at greater risk of coastal erosion while inland communities are not at risk. Table 18-2 lists the estimated annualized losses in dollars for each participating community. Annualized losses of ‘negligible’ are less than $50 annually. Negligible loss hazards may still be included despite minimal annualized losses if the community perceives the hazard as a risk.

- **City of Bay City -** The City of Bay City is rated “No Exposure” due to its non-coastal, inland location and local knowledge.
- **City of Palacios** – The City of Palacios’ location along the coast leaves it vulnerable to property damage associated with coastal erosion. These damages can include foundation damage due to the

loss of supporting material from wave action, drainage, winds, or tidal currents. Damages to coastal properties are at the most risk. Critical facilities and infrastructure along the are most vulnerable. These include police and fire stations, schools, lift stations, and port facilities. Damages up to a complete loss in a more significant event, such as a hurricane are possible. Communities who implement erosion mitigation measures such as bulkheads, breakwater jetties, or groins to limit the movement of sediment and restrict water flow help to reduce these vulnerabilities.

- **Matagorda County (Unincorporated Area) -** Matagorda County Unincorporated Areas are at a greater risk of structural damage and property loss due to their coastal location. These damages can include foundation damage due to the loss of supporting material from wave action, drainage, winds, or tidal currents. Property damage can also be more severe, such as a complete loss in a more significant event, such as a hurricane, where the easily erodible, fine grained material that dominates coastal areas are washed away due to a lack of vegetation in a significant or intense storm surge or flooding situation. The County's Unincorporated area is also at risk for significant negative impacts to the environment such as destruction of wetlands and loss of habitat for birds, fish and other species. Coastal erosion results in a loss of land area that is also a significant part of the County's economy through tourism and fisheries. Communities who are not implementing mitigation measures, such as Beach Restoration Programs, are more vulnerable to these effects. The Matagorda Ship channel, a major economic sector, is also vulnerable. An event damaging this facility would severely damage the local economy and infrastructure.

Community Perception of Vulnerability

See front page of current chapter for a summary of hazard rankings for Matagorda County and participating communities in this HMP update. Chapter 19 gives a detailed description of this rankings and Chapter 20 addresses mitigations actions for this hazard vulnerability.

18.6.3 Critical Facilities and Infrastructure

Coastal erosion can result in serious structural damage to critical facilities and infrastructure such as roads, irrigation ditches, underground utilities, and pipelines. Large areas of erosion and displacements caused by coastal erosion can totally destroy roads and structures and alter surface drainage. Minor cracking and distress may result as the improvements respond to small adjustments in the ground beneath them. Erosion can also impact structures such as bridges and roads by undermining their foundations. Structures and underground utilities found in areas prone to subsidence or soil erosion can suffer from distress.

Even though coastal erosion causes enormous amounts of damage, the effects can occur slowly and may not be attributed to a specific event. Cracked foundations, floors, and basement walls, as well damage to the upper floors of the building when the motion in the structure is significant are typical types of damage done by erosion. Coastal Erosion can remove support from buildings or other structures and result in damaging subsidence.

18.6.4 Environment

Ecosystems that are exposed to increased sedimentation as a result of erosion and deposition degrades habitat. However, some erosion and disposition is required for healthful ecosystem functioning. Ecosystems that are already exposed to other pressures, such as encroaching development, may be more vulnerable to impacts from these hazards.

18.7 FUTURE TRENDS IN DEVELOPMENT

According to the *2013 State of Texas Hazard Mitigation Plan* (TDEM 2013):

> *Because of climate change, the Texas Coast is becoming exposed to increasing risk of inundation and coastal erosion over the coming decades. Sea level rise measured by Texas Coastal Ocean Observation Network tide gauges in the Galveston area measured a current rise of about 6 millimeters per year. At this current rate of rise, local sea levels in the Galveston area can be projected to be 0.6 meters (approximately 2 feet) by the year 2100. With current rates of coastal subsidence and with the majority of the Texas Gulf Coast being characterized by low-lying topography, in addition to a broad gently sloping outer continental shelf, this anticipated rise in sea level is important. A small rise in sea level along the Texas Coast can result in a significant shoreline retreat and an increased risk of inundation of wetlands, marshes, private property, and public infrastructure. Relative sea level rise increases the vulnerability of barrier islands and peninsulas along the Texas Coast to inundation from storm surge, even from smaller storms and coastal weather systems.*

As steward of the Texas coast, the Texas GLO is leading the fight against coastal erosion by:

- Implementing coastal erosion response projects and related studies through the Coastal Erosion Planning and Response Act (CEPRA) program and other grant programs at the GLO.
- Maximizing federal, state, and local resources. The GLO works with all coastal stakeholders to fight erosion where it makes economic sense to do so.

Jurisdictions in the planning area should ensure that known hazard areas are regulated under their planning and zoning programs. In areas where hazards may be present, permitting processes should require geotechnical investigations to access risk and vulnerability to hazard areas. Erosion issues generally do not impact land use except along river channels. Issues pertaining to land use in these areas are likely addressed through jurisdictional floodplain ordinances and regulations.

18.8 SCENARIO

A worst case scenario would occur if a large storm effected Matagorda County cause rapid and significant coastal erosion and loss near populated and economic areas, such as the City of Palacios, Matagorda Island, and the ship channel. This situation could result in a number of injuries or fatalities and would cause extensive damage to the area directly impacted.

18.9 ISSUES

The major issues for coastal erosion deposition are the following:

- Onset of actual or observed subsidence in many cases is related to changes in land use. Land uses permitted in known hazard areas should be carefully evaluated.
- Knowledge of hydrologic factors is critical for evaluating most types of ground subsidence.
- Some housing developments have had subsidence hazard investigations completed before development. This practice should be reviewed and expanded as needed.
- Human activities greatly influence the rate and extent of erosion and deposition. Activities should be evaluated before proceeding.
- Riverine erosion can reduce water quality and impact aquatic habitat as well as impact private property and critical infrastructure.

- More detailed analysis should be conducted for critical facilities and infrastructure exposed to hazard areas. This analysis should address how potential structural issues were addressed in facility design and construction.
- Evaluate how Texas should address sea level rise and it causal effect on coastal subsidence and coastal erosion.
- Texas is one of the leading consumers of water in the nation and also uses extensive irrigation agriculture. Alternates source of water should be researched.
- The increased (potential and existing) use of groundwater and its effects land subsidence should be addressed.

CHAPTER 19.
PLANNING AREA RISK RANKING

A risk ranking was performed for the hazards of concern described in this plan. This risk ranking assesses the probability of each hazard's occurrence as well as its likely impact on the people, property, and economy of the planning area. The risk ranking was conducted by the Steering Committee based on the hazard risk assessment presented during the second Steering Committee meeting, community survey results, and personal and professional experience with hazards in the planning area. Estimates of risk were generated with data from HAZUS-MH using methodologies promoted by FEMA. The results are used in establishing mitigation priorities. The hazard rankings were used in establishing mitigation action priorities.

19.1 PROBABILITY OF OCCURRENCE

The probability of occurrence of a hazard is indicated by a probability factor based on likelihood of annual occurrence:

- High – Hazard event is likely to occur within 25 years (Probability Factor = 3)
- Medium – Hazard event is likely to occur within 100 years (Probability Factor = 2)
- Low – Hazard event is not likely to occur within 100 years (Probability Factor = 1)
- No exposure – There is no probability of occurrence (Probability Factor = 0)

The assessment of hazard frequency is generally based on past hazard events in the planning area. The Steering Committee assigned the probabilities of occurrence for each hazard, as shown on Table 19-1.

TABLE 19-1.
HAZARD PROBABILITY OF OCCURRENCE

	Matagorda County		City of Bay City		City of Palacios	
Hazard	High/Med /Low/No	Probability Factor	High/Med /Low/No	Probability Factor	High/Med /Low/No	Probability Factor
Coastal Erosion	High	3	No	0	Low	1
Dam/Levee Failure	Medium	2	Low	1	No	0
Drought	High	3	Medium	2	Medium	2
Earthquake	Low	1	Low	1	Low	1
Expansive Soils	Medium	2	High	3	Low	1
Extreme Heat	High	3	High	3	Medium	2
Flood	High	3	High	3	Medium	2
Hail	Medium	2	Medium	2	Medium	2
Hurricane/ Tropical Storm	High	3	High	3	High	3
Lightning	High	3	Medium	2	High	3
Tornado	High	3	Medium	2	Medium	2
Wildfire	Low	1	Low	1	No	0
Wind	Medium	2	High	3	High	3

TABLE 19-1. HAZARD PROBABILITY OF OCCURRENCE						
	Matagorda County		City of Bay City		City of Palacios	
Hazard	High/Med /Low/No	Probability Factor	High/Med /Low/No	Probability Factor	High/Med /Low/No	Probability Factor
Winter Weather	High	3	Low	1	Low	1

19.2 IMPACT

Hazard impacts were assessed in three categories, impacts on: people, property, and the local economy. Numerical impact factors were assigned as follows:

- **People** – Values were assigned based on the percentage of the total ***population exposed*** to the hazard event. The degree of impact on individuals will vary and is not measurable, so the calculation assumes for simplicity and consistency that all people who live in a hazard zone will be equally impacted when a hazard event occurs. It should be noted that planners can use an element of subjectivity when assigning values for impacts on people. Impact factors were assigned as follows:
  - High – 50% or more of the population is exposed to a hazard (Impact Factor = 3)
  - Medium – 25% to 49% of the population is exposed to a hazard (Impact Factor = 2)
  - Low – 24% or less of the population is exposed to the hazard (Impact Factor = 1)
  - No impact – None of the population is exposed to a hazard (Impact Factor = 0)
- **Property** – Values were assigned based on the percentage of the total ***assessed property value*** exposed to the hazard event:
  - High – 30% or more of the total assessed property value is exposed to a hazard (Impact Factor = 3)
  - Medium – 15% to 29% of the total assessed property value is exposed to a hazard (Impact Factor = 2)
  - Low – 14% or less of the total assessed property value is exposed to the hazard (Impact Factor = 1)
  - No impact – None of the total assessed property value is exposed to a hazard (Impact Factor = 0)
- **Economy** – Values were assigned based on total impact to the economy from the hazard event and activities conducted after the event to restore the community to previous functions. Values were assigned based on the number of days the hazard impacts the community, including impacts on tourism, businesses, road closures, or government response agencies.
  - High – Community impacted for more than 7 days (Impact Factor = 3)
  - Medium – Community impacted for 1 to 7 days (Impact Factor = 2)
  - Low – Community impacted for less than 1 day (Impact Factor = 1)
  - No impact – No community impacts estimated from the hazard event (Impact Factor = 0)

The impacts of each hazard category were assigned a weighting factor to reflect the significance of the impact. These weighting factors are consistent with those typically used for measuring the benefits of hazard mitigation actions: impact on people was given a weighting factor of 3; impact on property was given a weighting factor of 2; and impact on the economy was given a weighting factor of 1. The impacts for each hazard are summarized in Table 19-2 through Table 19-4. The total impact factor shown on the tables equals the impact factor multiplied by the weighting factor.

TABLE 19-2. IMPACT ON PEOPLE FROM HAZARDS

	Matagorda County		City of Bay City		City of Palacios	
Hazard	High/Med /Low/No	Total Impact Factor	High/Med /Low/No	Total Impact Factor	High/Med /Low/No	Total Impact Factor
Coastal Erosion	Medium	6	No	0	Low	3
Dam/Levee Failure	Medium	6	Low	3	No	0
Drought	Medium	6	Low	3	Medium	6
Earthquake	Low	3	Low	3	Low	3
Expansive Soils	Low	3	Low	3	Low	3
Extreme Heat	Medium	6	High	9	Medium	6
Flood	Medium	6	Low	3	Medium	6
Hail	Low	3	Low	3	Medium	6
Hurricane/ Tropical Storm	High	9	High	9	High	9
Lightning	Low	3	Low	3	High	9
Tornado	Medium	6	Low	3	Low	3
Wildfire	Low	3	Low	3	No	0
Wind	Low	3	Medium	6	Medium	6
Winter Weather	Medium	6	Low	3	Low	3

TABLE 19-3. IMPACT ON PROPERTY FROM HAZARDS

	Matagorda County		City of Bay City		City of Palacios	
Hazard	High/Med /Low/No	Total Impact Factor	High/Med /Low/No	Total Impact Factor	High/Med /Low/No	Total Impact Factor
Coastal Erosion	High	6	No	0	Low	2
Dam/Levee Failure	Medium	4	Low	2	No	0
Drought	Medium	4	Low	2	Low	2
Earthquake	Low	2	Low	2	Low	2
Expansive Soils	Low	2	Low	2	Low	2

TABLE 19-3.
IMPACT ON PROPERTY FROM HAZARDS

	Matagorda County		City of Bay City		City of Palacios	
Hazard	High/Med /Low/No	Total Impact Factor	High/Med /Low/No	Total Impact Factor	High/Med /Low/No	Total Impact Factor
Extreme Heat	Low	2	Low	2	Low	2
Flood	Low	2	Low	2	Medium	4
Hail	No	0	Low	2	Medium	4
Hurricane/ Tropical Storm	Medium	4	High	6	High	6
Lightning	Low	2	Low	2	Low	2
Tornado	Low	2	Low	2	Low	2
Wildfire	Low	2	Low	2	No	0
Wind	Medium	4	Medium	4	Medium	4
Winter Weather	Medium	4	Low	2	Low	2

TABLE 19-4.
IMPACT ON ECONOMY FROM HAZARDS

	Matagorda County		City of Bay City		City of Palacios	
Hazard	High/Med /Low/No	Total Impact Factor	High/Med /Low/No	Total Impact Factor	High/Med /Low/No	Total Impact Factor
Coastal Erosion	Medium	2	Low	1	No	0
Dam/Levee Failure	Medium	2	Low	1	Low	1
Drought	Medium	2	Low	1	No	0
Earthquake	Low	1	Low	1	Low	1
Expansive Soils	Low	1	Low	1	No	0
Extreme Heat	No	0	Low	1	Low	1
Flood	Low	1	Low	1	Low	1
Hail	No	0	Low	1	Medium	2
Hurricane/ Tropical Storm	Medium	2	High	3	Medium	2
Lightning	Low	1	Low	1	No	0
Tornado	Low	1	Low	1	Low	1
Wildfire	Low	1	Low	1	Low	1

TABLE 19-4. IMPACT ON ECONOMY FROM HAZARDS						
	Matagorda County		City of Bay City		City of Palacios	
Hazard	High/Med /Low/No	Total Impact Factor	High/Med /Low/No	Total Impact Factor	High/Med /Low/No	Total Impact Factor
Wind	Low	1	Medium	2	No	0
Winter Weather	Medium	2	Low	1	Low	1

19.3 RISK RATING AND RANKING

The risk rating for each hazard was calculated by multiplying the probability factor by the sum of the weighted impact factors for people, property, and operations, as summarized in Table 19-5. Based on these ratings, a priority of high, medium, or low was assigned to each hazard. Hurricane/tropical storm was ranked high by Matagorda County and the Cities of Bay City and Palacios. Matagorda County also ranked coastal erosion as high. The hazards ranked as being of medium concern vary by jurisdiction but generally include dam/levee failure, drought, extreme heat, flood, hail, lightning, tornado, wind, and wildfire. All other hazards were ranked low or there was no exposure of the community to the hazard. Table 19-6 summarizes the hazard risk ranking.

TABLE 19-5. HAZARD RISK RANKING CALCULATIONS									
	Matagorda County			City of Bay City			City of Palacios		
Hazard	Probability Factor	Impact Weighted Sum	Total	Probability Factor	Impact Weighted Sum	Total	Probability Factor	Impact Weighted Sum	Total
Coastal Erosion	3	14	42	0	1	0	1	5	5
Dam/Levee Failure	2	12	24	1	6	6	0	1	0
Drought	3	12	36	2	6	12	2	8	16
Earthquake	1	6	6	1	6	6	1	6	6
Expansive Soils	2	6	12	3	6	18	1	5	5
Extreme Heat	3	8	24	3	12	36	2	9	18
Flood	3	9	27	3	6	18	2	11	22
Hail	2	3	6	2	6	12	2	12	24
Hurricane/ Tropical Storm	3	15	45	3	18	54	3	17	51
Lightning	3	6	18	2	6	12	3	11	33
Tornado	3	9	27	2	6	12	2	6	12
Wildfire	1	6	6	1	6	6	0	1	0

TABLE 19-5.
HAZARD RISK RANKING CALCULATIONS

	Matagorda County			City of Bay City			City of Palacios		
Hazard	Probability Factor	Impact Weighted Sum	Total	Probability Factor	Impact Weighted Sum	Total	Probability Factor	Impact Weighted Sum	Total
Wind	2	8	16	3	12	36	3	10	30
Winter Weather	3	12	36	1	6	6	1	6	6

Notes:
Impact Weighted Sum=Total Impact Factor People+ Total Impact Factor Property + Total Impact Factor Economy
Total = Probability x Impact Weighted Sum

TABLE 19-6.
HAZARD RISK SUMMARY

Hazard	Matagorda County	City of Bay City	City of Palacios
Coastal Erosion	High	No Exposure	Low
Dam/Levee Failure	Medium	Low	No Exposure
Drought	Medium	Low	Low
Earthquake	Low	Low	Low
Expansive Soils	Low	Low	Low
Extreme Heat	Medium	Medium	Low
Flood	Medium	Low	Medium
Hail	Low	Low	Medium
Hurricane/ Tropical Storm	High	High	High
Lightning	Low	Low	Medium
Tornado	Medium	Low	Low
Wildfire	Low	Low	No Exposure
Wind	Low	Medium	Medium
Winter Weather	Medium	Low	Low

PART 3
MITIGATION AND PLAN MAINTENANCE STRATEGY

CHAPTER 20.
AREA-WIDE MITIGATION ACTIONS AND IMPLEMENTATION

The Steering Committee reviewed a menu of hazard mitigation alternatives that present a broad range of alternatives to be considered for use in the planning area, in compliance with Title 44 Code of Federal Regulations (44 CFR) (Section 201.6(c)(3)(ii)). The menu provided a baseline of mitigation alternatives that are backed by a planning process, are consistent with the planning partners' goals and objectives, and are within the capabilities of the partners to implement. The Steering Committee reviewed the full range of actions as well as the county's and the participating communities' abilities to implement the variety of mitigation actions. Hazard mitigation actions recommended in this plan were selected from among the alternatives presented in the menu as well as other projects known to be necessary.

20.1 RECOMMENDED MITIGATION ACTIONS

The planning partners and the Steering Committee identified actions that could be implemented to provide hazard mitigation benefits. Table 20-1 lists the recommended mitigation actions and the hazards addressed by the action. All of the hazards profiled in this plan are addressed by more than one mitigation action.

Table 20-2 provides more details on the mitigation actions, including the mitigation action description, action type, estimated cost, potential funding sources, timeline, and benefit to the community (high, medium or low). Mitigation types used for this categorization are as follows:

- Local Plans and Regulations (LPR) – These actions include government authorities, policies, or codes that influence the way land and buildings are being developed and built.
- Structure and Infrastructure Projects (SIP) – These actions involve modifying existing structures and infrastructure to protect them from a hazard or remove them from a hazard area. This could apply to public or private structures as well as critical facilities and infrastructure. This type of action also involves projects to construct manmade structures to reduce the impact of hazards.
- Natural Systems Protection (NSP) – These are actions that minimize damage and losses, and also preserve or restore the functions of natural systems.
- Education and Awareness Programs (EAP) – These are actions to inform and educate citizens, elected officials, and property owners about hazards and potential ways to mitigate them. These initiatives may also include participation in national programs, such as StormReady and Firewise Communities.

Mitigation action worksheets were developed to provide more information for each recommended mitigation action, including the specific problem being mitigated, alternative actions considered, whether the action applies to existing or future development, the benefits or losses avoided, the department, position, office or agency responsible for implementing the action, the local planning mechanism, and potential funding sources. These worksheets were developed to provide a tool for the planning partners to apply for grants or general funds to complete the mitigation action. An example worksheet for Matagorda County and the participating communities is shown in Figure 20-1. These worksheets are kept on file with the county and cities and can be a valuable resource for annual progress updates and reports.

Mitigation Action Worksheet

Please complete one worksheet per action with as much detail as possible, using the instructions beginning on page 3 and examples provided by FEMA.

Name of Jurisdiction: ______________________ **Mitigation Action #:** ______________

Mitigation Action Title: ____

Assessing the Risk	
Hazard(s) addressed: (check all that apply)	☐All Hazards ☐Coastal Erosion ☐ Dam/Levee Failure ☐ Drought ☐ Earthquake ☐Expansive Soils ☐ Extreme Heat ☐ Flood ☐ Hail ☐Hurricanes/Tropical Storms ☐Land Subsidence ☐ Lightning ☐Thunderstorm ☐Tornado ☐ Wildfire ☐Wind ☐Winter Weather
Specific problem being Mitigated (describe why action is needed)	
Evaluation of Potential Alternatives	
Alternatives Considered (name of project and reason for not selecting)	1. 2. 3.
Action/Project Intended for Implementation	
Describe how action will be implemented (main steps involved)	
Action/Project Type	☐ Local Plans and Regulations ☐Structure and Infrastructure Project ☐Natural Systems Protection ☐Education and Awareness Programs
Applicable Goals/Objectives (refer to list of goals/objectives)	☐Goal #1 ☐Goal #2 ☐ Goal #3 ☐ Goal #4 ☐Goal #5 ☐Goal #6 Objective:
Applies to existing or future development	☐Existing Development ☐Future Development ☐ Both Existing and Future Development ☐ Not Applicable
Describe benefits (losses avoided)	☐ Life Safety ☐Damage Reduction ☐Other Describe:
Estimated Cost	☐< $10,000; ☐$10,000 to $100,000; ☐>$100,000 Other Amount: $
Plan for Implementation	
Responsible Department	
Local Planning Mechanism (check all that apply)	☐Capital Improvement Plan ☐Comprehensive Plan ☐Building Code ☐Ordinance ☐ Other: New Local Plan
Potential Funding Sources	General Fund
Timeline for Completion	_________months
Reporting on Progress	
Status/Comment	☐ Not Started ☐In-progress ☐Delayed ☐Completed ☐No Longer Required Comment:
Completed by: (name, title, phone #)	**Date:**

1

Figure 20-1. Blank Mitigation Action Worksheet

20.2 BENEFIT/COST REVIEW AND PRIORITIZATION

The action plan must be prioritized according to a benefit/cost analysis of the proposed projects and their associated costs (44 CFR, Section 201.6(c)(3)(iii)). The benefits of proposed projects were weighed against estimated costs as part of the project prioritization process. The benefit/cost analysis was not of the detailed variety required by FEMA for project grant eligibility under the Hazard Mitigation Grant Program (HMGP) and Pre-Disaster Mitigation (PDM) Grant Program. A less formal approach was used because some projects may not be implemented for up to 10 years, and associated costs and benefits could change dramatically in that time. Therefore, a review of the apparent benefits versus the apparent cost of each project was performed. Parameters were established for assigning subjective ratings (high, medium, and low) to the costs and benefits of these projects.

Fourteen criteria were used to assist in evaluating and prioritizing the mitigation initiatives. For each mitigation action, a numeric rank (0, 1, 2, 3, 4) was assigned for each of the 14 evaluation criteria defined as follows:

- Definitely Yes - 4
- Maybe Yes - 3
- Unknown/Neutral - 2
- Probably No - 1
- Definitely No - 0

The 14 evaluation/prioritization criteria are:

1. Life Safety – How effective will the action be at protecting lives and preventing injuries? The numeric rank for this criterion is multiplied by 2 to emphasize the importance of life safety when evaluating the benefit of the action.
2. Property Protection – How significant will the action be at eliminating or reducing damage to structures and infrastructure? The numeric rank for this criterion is multiplied by 2 to emphasize the importance of property protection when evaluating the benefit of the action.
3. Cost-Effectiveness – Will the future benefits achieved by implementing the action, exceed the cost to implement the action?
4. Technical – Is the mitigation action technically feasible? Will it solve the problem independently and is it a long-term solution? Eliminate actions that, from a technical standpoint, will not meet the goals.
5. Political – Is there overall public support for the mitigation action? Is there the political will to support it?
6. Legal – Does the jurisdiction have the authority to implement the action?
7. Fiscal - Can the project be funded under existing program budgets (i.e., is this action currently budgeted for)? Or would it require a new budget authorization or funding from another source such as grants?
8. Environmental – What are the potential environmental impacts of the action? Will it comply with environmental regulations?
9. Social – Will the proposed action adversely affect one segment of the population? Will the action disrupt established neighborhoods, break up voting districts, or cause the relocation of lower income people?

10. Administrative – Does the jurisdiction have the personnel and administrative capabilities to implement the action and maintain it or will outside help be necessary?
11. Multi-hazard – Does the action reduce the risk to multiple hazards?
12. Timeline - Can the action be completed in less than 5 years (within our planning horizon)?
13. Local Champion – Is there a strong advocate for the action or project among the jurisdiction's staff, governing body, or committees that will support the action's implementation?
14. Other Local Objectives – Does the action advance other local objectives, such as capital improvements, economic development, environmental quality, or open space preservation? Does it support the policies of other plans and programs?

The numeric results of this exercise are shown on the mitigation action worksheets. An example worksheet for is shown in Figure 20-2. These results were used to identify the benefit of the action to the community as low, medium, or high priority. Table 20-2 shows the benefit of each mitigation action.

The Steering Committee used the results of the benefit/cost review and prioritization exercise to rank the mitigation actions in order of priority, with 1 being the highest priority. The highest priority mitigation actions are shown in red on Table 20-2, medium priority actions are shown in yellow and low priority actions are shown in green.

Prioritization Worksheet

Mitigation Action #: ____________

Mitigation Action Title: ______________________________

Criteria	Numeric Rank: Definitely Yes = 4 Maybe Yes = 3 Unknown/Neutral = 2 Probably No = 1 Definitely No = 0		Provide brief rationale for numeric rank when appropriate
1. Will the action result in Life Safety?		x 2 =	
2. Will the action result in Property Protection?		x 2 =	
3. Will the action be Cost-Effective? (future benefits exceed cost)			
4. Is the action Technically feasible			
5. Is the action Politically acceptable?			
6. Does the jurisdiction have the Legal authority to implement?			
7. Is Funding available for the action?			
8. Will the action have a positive impact on the natural Environment?			
9. Is the action Socially acceptable?			
10. Does the jurisdiction have the Administrative capability to execute the action?			
11. Will the action reduce risk to more than one hazard (Multi-Hazard)?			
12. Can the action be implemented Quickly?			
13. Is there an Agency/Department Champion for the action?			
14. Will the action meet other Community Objectives?			
Total			
Priority: Low = <35 Medium = 35-49 High = >50	☐Low ☐Medium ☐High		

Figure 20-2. Example Benefit/Cost Review and Prioritization Worksheet

TABLE 20-1.
MITIGATION ACTIONS DEVELOPED TO ADDRESS HAZARDS

Action No.	Title	Coastal Erosion	Dam/Levee Failure	Drought	Earthquake	Expansive Soil	Extreme Heat	Flood	Hail	Hurricane/ Tropical Storms	Lightning	Tornado	Wildfire	Wind	Winter Weather
MATAGORDA COUNTY															
1	Install automated Flood Warning Systems							X							
2	Construct tornado and hurricane safe rooms									X		X			
3	Waterproofing Ordinance					X		X							
4	Education on hail damage								X						
5	Build new water reservoirs for water supply			X									X		
6	Education on tornado awareness and knowledge of insurance needs											X		X	
7	Develop a Beach Restorations Program	X													
8	Design & construct drainage improvement projects							X		X					
9	Expand rainfall observer program through CoCoRaHS							X	X	X					X
10	Purchase and install generators including auto switch.		X		X		X	X	X	X	X	X	X	X	X
11	Conduct outreach and educate public about natural hazards	X	X	X	X	X	X	X	X	X	X	X	X	X	X
12	Flood Insurance							X							
13	Update the Matagorda County Flood Insurance Study and FIRMs							X							
14	Provide support to the TCRFC for flood reduction projects							X							

15	Install Reverse 911 Emergency Notifications System		X		X		X	X	X	X	X	X	X	X	X
16	Inspect, improve, and certify Flood Protection Levees		X												
17	Establish Burning Ordinance			X									X		
CITY OF BAY CITY															
1	Update Building Codes	N/A	X	X	X	X	X	X	X	X	X	X	X	X	X
2	Drought, Expansive Soils Contingency Plan	N/A		X		X	X								
3	Adopt sediment control regulations.	N/A				X									
4	Master Generator Plan & Purchase Generators	N/A	X		X		X	X	X	X	X	X	X	X	X
5	Construct Regional Detention	N/A						X							
6	Retrofit water supply system	N/A		X				X							
7	Education on natural hazards affecting homeowners	N/A	X	X	X	X	X	X	X	X	X	X	X	X	X
8	Adopt Tree Ordinance	N/A						X		X	X	X	X	X	X
9	Institute a buy-out program after enactment of building codes and ordinances	N/A						X		X					
10	City's floodplain management ordinance	N/A						X							
11	Flood insurance	N/A						X							
12	Design, construct, and maintain drainage improvement projects	N/A						X							
13	Provide training for CFM and CEM.	N/A	X	X	X	X	X	X	X	X	X	X	X	X	X
14	Participate in FEMA's CRS	N/A						X							
15	Inspect, improve, and certify flood protection levees and seawalls in Bay City	N/A	X												
16	Raise bridges above the BFE	N/A						X		X					
CITY OF PALACIOS															
1	Construct new Emergency Operation Center		N/A	X	X	X	X	X	X	X	X	X	N/A	X	X

2	Install generators at City Hall complex and critical facilities		N/A	X			X	X	X	X	X	X	N/A	X	X
3	Construct bulkhead along the west end of Tres Palacios Bay	X	N/A										N/A		
4	Extend breakwater jetty and groins to prevent damage to facilities and marina	X	N/A										N/A		
5	Purchase NOAA all-hazard radios	X	N/A	X	X		X	X	X	X	X	X	N/A	X	X
6	Educate builders and homeowners of foundation shifting due to expansive soils		N/A			X							N/A		
7	Prevention of utility failures		N/A	X		X	X	X					N/A		
8	Bury electrical lines to critical facilities		N/A							X	X	X	N/A	X	
9	Building design and construction of roofs and pre-engineered windows		N/A							X		X	N/A	X	
10	Education on hail damage		N/A						X				N/A		
11	Institute ordinances for tie-down requirements.		N/A					X		X		X	N/A	X	
12	Raise bridges above the BFE		N/A					X		X			N/A		
13	Increase drainage for airport property		N/A					X		X			N/A		
14	Relocate Police Station outside Flood Zone B		N/A					X		X			N/A		
15	Promote flood insurance		N/A					X					N/A		
16	Design, construct and maintain drainage improvement projects		N/A					X					N/A		
17	Adopt "Higher Standard" riverine flood damage prevention ordinances and standards		N/A					X		X			N/A		
18	Provide training for CFMs and CEMs.	X	N/A	X	X	X	X	X	X	X	X	X	N/A	X	X
19	Participate in FEMA's CRS		N/A					X					N/A		
20	Construct cover over Park N Ride Parking Lot		N/A						X				N/A		
21	Public information on how to reduce water usage		N/A	X			X						N/A		
Notes:															

BFE	Base Flood Elevation	CRS	Community Rating System
CEM	Community Emergency Managers	FEMA	Federal Emergency Management Agency
CFM	Community Flood Manager	FIRM	Flood Insurance Rate Map
CoCoRaHS	Community Collaborative Rain, Hail and Snow Network	TCRFC	Texas Colorado River Floodplain Coalition

TABLE 20-2.
RECOMMENDED MITIGATION ACTIONS

Action No.	Title	Description	Mitigation Action Ranking	Action Type	Applicable Goals	Responsible Department	Estimated Cost	Potential Funding Sources	Timeline in months	Benefit
MATAGORDA COUNTY										
1	Install automated Flood Warning Systems	Prevent surprise flooding that public might not be aware of especially on the Tres Palacios River.	7	SIP	G1, G2	Emergency Management	$10,000 to $100,000	FMA, CDBG	36	Medium
2	Construct tornado and hurricane safe rooms	Construct tornado and hurricane safe rooms with the proper design for windstorm requirements.	8	EAP	G3, G6	Emergency Management	< $10,000	State and federal grants	48	Medium
3	Waterproofing Ordinance	Require structures to be surrounded by an impermeable apron around the structures to keep water away from the foundation thus minimizing expansive soils and flooding issues – Commissioners' have to approve changes made to the ordinance.	16	SIP EAP	G1, G2	Environmental Health Dept	< $10,000	State and federal grants	36	Medium
4	Education on hail damage	Inform the public on county website on how to prevent or alleviate hail damage: install roofing material of stronger quality, enforce county codes, and encourage farmers to become more educated about protection of crops.	11	EAP	G1, G3,	Public Works	< $10,000	PDM, HMGP	36	Medium
5	Build new water reservoirs for water supply	Build new water reservoirs for water supply & wildfire fighting. The reservoirs would be impounded behind 12- to-15 foot high dikes on farmland.	9	LPR SIP	G1	Emergency Management	< $10,000	County funds	60	Medium
6	Education on tornado awareness and knowledge of insurance needs	Inform the public on county website.	12	EAP	G1, G4	Emergency Management	< $10,000	Rural development grants	36	High

TABLE 20-2.
RECOMMENDED MITIGATION ACTIONS

Action No.	Title	Description	Mitigation Action Ranking	Action Type	Applicable Goals	Responsible Department	Estimated Cost	Potential Funding Sources	Timeline in months	Benefit
7	Beach Restorations Program	Plant dune vegetation seaward and strengthen dunes. The County will work with Commissioner's Court, Beach Dune Committee and Emergency Management for specific sections of the beach.	2	NSP	G1, G5	Emergency Management	>$100,000	State and federal grants	24	Medium
8	Design & construct drainage improvement projects	Design and construct drainage improvement projects along Perryman Avenue, Humphrey Avenue, Moore Avenue, and Johnson Avenue. These drainage channels will be constructed to carry 25-year flood events.	6	SIP	G1, G2, G6	Public Works	>$100,000	Local, CDBG and FEMA	36	Medium
9	Expand rainfall observer program through CoCoRaHS	This non-profit organization uses volunteers to measure and map precipitation. Sometimes specific rain, hail, and snow totals are unknown in the County.	17	EAP	G3	Emergency Management	< $10,000	County funds, grants	12	Medium
10	Purchase and install generators including auto switch	Purchase generators to use during outages at Precinct Barn's, County Office Building and critical facilities to provide back-up power from hazard events of extreme heat, Earthquake, flood, hail, hurricane/tropical storms, lightning, tornado, wildfire, wind, and winter weather.	5	SIP	G1	Emergency Management	< $10,000	HMGP, other grants	36	Medium

**TABLE 20-2.
RECOMMENDED MITIGATION ACTIONS**

Action No.	Title	Description	Mitigation Action Ranking	Action Type	Applicable Goals	Responsible Department	Estimated Cost	Potential Funding Sources	Timeline in months	Benefit
11	Conduct outreach and educate public about natural hazards	Conduct outreach at local events and educate public using County website about the full range of hazards we face and how to protect themselves & their homes during drought, extreme heat, earthquake, flooding, hurricanes and tropical storms, lightning, thunderstorms, tornadoes, all winter weather, and wildfire.	13	EAP	G1, G3	Emergency Management	< $10,000	County funds	36	Medium
12	Flood insurance	Promote the benefits of purchasing flood insurance to minimize the financial impact of future floods with pamphlets and county website.	14	EAP	G2, G3	Environmental Health Dept	< $10,000	County funds	36	High
13	Update the Matagorda County Flood Insurance Study and FIRMs	Detailed floodplain information for all streams in needed.	3	LPR	G2, G5	Emergency Management	$10,000 to $100,000	FEMA	24	High
14	Provide support to the TCRFC for flood reduction projects	Flood reduction projects need regional support.	15	SIP	G2, G5	Environmental Health Dept	$10,000 to $100,000	State and federal grants	60	High
15	Install Reverse 911 Emergency Notifications System	Purchase & install Reverse 911 Emergency Notifications System to be used for the following hazard notifications: dam failure, extreme heat, earthquake, flood, hail, hurricane/tropical storms, lightning tornado, wildfire, wind, and winter weather.	1	EAP	G1, G3	Environmental Health Dept	< $10,000	County funds	24	Medium

TABLE 20-2.
RECOMMENDED MITIGATION ACTIONS

Action No.	Title	Description	Mitigation Action Ranking	Action Type	Applicable Goals	Responsible Department	Estimated Cost	Potential Funding Sources	Timeline in months	Benefit
16	Inspect, improve and certify flood protection levees	Protecting property and residents inside the Ring Levee.	4	NSP	G1, G2	Environmental Health Dept	>$100,000	County, USACE, FEMA	12	Medium
17	Establish Burning Ordinance	During drought conditions, establish burning procedures for new ordinance	10	LPR	G1	Emergency Management	< $10,000	County funds	12	Medium
CITY OF BAY CITY										
1	Update Building Codes	Adopt updated building codes the require tornado, wind, fire, hail, earthquake, ground movement, and impact resistant materials (windows, doors, roofing, construction, siding, roof bracings); dry-proofing buildings; upgrading to higher standard insulation; installing lighting rods and grounding systems; retrofitting for low-flow plumbing; replacing landscaping with drought and fire resistant plants; implementing higher standards for foundations for expansive soils, and using R-value building materials to resist heat for residential and commercial construction.	2	LPR EAP	G1, G2, G5	Public Works	$10,000 to $100,000	Local, CDBG and FEMA	24	Medium

TABLE 20-2.
RECOMMENDED MITIGATION ACTIONS

Action No.	Title	Description	Mitigation Action Ranking	Action Type	Applicable Goals	Responsible Department	Estimated Cost	Potential Funding Sources	Timeline in months	Benefit
2	Drought and Expansive Soils Contingency Plan	Create & implement a drought emergency plan and criteria for drought/expansive soils related actions. Drought & extreme heat exacerbates expansive soils because large amounts of groundwater are withdrawn & not recharged at normal rates. When water is taken out of the soil, the soil collapse, compacts, and shrinks thus causing damage to infrastructure and structures.	4	LPR NSP	G1, G2, G4, G5	Public Works	>$100,000	Local, CDBG and FEMA	36	Low
3	Adopt sediment regulations	Develop, adopt and enforce a sediment and erosion control ordinance to eliminate erosion and expansive soils associated with construction and land development.	8	LPR	G3, G4, G5	Building Department	< $10,000	Local, CDBG and FEMA	36	Medium
4	Master Generator Plan & Purchase Generators	Develop a master generator plan and purchase generators and associated items. The generators are for identified critical facilities to provide back-up power from hazard events of dam/levee failure, extreme heat, earthquake, flood, hail, hurricane/tropical storms, lightning, tornado, wildfire, wind, and winter weather.	1	LPR	G1, G2, G4, G5, G6	Public Works	$10,000 to $100,000	Operating budget and grants	36	Medium
5	Construct Regional Detention	Construct regional detention/retention ponds. Identify locations and obtain easements for planned and regulated public use for detention/retention and drainage.	3	LPR	G1, G2, G3, G5, G6	Public Works	< $10,000	Local, CDBG and FEMA	48	Medium

TABLE 20-2.
RECOMMENDED MITIGATION ACTIONS

Action No.	Title	Description	Mitigation Action Ranking	Action Type	Applicable Goals	Responsible Department	Estimated Cost	Potential Funding Sources	Timeline in months	Benefit
6	Retrofit water supply system	Improve water delivery system to save water by designing a water delivery system to mitigate drought conditions by installing new/upgrade existing systems to eliminate breaks.	13	SIP	G1, G4, G5, G6	Public Works	>$100,000	Local, CDBG and FEMA	36	Medium
7	Education on natural hazards affecting homeowners	Educate homeowners about how to mitigate the damage to homes caused by natural hazards. Inform the public on city website.	7	EAP	G1, G3,	Public Works	< $10,000	PDM, HMGP	60	Medium
8	Adopt Tree Ordinance	Adopt tree ordinance to promote planting of trees that can better withstand hazards with minimal damage to the tree and/or other property. Establish standards for all utilities and citizens regarding tree maintenance and pruning.	11	LPR NSP	G1, G2. G5	Public Works	$10,000 to $100,000	Local, CDBG, and FEMA	48	Medium
9	Institute a flood buy-out program	Create a voluntary buy-out program for residents that have repetitive flood and hurricane/tropical storm damages.	16	SIP	G2	Public Works	>$100,000	PDM, HMGP	48	Low
10	City's floodplain management ordinance	The floodplain management ordinance will be reviewed at a City Council meeting.	14	LPR	G2	Building Department	< $10,000	City funds	12	Medium

TABLE 20-2.
RECOMMENDED MITIGATION ACTIONS

Action No.	Title	Description	Mitigation Action Ranking	Action Type	Applicable Goals	Responsible Department	Estimated Cost	Potential Funding Sources	Timeline in months	Benefit
11	Flood insurance	Educate the public on the benefits of purchasing flood insurance to minimize the financial impact of future floods with pamphlets and city website.	6	EAP	G2, G3	Public Works	< $10,000	City funds	12	High
12	Design, construct, and maintain drainage improvement projects	Design, construct, and maintain drainage improvement projects to minimize the risk of loss of life and future flood damages by utilizing funding from all sources to improve drainage, specifically by increasing capacity of ditches and structures.	9	SIP	G1, G2, G6	Public Works	>$100,000	Local, CDBG, and FEMA	36	Medium
13	Provide training for CFM and CEM	Provide training for CFM and CEM.	10	EAP	G4	City Administration	< $10,000	Texas Emergency Management	24	Medium
14	Participate in FEMA’s CRS.	Review requirements for CRS compared to current ordinance and design standards. Implement policies and procedures to meet CRS requirement and submit documentation for community rating.	15	LPR EAP	G1, G2, G3, G4, G5, G6	Floodplain manager	< $10,000	City funds	36	Medium
15	Inspect, improve, and certify flood protection levees and seawalls in Bay City	Develop and implement inspection and certification of the flood protection levees and flap gates. Use the inspections to plan and budget for necessary improvements.	12	LPR	G1, G2, G4, G6	Public Works	$10,000 to $100,000	Local, CDBG, and FEMA	24	Medium
16	Raise bridges above the BFE	Raise bridge above the BFE because bridges can be impassible during flooding events and homes are being flooded.	5	SIP	G2	Public Works	>$100,000	PDM, HMGP	36	Medium
CITY OF PALACIOS										

TABLE 20-2.
RECOMMENDED MITIGATION ACTIONS

Action No.	Title	Description	Mitigation Action Ranking	Action Type	Applicable Goals	Responsible Department	Estimated Cost	Potential Funding Sources	Timeline in months	Benefit
1	Construct new hardened Emergency Operation Center	EOC will be hardened by the use of tornado, wind, hail, earthquake, ground movement, and impact resistant materials (windows, doors, roofing, construction, siding, roof bracings); dry-proofing buildings; upgrading to higher standard insulation; installing lighting rods and grounding systems; retrofitting for low-flow plumbing; replacing landscaping with drought resistant plants; implementing higher standards for foundations to mitigate expansive soils, and using R-value building materials to resist heat.	2	SIP	G1	Building Department	>$100,000	Rural development grants	48	High
2	Install generators at City Hall complex and critical facilities	Install generators at City Hall complex to provide back-up power from hazard events of dam/levee failure, earthquakes, extreme heat, flood, hail, hurricane/tropical storms, lightning, tornado, wind, and winter weather.	1	SIP	G1	Public Works	$10,000 to $100,000	PDM, Rural development grants, HMGP	36	High
3	Construct bulkhead along the west end of Tres Palacios Bay	Construct breakwater wall along west end of bay to reduce the wave action during storms to prevent erosion to wetlands and property.	7	SIP	G2	Building Department	>$100,000	Rural development grants, HMGP, USACE, CIAP	24	High
4	Extend breakwater jetty and groins to prevent damage to facilities and marina	Construct an extension to the 6th Street breakwater jetty and South Bay rock groins to prevent damage to marina and boat ramp.	9	SIP	G2	Building Department	>$100,000	Rural development grants, HMGP, USACE, CIAP	36	High

TABLE 20-2.
RECOMMENDED MITIGATION ACTIONS

Action No.	Title	Description	Mitigation Action Ranking	Action Type	Applicable Goals	Responsible Department	Estimated Cost	Potential Funding Sources	Timeline in months	Benefit
5	Purchase NOAA all-hazard radios	Purchase NOAA all-hazard radios available for businesses & residents	21	SIP	G1	Building Department	< $10,000	HMGP	60	Medium
6	Educate builders and homeowners of foundation shifting due to expansive soils	Provide information flyers to builders and homeowners on the effects of expansive soils on foundations and preventative measures around foundations.	16	EAP	G2, G3	Building Department	< $10,000	Rural development grants, USDA Grants	60	Medium
7	Prevention of utility failures	Replace old substandard water and sewer pipes with materials that are conducive to drought, expansive soils, & extreme heat conditions.	3	SIP	G1	Public Works	>$100,000	CDBG, Rural development grants, HMGP	24	High
8	Bury electrical lines to critical facilities	Bury power lines from public power to critical infrastructure to mitigate power outages to critical facilities during thunderstorms and other storms.	6	SIP	G2, G6	Building Department	$10,000 to $100,000	PDM, Rural development grants, HMGP	24	High
9	Building design and construction of roofs and pre-engineered windows	Require builders to engineer roofing systems and windows to sustain high winds or wind gusts.	15	SIP EAP	G1, G2, G5	Public Works	< $10,000	PDM, Rural development grants, HMGP	48	High
10	Education on hail damage	Inform the public on city website. Install roofing material of stronger quality, enforce codes and educate the general public about the damage caused by hail and how to mitigate it	20	EAP	G1, G3	Public Works	< $10,000	Rural development grants	24	Medium

TABLE 20-2.
RECOMMENDED MITIGATION ACTIONS

Action No.	Title	Description	Mitigation Action Ranking	Action Type	Applicable Goals	Responsible Department	Estimated Cost	Potential Funding Sources	Timeline in months	Benefit
11	Institute ordinances for tie-down requirements.	Inspect and require all manufactured homes to be tied down.	11	EAP	G1, G4	Public Works	< $10,000	Rural development grants	24	High
12	Raise bridges above the BFE	Bridges can be impassible during flooding events. Raise them above the base flood elevation.	8	SIP	G2	Public Works	>$100,000	Rural development grants	36	Medium
13	Increase drainage for airport property	Airport property has flash flooding problems.	4	SIP	G2	Public Works	$10,000 to $100,000	Rural development grants	36	High
14	Relocate Police Station outside Flood Zone B	Move the police station into old bank building. Also build a safe room inside to store records and use as EOC during disasters.	10	SIP	G2, G6	Public Works	>$100,000	Rural development grants, HMGP	24	High
15	Promote flood insurance	Educate the public on the benefits of purchasing flood insurance to minimize the financial impact of future floods using pamphlets and city website.	13	EAP	G2, G3	Public Works	< $10,000	City funds	24	High
16	Design, construct and maintain drainage improvement projects	Design and construct drainage improvement projects along Perryman Avenue, Humphrey Avenue, Moore Avenue, and Johnson Avenue. These drainage channels will be constructed to carry 25-year flood events.	5	SIP	G1, G2	Public Works	>$100,000	HMPG, FMAP, Rural development grants	24	High

TABLE 20-2.
RECOMMENDED MITIGATION ACTIONS

Action No.	Title	Description	Mitigation Action Ranking	Action Type	Applicable Goals	Responsible Department	Estimated Cost	Potential Funding Sources	Timeline in months	Benefit
17	Adopt "Higher Standard" riverine flood damage prevention ordinances and standards.	When final maps are approved, ordinance will be revised to include structures in flood prone areas must be built 1 foot above base flood elevation.	14	LPR	G2	Building Department	< $10,000	City funds	24	High
18	Provide training for CFM and CEM.	Provide training for CFM and CEM.	18	EAP	G4	City Administration	< $10,000	Texas Emergency Management	36	Medium
19	Participate in FEMA's CRS.	This is a voluntary program that communities earn credit points that determine classifications and reduced flood insurance premiums for buildings in the city. The city would need to do activities such as: public information, mapping and regulations, flood damage reduction, and warning and response.	19	LPR	G2, G4, G5, G6	City Administration	< $10,000	City funds	36	High
20	Construct cover over Park N Ride Parking Lot	Reduce the high cost of vehicle damage caused by severe hail storms.	12	SIP	G4, G6	Public Works	$10,000 to $100,000	Public Works	36	Medium
21	Public information on how to reduce water usage	Develop drought & extreme heat education materials to homeowners such as letting your lawn go dormant, Xeriscaping, installing low-flow showerheads & toilets, repairing leaky faucets, etc. in public messages through media outlets.	17	EAP	G1, G3	Building Department	< $10,000	PDM, Rural development grants	24	Medium

TABLE 20-2.
RECOMMENDED MITIGATION ACTIONS

Action No.	Title	Description	Mitigation Action Ranking	Action Type	Applicable Goals	Responsible Department	Estimated Cost	Potential Funding Sources	Timeline in months	Benefit

Notes:

BFE	Base Flood Elevation
CDBG	Community Development Block Grant
CEM	Community Emergency Managers
CFM	Community Flood Manager
CIAP	Coastal Impact Assistance Program
CoCoRaHS	Community Collaborative Rain, Hail and Snow Network
CRS	Community Rating System
EAP	Education and Awareness Programs
EOC	Emergency Operations Center
FEMA	Federal Emergency Management Agency
FIRM	Flood Insurance Rate Map
FMA	Flood Mitigation Assistance
FMAP	Flood Mitigation Assistance Program
HMGP	Hazard Mitigation Grant Program
LPR	Local Plans and Regulations
NOAA	National Oceanic and Atmospheric Administration
NSP	Natural Systems Protection
PDM	Pre-Disaster Mitigation
SIP	Structure and Infrastructure Project
TCRFC	Texas Colorado River Floodplain Coalition
USACE	U.S. Army Corps of Engineers
USDA	U.S. Department of Agriculture

CHAPTER 21.
PLAN ADOPTION AND MAINTENANCE

21.1 PLAN ADOPTION

A hazard mitigation plan must document that it has been formally adopted by the governing body of the jurisdiction requesting federal approval of the plan (44 CFR Section 201.6(c)(5)). For multi-jurisdictional plans, each jurisdiction requesting approval must document that is has been formally adopted. All planning partners fully met the participation requirements specified by the Steering Committee and will seek Disaster Mitigation Act of 2000 (DMA) compliance under this plan. The plan will be submitted for review to the Texas Division of Emergency Management (TDEM) and then to the Federal Emergency Management Agency (FEMA) Region VI for review and pre-adoption approval. Once pre-adoption approval has been provided, all planning partners will formally adopt the plan. All partners understand that DMA compliance and its benefits cannot be achieved until the plan is adopted. Copies of the resolutions adopting this plan for all planning partners can be found in Appendix F.

21.2 PLAN MAINTENANCE STRATEGY

A hazard mitigation plan must present a plan maintenance process that includes the following (44 CFR Section 201.6(c)(4)):

- A section describing the method and schedule of monitoring, evaluating, and updating the mitigation plan over a 5-year cycle
- A process by which local governments incorporate the requirements of the mitigation plan into other planning mechanisms, such as comprehensive or capital improvement plans, when appropriate
- A discussion on how the community will continue public participation in the plan maintenance process.

This chapter details the formal process that will ensure that the Matagorda County Hazard Mitigation Plan remains an active and relevant document and that the planning partners maintain their eligibility for applicable funding sources. The plan maintenance process includes a schedule for monitoring and evaluating the plan annually and producing an updated plan every 5 years. This chapter also describes how public participation will be integrated throughout the plan maintenance and implementation process. It also explains how the mitigation strategies outlined in this plan will be incorporated into existing planning mechanisms and programs, such as comprehensive land-use planning processes, capital improvement planning, and building code enforcement and implementation. The plan's format allows sections to be reviewed and updated when new data become available, resulting in a plan that will remain current and relevant.

21.2.1 Plan Implementation

The effectiveness of the hazard mitigation plan depends on its implementation and incorporation of its action items into partner jurisdictions' existing plans, policies, and programs. Together, the action items in the plan provide a framework for activities that the partnership can implement over the next 5 years. The planning team and the Steering Committee have established goals and objectives and have prioritized mitigation actions that will be implemented through existing plans, policies, and programs.

The Matagorda County Office of Emergency Management will have lead responsibility for overseeing the plan implementation and maintenance strategy. Plan implementation and evaluation will be a shared responsibility among all planning partnership members. The public will be invited to attend meetings regarding the implementation of the plan and feedback will be solicited at the end of the meeting.

21.2.2 Steering Committee

The Steering Committee is a total volunteer body that oversaw the development of the plan and made recommendations on key elements of the plan, including the maintenance strategy. It was the Steering Committee's position that an implementation committee with representation similar to the initial Steering Committee should have an active role in the plan maintenance strategy. The Steering Committee and the Implementation Committee are one and the same. Therefore, it is recommended that a Steering Committee remain a viable body involved in key elements of the plan maintenance strategy. The new Steering Committee should strive to include representation from the planning partners, as well as other stakeholders in the planning area. The pubic will be invited to attend Steering Committee meetings regarding maintenance of the plan and will be asked for feedback or comments on the maintenance strategy.

The principal role of the new implementation committee in this plan maintenance strategy will be to review the annual progress report and provide input to the Matagorda County Emergency Management Coordinator on possible enhancements to be considered at the next update. Future plan updates will be overseen by a Steering Committee similar to the one that participated in this plan development process, so keeping an interim Steering Committee intact will provide a head start on future updates. Completion of the progress report is the responsibility of each planning partner, not the responsibility of the Steering Committee. It will simply be the Steering Committee's role to review the progress report in an effort to identify issues needing to be addressed by future plan updates.

With adoption of this plan, the implementation committee will be tasked with plan monitoring, evaluation and maintenance. The participating jurisdictions and agencies, led by the Matagorda County Emergency Management Coordinator, agree to:

- Meet annually, and after a disaster event, to monitor and evaluate the implementation of the plan;
- Act as a forum for hazard mitigation issues;
- Disseminate hazard mitigation ideas and activities to all participants;
- Pursue the implementation of high priority, low- or no-cost recommended actions;
- Maintain vigilant monitoring of multi-objective, cost-share, and other funding opportunities to help the community implement the plan's recommended actions for which no current funding exists;
- Monitor and assist in implementation and update of this plan;
- Keep the concept of mitigation in the forefront of community decision making by identifying plan recommendations when other community goals, plans, and activities overlap, influence, or directly affect increased community vulnerability to disasters;
- Report on plan progress and recommended changes to the Matagorda County Commissioners Court and governing bodies of participating jurisdictions; and
- Inform and solicit input from the public.

The implementation committee is an advisory body and can only make recommendations to county, city, or district elected officials. Its primary duty is to see the plan successfully carried out and to report to the community governing boards and the public on the status of plan implementation and mitigation opportunities. Other duties include reviewing and promoting mitigation proposals, hearing stakeholder concerns about hazard mitigation, passing concerns on to appropriate entities, and posting relevant information in areas accessible to the public.

21.2.3 Plan Maintenance Schedule

The implementation committee will meet annually and after a state or federally declared hazard event as appropriate to monitor progress and update the mitigation strategy. The Matagorda County Emergency Management Coordinator will be responsible for initiating the plan reviews with the implementation committee.

21.2.4 Annual Progress Report

The minimum task of each planning partner will be the evaluation of the progress of its individual action plan during a 12-month performance period. This review will include the following:

- Summary of any hazard events that occurred during the performance period and the impact these events had on the planning area
- Review of mitigation success stories
- Review of continuing public involvement and feedback received from the community
- Brief discussion about why targeted strategies were not completed
- Re-evaluation of the action plan to evaluate whether the timeline for identified projects needs to be amended (such as changing a long-term project to a short-term one because of new funding)
- Recommendations for new projects
- Changes in or potential for new funding options (grant opportunities)
- Impact of any other planning programs or initiatives that involve hazard mitigation
- Monitor the incorporation of the Mitigation Plan into planning mechanisms.

The planning team has created a template to guide the planning partners in preparing a progress report (see Appendix G). The plan maintenance Steering Committee and the public will provide feedback to the planning team on items included in the template. The planning team will then prepare a formal annual report on the progress of the plan. This report should be used to:

- Post on the Matagorda County Office of Emergency Management website dedicated to the hazard mitigation plan
- Provide information for a press release that will be issued to the local media
- Inform planning partner governing bodies of the progress of actions implemented during the reporting period.

Uses of the progress report will be at the discretion of each planning partner. Annual progress reporting is not a requirement specified under 44 CFR. However, it may enhance the planning partnership's opportunities for funding. While failure to implement this component of the plan maintenance strategy will not jeopardize a planning partner's compliance under the DMA, it may jeopardize its opportunity to partner and leverage funding opportunities with the other partners.

Evaluation of progress can be achieved by monitoring changes in vulnerabilities identified in the plan. Changes in vulnerability can be identified by noting:

- Decreased vulnerability as a result of implementing recommended actions,
- Increased vulnerability as a result of failed or ineffective mitigation actions, and/or
- Increased vulnerability as a result of new development (and/or annexation).

21.2.5 Plan Update

Local hazard mitigation plans must be reviewed, revised if appropriate, and resubmitted for approval in order to remain eligible for benefits under the DMA (44 CFR, Section 201.6(d)(3)). The Matagorda County partnership intends to update the hazard mitigation plan on a 5-year cycle from the date of initial plan adoption. This cycle may be accelerated to less than 5 years based on the following triggers:

- A Presidential Disaster Declaration that impacts the planning area
- A hazard event that causes loss of life
- A comprehensive update of the county or participating cities' comprehensive plans

It will not be the intent of future updates to develop a complete new hazard mitigation plan for the planning area. The update will, at a minimum, include the following elements:

- The update process will be convened through a Steering Committee.
- The hazard risk assessment will be reviewed and, if necessary, updated using best available information and technologies.
- The action plans will be reviewed and revised to account for any actions completed, dropped, or changed and to account for changes in the risk assessment or new partnership policies identified under other planning mechanisms (such as the comprehensive plan).
- The draft update will be sent to appropriate agencies and organizations for comment.
- The public will be given an opportunity to participate in the update process and comment on the update prior to adoption.
- The partnership governing bodies will adopt their respective portions of the updated plan.

21.2.6 Continuing Public Involvement

The public will continue to be apprised of the plan's progress through the TCRFC and Matagorda County Office of Emergency Management's websites and other methods as appropriate. This site will not only house the final plan, it will become the one-stop shop for information regarding the plan, the partnership and plan implementation. Copies of the plan will be distributed to the public library system in Matagorda County Library. Upon initiation of future update processes, a new public involvement strategy will be initiated based on guidance from a new Steering Committee. This strategy will be based on the needs and capabilities of the planning partnership at the time of the update. This strategy will include the use of local media outlets within the planning area to notify the public of the implementation, monitoring, and evaluation of the plan. The public will be invited to participate in each stage by attending meetings and provide feedback to the planning team and new Steering Committee. The Steering Committee may include community stakeholders, such as prominent businesses, local action groups, etc.

21.2.7 Incorporation into Other Planning Mechanisms

The information on hazard, risk, vulnerability, and mitigation contained in this plan is based on the best science and technology available at the time this plan was prepared. The existing Matagorda County regulations, ordinances, and plans (including the Matagorda County Emergency Operations Plan), and the comprehensive plans of the partner cities are considered to be integral parts of this plan. The county and partner cities, through adoption of comprehensive plans and zoning ordinances, have planned for the impact of natural hazards.

It will be the responsibility of the county and the cities to determine additional implementation procedures when appropriate. This includes integrating the requirements of the hazard mitigation plan into other local planning documents, processes, or mechanisms.

All municipal planning partners are committed to creating a linkage between the hazard mitigation plan and their individual comprehensive plans. Other planning processes and programs to be coordinated with the recommendations of the hazard mitigation plan include the following:

- Comprehensive plans
- Strategic plans
- Partners' emergency response plans
- Capital improvement programs
- Municipal codes
- Community design guidelines
- Water-efficient landscape design guidelines
- Stormwater management programs
- Water system vulnerability assessments
- Community wildfire protection plans
- Growth management plans
- Ordinances, resolutions, and regulations
- Continuity of operations plans

The previous *TCRFC Multi-Jurisdictional Hazard Mitigation Plan Update 2011-2016* identified mitigation actions for each participating community. These mitigation actions and their current status are listed in Table 2-2. Ongoing or delayed mitigation actions identified in the previous plan were carried forward into new mitigation actions for Matagorda County, the City of Bay City, or the City of Palacios. The county and the cities did not actively track the linkage of the previous 2011 TCRFC plan into other local planning mechanisms. However, the annual progress report discussed in Chapter 21.2.4 and Appendix E will provide a framework for tracking future mitigation actions and the incorporation of this plan into other planning mechanisms.

Opportunities to integrate the requirements of this plan into other local planning mechanisms will continue to be identified through future meetings of the Steering Committee, by the individual communities and the county, and through the annual and five-year review processes as required by FEMA. The primary means for integrating mitigation strategies into other local planning mechanisms will be through the revision, update, and implementation of each jurisdiction's individual plans that require specific planning and administrative tasks (for example, plan amendments, ordinance revisions, capital improvement projects, etc.).

The previous Steering Committee representatives will remain charged with ensuring that the goals and strategies of new and updated local planning documents for their jurisdictions or agencies are consistent with the goals and actions of the Matagorda County Hazard Mitigation Plan Update and will not contribute to increased hazard vulnerability in Matagorda County, the City of Bay City, or the City of Palacios. During the planning process for new and updated local planning documents, such as a comprehensive plan, capital improvements plan, or emergency management plan, the applicable jurisdiction will provide a copy of the Matagorda County Hazard Mitigation Plan Update to the appropriate parties and recommend that all goals and strategies of new and updated local planning documents are consistent with and support the goals of the Matagorda County plan and will not contribute to increased hazards in the affected jurisdiction(s).

Although it is recognized that there are many possible benefits to integrating components of this plan into other local planning mechanisms, the development and maintenance of this stand-alone hazard mitigation plan is deemed by the Steering Committee to be the most effective and appropriate method to ensure implementation of local hazard mitigation actions at this time. All participating jurisdictions will comply with local and all applicable statutory requirements while incorporating the Matagorda County Hazard Mitigation Plan Update into existing plans in an effort to mitigate the impact of future disasters. A list of the existing plans and procedures in which mitigation activities will be integrated is listed in Table 21-1.

Specifically, the communities will:

- Matagorda County - The identified actions will be brought forward by the responsible department or entity to the County Commissioners for approval. The Commissioners will approve or deny the actions. All approved actions will be implemented/acted upon.
- City of Bay City - The identified actions will be brought forward by the responsible department or entity to the appropriate sub-committee and then on to the City Council for approval. The Council will approve or deny the actions. All approved actions will be implemented/acted upon.
- City of Palacios - The identified actions will be brought forward by the responsible department or entity to the appropriate sub-committee and then on to the City Council for approval. The Council will approve or deny the actions. All approved actions will be implemented/acted upon.

With decision making processes and identified mitigation actions in place, the planning team will ensure that the processes described in Table 21-1 will continue to integrate the Matagorda County Hazard Mitigation Plan Update into existing plans, ordinances and budget discussions.

TABLE 21-1. INCORPORATION OF MITIGATION ACTIVITIES

Jurisdiction	Type Of Plan	Department	Review Timeline	New Or Existing	Actions To Be Integrated
Matagorda County	Subdivision Regulations	Environmental Health Department	5 years	Existing	Maintain current data on high risk areas via the mitigation plan and regularly incorporate information on high risk hazard areas into the subdivision requirements, thereby eliminating or reducing potential impacts on current and future development.
	Floodplain Regulations	Floodplain Officer in the Environmental Health Department	5 years	Existing	Overlay high risk/flood prone areas from new 2016 FIRMs with current and future floodplain regulations, thereby minimizing or reducing the impacts of flooding on current and future development. Continue to update the Matagorda County Flood Insurance Study and FIRMs to include detailed floodplain information for all streams in Matagorda County.
	Capital Improvement Project Funding	County Commissioners' Court	Annual	Existing	During the annual budget review process, bring the identified actions to the Commissioners for approval. The Commissioners' Court will approve or deny the actions.
	Site Plan Review Requirements	County Environmental Health Department	Regularly	Existing	The County Environmental Health Department administers a “Site Specific Development Plan” review process in accordance with the Subdivision Ordinance, and will consider the high hazard areas, integrating the mitigation

TABLE 21-1. INCORPORATION OF MITIGATION ACTIVITIES

Jurisdiction	Type Of Plan	Department	Review Timeline	New Or Existing	Actions To Be Integrated
					plan data and proposed actions as applicable, into their decision making processes.
	Beach Restorations Program	County Commissioner’s Court, Beach Dune Committee and Emergency Management	Annual	New	The county will work with Commissioner’s Court, Beach Dune Committee and Emergency Management, integrating the findings of the HMP, to develop best beach erosion mitigation strategy for specific sections of the beach.
	Matagorda County Emergency Operations Plan	Department of Emergency Management within the County Sherriff’s Department	2 years	Existing	Integrate and implement hazard mitigation plan data on high hazards and applicable mitigation actions that are affected by or will affect the emergency operations plan on an annual basis.
City of Bay City	Bay City Vision 2040	Bay City Community Development Corporation	10 years	Existing	During the regular review process, the City Council will consider mitigation actions from the HMP for incorporation into the Vision 2040 Goals and Objectives elements.
	Subdivision Ordinance, Ch. 98 of City Ordinance	Planning and Development Department, Building Official	5 years	Existing	In 2015, an updated City of Bay City Subdivision Ordinance is being codified to manage platting and other development best practices. During this and future updates of the subdivision regulations, the city will incorporate current data on high hazard areas thereby reducing or eliminating the potential negative impacts of high hazards on existing and future development.
	Flood Damage Reduction Ordinance, Ch. 46 of City Ordinance	City of Bay City Public Works Department	5 years	Existing	During the regular review process, the city Floodplain Administrator will bring any flood mitigation actions identified in the HMP to the City Council to recommend incorporation into the ordinance. The Council will approve or deny the actions.
	Site Plan Review Process	Construction Inspector	Regularly	Existing	The Construction Inspector will consider the high hazard areas within the community and make development decisions in the best interest of the community integrating the mitigation plan

TABLE 21-1. INCORPORATION OF MITIGATION ACTIVITIES					
Jurisdiction	Type Of Plan	Department	Review Timeline	New Or Existing	Actions To Be Integrated
					data and proposed actions as applicable into their decision making processes.
	Capital Improvements Plan	City Council	5 years	Existing	During the Capital Improvement Plan update, bring the identified actions to the City Council for approval and eligibility for funding.
	Economic Development Plan	Bay City Economic Development Corporation	5 years	Existing	During the regular review process, the Economic Development Corporation will bring any economic mitigation actions identified in the HMP to the City Council to recommend incorporation into the plan. The Council will approve or deny the actions.
	Capital Improvements Plan	City Council	5 years	Existing	During the Capital Improvement Plan update, bring the identified actions to the City Council for approval and eligibility for funding.
	Drought Emergency Plan	Public Works Department	Annual	New	Develop a drought emergency plan and criteria for drought-related actions, taking into consideration HMP data on extreme heat and expansive soils.
	Sediment and Erosion Control Regulations	Planning and Development Department, Public Works Department	Annual	New	Develop, adopt and enforce a sediment and erosion control ordinance to eliminate erosion and sediment associated with construction and land development. Incorporate mitigation actions identified in the HMP into the ordinance. Develop a tree and landscape ordinance to compliment the storm water ordinance.
City of Palacios	Palacios Comprehensive Planning and Capacity Study, 2009-2029	Planning Commission	10 years	Existing	During the regular review process, the Planning Commission and City Council will consider mitigation actions from the HMP for incorporation into the Comprehensive Plan Goals and Objectives elements.
	Palacios Consolidated Zoning Ordinance, Ordinance 27-11-2007	Building Inspector and Code Enforcement	5 years	Existing	During the regular review and update of the zoning ordinance, the city will incorporate current data on high hazard areas, thereby reducing or eliminating the potential negative impacts of high hazards on existing and future development.

TABLE 21-1. INCORPORATION OF MITIGATION ACTIVITIES

Jurisdiction	Type Of Plan	Department	Review Timeline	New Or Existing	Actions To Be Integrated
	Subdivision Ordinance - Ch. 10, Municipal Code	Building Inspector and Code Enforcement	5 years	Existing	During the regular review and update of the subdivision regulations, the city will incorporate current data on high hazard areas thereby reducing or eliminating the potential negative impacts of high hazards on existing and future development.
	Floodplain Ordinance - Ch 3, Building Code (2007 as codified)	City Manager, City Building Inspector	5 years	Existing	During the regular review process, the City Manager and City Building Inspector will bring the identified actions to the City Council for approval. When final maps are approved, ordinance will be revised to include structures in flood prone areas must be built 1 foot above base flood elevation. The Council will approve or deny the actions.
	Site Plan Review Process	City Building Inspector	Regularly	Existing	The City Building Inspector reviews plan and relation to floodplain, and will consider the high hazard areas, integrating the mitigation plan data and proposed actions as applicable, into their decision making processes.
	5-year Capital Improvement Plan	City Council	Regularly	Existing	During the Capital Improvement Plan update, bring the identified actions to the City Council for approval and eligibility for funding.

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APPENDIX A.
ACRONYMS AND DEFINITIONS

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ACRONYMS

Note: Acronyms are defined the first time they are used in each part of this plan.

°F	Degrees Fahrenheit
°C	Degrees Celsius
%g	Percentage of gravity
44 CFR	Title 44 Code of Federal Regulations
CAPCOG	Capital Regional Council of Governments
CDP	Comprehensive Development Plan
CEPRA	Coastal Erosion Planning and Response Act
CoCoRaHS	Community Collaborative Rain, Hail and Snow Network
CPZ	Community Protection Zone
CWA	Clean Water Act
CWPP	Community Wildfire Protection Plan
CWSRF	Clean Water State Revolving Fund
DMA	Disaster Mitigation Act of 2000
DPS	Department of Public Safety
EAP	Education and Awareness Program
EF	Enhanced Fujita
EPA	U.S. Environmental Protection Agency
ESA	Endangered Species Act
FEMA	Federal Emergency Management Agency
FERC	Federal Energy Regulatory Commission
FIRM	Flood Insurance Rate Map
FIS	Flood Insurance Study
FPA-FOD	Fire Program Analysis-Fire-Occurrence Database
GIS	Geographic Information System
GLF	Geophysical Log Facility
GLO	General Land Office
H-GAC	Houston-Galveston Area Council of Governments
HAZMAT	Hazardous materials
HAZUS-MH	Hazards, United States-Multi Hazard
HMGP	Hazard Mitigation Grant Program

KT	Knot
LCRA	Lower Colorado River Authority
LPR	Local Plans and Regulations
MCEDC	Matagorda County Economic Development Corporation
ML	Local Magnitude Scale
MLI	Midterm Levee Inventory
mph	Miles per Hour
M_W	Moment Magnitude
NEHRP	National Earthquake Hazards Reduction Program
NFIP	National Flood Insurance Program
NOAA	National Oceanic and Atmospheric Administration
NREL	National Renewable Energy Laboratory
NSP	Natural Systems Protection
NWS	National Weather Service
OTA	Congressional Office of Technology Assessment
PDM	Pre-Disaster Mitigation
PDI	Palmer Drought Index
PGA	Peak Ground Acceleration
PHDI	Palmer Hydrological Drought Index
PMF	Probable Maximum Flood
SIP	Structure and Infrastructure Project
SFHA	Special Flood Hazard Area
SPI	Standardized Precipitation Index
SSI	Storm Susceptibility Index
SWCD	Soil and Water Conservation District
TCEQ	Texas Commission on Environmental Quality
TCRFC	Texas Colorado River Floodplain Coalition
TDEM	Texas Division of Emergency Management
TFS	Texas Forest Service
TSSWCB	Texas State Soil and Water Conservation Board
TWDB	Texas Water Development Board
TxWRAP	Texas A&M Forest Service Wildfire Risk Assessment Portal
USACE	U.S. Army Corps of Engineers
USDA	U.S. Department of Agriculture
USFS	U.S. Forest Service

USGS	U.S. Geological Survey
VRI	Values Response Index
WHP	Wildfire Hazard Potential
WUI	Wildland Urban Interface

DEFINITIONS

100-Year Flood: The term “100-year flood” can be misleading. The 100-year flood does not necessarily occur once every 100 years. Rather, it is the flood that has a 1% chance of being equaled or exceeded in any given year. Thus, the 100-year flood could occur more than once in a relatively short period of time. The Federal Emergency Management Agency (FEMA) defines it as the 1% annual chance flood, which is now the standard definition used by most federal and state agencies and by the National Flood Insurance Program (NFIP).

Accredited Levee: A levee that is shown on a FIRM as providing protection from the 1% annual chance or greater flood. A **non-accredited or de-accredited levee** is a levee that is not shown on a FIRM as providing protection from the 1% annual chance or greater flood. A **provisionally accredited levee** is a previously accredited levee that has been de-accredited for which data and/or documentation is pending that will show the levee is compliant with NFIP regulations.

Acre-Foot: An acre-foot is the amount of water it takes to cover 1 acre to a depth of 1 foot. This measure is used to describe the quantity of storage in a water reservoir. An acre-foot is a unit of volume. One acre foot equals 7,758 barrels; 325,829 gallons; or 43,560 cubic feet. An average household of four will use approximately 1 acre-foot of water per year.

Asset: An asset is any man-made or natural feature that has value, including, but not limited to, people; buildings; infrastructure, such as bridges, roads, sewers, and water systems; lifelines, such as electricity and communication resources; and environmental, cultural, or recreational features such as parks, wetlands, and landmarks.

Base Flood: The flood having a 1% chance of being equaled or exceeded in any given year, also known as the “100-year” or “1% chance” flood. The base flood is a statistical concept used to ensure that all properties subject to the NFIP are protected to the same degree against flooding.

Basin: A basin is the area within which all surface water, whether from rainfall, snowmelt, springs, or other sources, flows to a single water body or watercourse. The boundary of a river basin is defined by natural topography, such as hills, mountains, and ridges. Basins are also referred to as “watersheds” and “drainage basins.”

Benefit: A benefit is a net project outcome and is usually defined in monetary terms. Benefits may include direct and indirect effects. For the purposes of benefit-cost analysis of proposed mitigation measures, benefits are limited to specific, measurable risk reduction factors, including reduction in expected property losses (buildings, contents, and functions) and protection of human life.

Benefit/Cost Analysis: A benefit/cost analysis is a systematic, quantitative method of comparing projected benefits to projected costs of a project or policy. It is used as a measure of cost effectiveness.

Breach: An opening through which floodwaters may pass after part of a levee has given way.

Building: A building is defined as a structure that is walled and roofed, principally aboveground, and permanently fixed to a site. The term includes manufactured homes on permanent foundations on which the wheels and axles carry no weight.

Capability Assessment: A capability assessment provides a description and analysis of a community's current capacity to address threats associated with hazards. The assessment includes two components: an inventory of an agency's mission, programs, and policies, and an analysis of its capacity to carry them out. A capability assessment is an integral part of the planning process in which a community's actions to reduce losses are identified, reviewed, and analyzed, and the framework for implementation is identified. The following capabilities were reviewed under this assessment:

- Legal and regulatory capability
- Administrative and technical capability
- Fiscal capability

Collapsible soils: Collapsible soils consist of loose, dry, low-density materials that collapse and compact under the addition of water or excessive loading. Soil collapse occurs when the land surface is saturated at depths greater than those reached by typical rain events. This saturation eliminates the clay bonds holding the soil grains together. Similar to expansive soils, collapsible soils result in structural damage such as cracking of the foundation, floors, and walls in response to settlement.

Community Protection Zones (CPZ): CPZs are based on an analysis of the "Where People Live" housing density data and surrounding fire behavior potential and represent those areas considered highest priority for wildfire mitigation planning activities. "Rate of Spread" data is used to determine the areas of concern around populated areas that are within a 2-hour fire spread distance.

Conflagration: A fire that grows beyond its original source area to engulf adjoining regions. Wind, extremely dry or hazardous weather conditions, excessive fuel buildup, and explosions are usually the elements behind a wildfire conflagration.

Critical Area: An area defined by state or local regulations as deserving special protection because of unique natural features or its value as habitat for a wide range of species of flora and fauna. A sensitive/critical area is usually subject to more restrictive development regulations.

Critical Facility: Facilities and infrastructure that are critical to the health and welfare of the population. These become especially important after any hazard event occurs. For the purposes of this plan, critical facilities include:

- Structures or facilities that produce, use, or store highly volatile, flammable, explosive, toxic or water reactive materials.
- Hospitals, nursing homes, and housing likely to contain occupants who may not be sufficiently mobile to avoid death or injury during a hazard event.
- Police stations, fire stations, vehicle and equipment storage facilities, and emergency operations centers that are needed for disaster response before, during, and after hazard events.
- Public and private utilities, facilities and infrastructure that are vital to maintaining or restoring normal services to areas damaged by hazard events.
- Government facilities.

Dam: A barrier, including one for flood detention, designed to impound liquid volumes and which has a height of dam greater than six feet (Texas Administrative Code, Ch. 299, 1986).

Dam Failure: Dam failure refers to a partial or complete breach in a dam (or levee) that impacts its integrity. Dam failures occur for a number of reasons, such as flash flooding, inadequate spillway size, mechanical failure of valves or other equipment, freezing and thawing cycles, earthquakes, and intentional destruction.

Debris Flow: Dense mixtures of water-saturated debris that move down-valley; looking and behaving much like flowing concrete. They form when loose masses of unconsolidated material are saturated, become unstable, and move down slope. The source of water varies but includes rainfall, melting snow or ice, and glacial outburst floods.

Deposition: Deposition is the placing of eroded material in a new location.

Disaster Mitigation Act of 2000 (DMA): The DMA is Public Law 106-390 and is the latest federal legislation enacted to encourage and promote proactive, pre-disaster planning as a condition of receiving financial assistance under the Robert T. Stafford Act. The DMA emphasizes planning for disasters before they occur. Under the DMA, a pre-disaster hazard mitigation program and new requirements for the national post-disaster hazard mitigation grant program (HMGP) were established.

Drainage Basin: A basin is the area within which all surface water, whether from rainfall, snowmelt, springs or other sources, flows to a single water body or watercourse. The boundary of a river basin is defined by natural topography, such as hills, mountains and ridges. Drainage basins are also referred to as **watersheds** or **basins**.

Drought: Drought is a period of time without substantial rainfall or snowfall from one year to the next. Drought can also be defined as the cumulative impacts of several dry years or a deficiency of precipitation over an extended period of time, which in turn results in water shortages for some activity, group, or environmental function. A hydrological drought is caused by deficiencies in surface and subsurface water supplies. A socioeconomic drought impacts the health, well-being, and quality of life or starts to have an adverse impact on a region. Drought is a normal, recurrent feature of climate and occurs almost everywhere.

Earthquake: An earthquake is defined as a sudden slip on a fault, volcanic or magmatic activity, and sudden stress changes in the earth that result in ground shaking and radiated seismic energy. Earthquakes can last from a few seconds to over 5 minutes, and have been known to occur as a series of tremors over a period of several days. The actual movement of the ground in an earthquake is seldom the direct cause of injury or death. Casualties may result from falling objects and debris as shocks shake, damage, or demolish buildings and other structures.

Emergency Action Plan: A document that identifies potential emergency conditions at a dam and specifies actions to be followed to minimize property damage and loss of life. The plan specifies actions the dam owner should take to alleviate problems at a dam. It contains procedures and information to assist the dam owner in issuing early warning and notification messages to responsible downstream emergency management authorities of the emergency situation. It also contains inundation maps to show emergency management authorities the critical areas for action in case of an emergency. (FEMA 64)

Enhanced Fujita Scale (EF-scale): The EF-scale is a set of wind estimates (not measurements) based on damage. It uses 3-second gusts estimated at the point of damage based on a judgment of 8 levels of damage to the 28 indicators. These estimates vary with height and exposure. Standard measurements are taken by weather stations in openly exposed area.

Epicenter: The point on the earth's surface directly above the hypocenter of an earthquake. The location of an earthquake is commonly described by the geographic position of its epicenter and by its focal depth.

Expansive Soil: Expansive soil and rock are characterized by clayey material that shrinks as it dries or swells as it becomes wet.

Exposure: Exposure is defined as the number and dollar value of assets considered to be at risk during the occurrence of a specific hazard.

Extent: The extent is the size of an area affected by a hazard.

Extreme Heat: Summertime weather that is substantially hotter or more humid than average for a location at that time of year.

Fault: A fracture in the earth's crust along which two blocks of the crust have slipped with respect to each other.

Fire Behavior: Fire behavior refers to the physical characteristics of a fire and is a function of the interaction between the fuel characteristics (such as type of vegetation and structures that could burn), topography, and weather. Variables that affect fire behavior include the rate of spread, intensity, fuel consumption, and fire type (such as underbrush versus crown fire).

Fire Frequency: Fire frequency is the broad measure of the rate of fire occurrence in a particular area. An estimate of the areas most likely to burn is based on past fire history or fire rotation in the area, fuel conditions, weather, ignition sources (such as human or lightning), fire suppression response, and other factors.

Flash Flood: A flash flood occurs with little or no warning when water levels rise at an extremely fast rate.

Flood: The inundation of normally dry land resulting from the rising and overflowing of a body of water.

Flood Insurance Rate Map (FIRM): FIRMs are the official maps on which the Federal Emergency Management Agency (FEMA) has delineated the Special Flood Hazard Area (SFHA).

Flood Insurance Study: A report published by the Federal Insurance and Mitigation Administration for a community in conjunction with the community's FIRM. The study contains such background data as the base flood discharges and water surface elevations that were used to prepare the FIRM. In most cases, a community FIRM with detailed mapping will have a corresponding flood insurance study.

Floodplain: Any land area susceptible to being inundated by flood waters from any source. A FIRM identifies most, but not necessarily all, of a community's floodplain as the SFHA.

Floodway: Floodways are areas within a floodplain that are reserved for the purpose of conveying flood discharge without increasing the base flood elevation more than one foot. Generally speaking, no development is allowed in floodways, as any structures located there would block the flow of floodwaters.

Focal Depth: The depth from the earth's surface to the hypocenter.

Freeboard: Freeboard is the margin of safety added to the base flood elevation.

Freezing Rain: The result of rain occurring when the temperature is below the freezing point. The rain freezes on impact, resulting in a layer of glaze ice up to an inch thick. In a severe ice storm, an evergreen tree 60 feet high and 30 feet wide can be burdened with up to 6 tons of ice, creating a threat to power and telephone lines and transportation routes.

Frequency: For the purposes of this plan, frequency refers to how often a hazard of specific magnitude, duration, or extent is expected to occur on average. Statistically, a hazard with a 100-year frequency is expected to occur about once every 100 years on average and has a 1% chance of occurring any given year. Frequency reliability varies depending on the type of hazard considered.

Fujita Scale of Tornado Intensity: Tornado wind speeds are sometimes estimated on the basis of wind speed and damage sustained using the Fujita Scale. The scale rates the intensity or severity of tornado events using numeric values from F0 to F5 based on tornado wind speed and damage. An F0 tornado (wind speed less than 73 miles per hour [mph]) indicates minimal damage (such as broken tree limbs), and an F5 tornado (wind speeds of 261 to 318 mph) indicates severe damage.

Goal: A goal is a general guideline that explains what is to be achieved. Goals are usually broad-based, long-term, policy-type statements and represent global visions. Goals help define the benefits that a plan is trying to achieve. The success of a hazard mitigation plan is measured by the degree to which its goals have been met (that is, by the actual benefits in terms of actual hazard mitigation).

Geographic Information System (GIS): GIS is a computer software application that relates data regarding physical and other features on the earth to a database for mapping and analysis.

Ground Subsidence: Ground subsidence is the sinking of land over human-caused or natural underground voids and the settlement of native low density soils.

Groundwater Depletion: Groundwater depletion occurs when groundwater is pumped from pore spaces between grains of sand and gravel. If an aquifer has beds of clay or silt within or next to it, the lowered water pressure in the sand and gravel causes slow drainage of water from the clay and silt beds. The reduced water pressure is a loss of support for the clay and silt beds. Because these beds are compressible, they compact (become thinner), and the effects are seen as a lowering of the land surface.

Hazard: A hazard is a source of potential danger or adverse condition that could harm people or cause property damage.

Hazard Mitigation Grant Program (HMGP): Authorized under Section 202 of the Robert T. Stafford Disaster Relief and Emergency Assistance Act, the HMGP is administered by FEMA and provides grants to states, tribes, and local governments to implement hazard mitigation actions after a major disaster declaration. The purpose of the program is to reduce the loss of life and property due to disasters and to enable mitigation activities to be implemented as a community recovers from a disaster.

Hazards U.S. Multi-Hazard (HAZUS-MH) Loss Estimation Program: HAZUS-MH is a GIS-based program used to support the development of risk assessments as required under the DMA. The HAZUS-MH software program assesses risk in a quantitative manner to estimate damages and losses associated with natural hazards. HAZUS-MH is FEMA's nationally applicable, standardized methodology and software program and contains modules for estimating potential losses from earthquakes, floods, and wind hazards. HAZUS-MH has also been used to assess vulnerability (exposure) for other hazards.

High Hazard Dam — Dams where failure or operational error will probably cause loss of human life. (FEMA 333)

Hurricane: A tropical cyclone with maximum sustained surface winds (using the U.S. 1-minute average) of 64 knot (kt) (74 miles per hour [mph]) or more.

Hydraulics: Hydraulics is the branch of science or engineering that addresses fluids (especially water) in motion in rivers or canals, works and machinery for conducting or raising water, the use of water as a prime mover, and other fluid-related areas.

Hydrology: Hydrology is the analysis of waters of the earth. For example, a flood discharge estimate is developed by conducting a hydrologic study.

Hypocenter: The region underground where an earthquake's energy originates.

Intensity: For the purposes of this plan, intensity refers to the measure of the effects of a hazard.

Interface Area: An area susceptible to wildfires and where wildland vegetation and urban or suburban development occur together. An example would be smaller urban areas and dispersed rural housing in forested areas.

Inventory: The assets identified in a study region comprise an inventory. Inventories include assets that could be lost when a disaster occurs and community resources are at risk. Assets include people, buildings, transportation, and other valued community resources.

Land Subsidence: Land subsidence is the loss of surface elevation due to the removal of subsurface support. In Texas there are three types of subsidence that warrant the most concern: groundwater depletion, sinkholes in karst areas, and erosion.

Landslide: Landslides can be described as the sliding movement of masses of loosened rock and soil down a hillside or slope. Fundamentally, slope failures occur when the strength of the soils forming the slope exceeds the pressure, such as weight or saturation, acting upon them.

Levee: A man-made structure, usually an earthen embankment or concrete floodwall, designed and constructed in accordance with sound engineering practices to contain, control, or divert the flow of water so as to provide reasonable assurance of excluding temporary flooding from the leveed area.

Lightning: Lightning is an electrical discharge resulting from the buildup of positive and negative charges within a thunderstorm. When the buildup becomes strong enough, lightning appears as a "bolt," usually within or between clouds and the ground. A bolt of lightning instantaneously reaches temperatures approaching 50,000ºF. The rapid heating and cooling of air near lightning causes thunder. Lightning is a major threat during thunderstorms. In the United States, 75 to 100 people are struck and killed by lightning each year (see http://www.fema.gov/hazard/thunderstorms/thunder.shtm).

Liquefaction: Liquefaction is the complete failure of soils, occurring when soils lose shear strength and flow horizontally. It is most likely to occur in fine grain sands and silts, which behave like viscous fluids when liquefaction occurs. This situation is extremely hazardous to development on the soils that liquefy, and generally results in extreme property damage and threats to life and safety.

Local Government: Any county, municipality, city, town, township, public authority, school district, special district, intrastate district, council of governments (regardless of whether the council of governments is incorporated as a nonprofit corporation under state law), regional or interstate government entity, or agency or instrumentality of a local government; any Indian tribe or authorized tribal organization, or Alaska Native village or organization; and any rural community, unincorporated town or village, or other public entity.

Magnitude: Magnitude is the measure of the strength of an earthquake, and is typically measured by the Richter scale. As an estimate of energy, each whole number step in the magnitude scale corresponds to the release of about 31 times more energy than the amount associated with the preceding whole number value.

Mitigation: A preventive action that can be taken in advance of an event that will reduce or eliminate the risk to life or property.

Mitigation Actions: Mitigation actions are specific actions to achieve goals and objectives that minimize the effects from a disaster and reduce the loss of life and property.

National Flood Insurance Program (NFIP): The NFIP provides federally backed flood insurance in exchange for communities enacting floodplain regulations.

Objective: For the purposes of this plan, an objective is defined as a short-term aim that, when combined with other objectives, forms a strategy or course of action to meet a goal.

Peak Ground Acceleration: Peak Ground Acceleration is a measure of the highest amplitude of ground shaking that accompanies an earthquake, based on a percentage of the force of gravity.

Preparedness: Preparedness refers to actions that strengthen the capability of government, citizens, and communities to respond to disasters.

Presidential Disaster Declaration: These declarations are typically made for events that cause more damage than state and local governments and resources can handle without federal government assistance. Generally, no specific dollar loss threshold has been established for such declarations. A Presidential Disaster Declaration puts into motion long-term federal recovery programs, some of which are matched by state programs, designed to help disaster victims, businesses, and public entities.

Probability of Occurrence: The probability of occurrence is a statistical measure or estimate of the likelihood that a hazard will occur. This probability is generally based on past hazard events in the area and a forecast of events that could occur in the future. A probability factor based on yearly values of occurrence is used to estimate probability of occurrence.

Repetitive Loss Property: Any NFIP-insured property that, since 1978 and regardless of any changes of ownership during that period, has experienced:

- Four or more paid flood losses in excess of $1,000; or
- Two paid flood losses in excess of $1,000 within any 10-year period since 1978; or

- Three or more paid losses that equal or exceed the current value of the insured property.

Riparian Zone: The area along the banks of a natural watercourse.

Riverine: Of or produced by a river. Riverine floodplains have readily identifiable channels. Floodway maps can only be prepared for riverine floodplains.

Risk: Risk is the estimated impact that a hazard would have on people, services, facilities, and structures in a community. Risk measures the likelihood of a hazard occurring and resulting in an adverse condition that causes injury or damage. Risk is often expressed in relative terms such as a high, moderate, or low likelihood of sustaining damage above a particular threshold due to occurrence of a specific type of hazard. Risk also can be expressed in terms of potential monetary losses associated with the intensity of the hazard.

Risk Assessment: Risk assessment is the process of measuring potential loss of life, personal injury, economic injury, and property damage resulting from hazards. This process assesses the vulnerability of people, buildings, and infrastructure to hazards and focuses on (1) hazard identification; (2) impacts of hazards on physical, social, and economic assets; (3) vulnerability identification; and (4) estimates of the cost of damage or costs that could be avoided through mitigation.

Risk Ranking: This ranking serves two purposes, first to describe the probability that a hazard will occur, and second to describe the impact a hazard will have on people, property, and the economy. Risk estimates for the jurisdiction are based on the methodology that the jurisdiction used to prepare the risk assessment for this plan. The following equation shows the risk ranking calculation:

Risk Ranking = Probability + Impact (people + property + economy)

Robert T. Stafford Act: The Robert T. Stafford Disaster Relief and Emergency Assistance Act, Public Law 100-107, was signed into law on November 23, 1988. This law amended the Disaster Relief Act of 1974, Public Law 93-288. The Stafford Act is the statutory authority for most federal disaster response activities, especially as they pertain to FEMA and its programs.

Severe Local Storm: Small-scale atmospheric systems, including tornadoes, thunderstorms, windstorms, ice storms, and snowstorms. These storms may cause a great deal of destruction and even death, but their impact is generally confined to a small area. Typical impacts are on transportation infrastructure and utilities.

Significant Hazard Dam: Dams where failure or operational error will result in no probable loss of human life but can cause economic loss, environmental damage, or disruption of lifeline facilities, or can impact other concerns. Significant hazard dams are often located in rural or agricultural areas but could be located in areas with population and significant infrastructure. (FEMA 333)

Sinkhole: A collapse depression in the ground with no visible outlet. Its drainage is subterranean. It is commonly vertical-sided or funnel-shaped.

Soil Erosion: Soil erosion is the removal and simultaneous transportation of earth materials from one location to another by water, wind, waves, or moving ice.

Special Flood Hazard Area: The base floodplain delineated on a FIRM. The SFHA is mapped as a Zone A in riverine situations. The SFHA may or may not encompass all of a community's flood problems.

Stakeholder: Business leaders, civic groups, academia, non-profit organizations, major employers, managers of critical facilities, farmers, developers, special purpose districts, and others whose actions could impact hazard mitigation.

Stream Bank Erosion: Stream bank erosion is common along rivers, streams, and drains where banks have been eroded, sloughed, or undercut. However, it is important to remember that a stream is a dynamic and constantly changing system. It is natural for a stream to want to meander, so not all eroding banks are "bad" and in need of repair. Generally, stream bank erosion becomes a problem where development has limited the meandering nature of streams, where streams have been channelized, or where stream bank structures (like bridges, culverts, etc.) are located in places where they can actually cause damage to downstream areas. Stabilizing these areas can help protect watercourses from continued sedimentation, damage to adjacent land uses, control unwanted meander, and improvement of habitat for fish and wildlife.

Steep Slope: Different communities and agencies define it differently, depending on what it is being applied to, but generally a steep slope is a slope in which the percent slope equals or exceeds 25%. For this study, steep slope is defined as slopes greater than 33%.

Sustainable Hazard Mitigation: This concept includes the sound management of natural resources, local economic and social resiliency, and the recognition that hazards and mitigation must be understood in the largest possible social and economic context.

Thunderstorm: A thunderstorm is a storm with lightning and thunder produced by cumulonimbus clouds. Thunderstorms usually produce gusty winds, heavy rains, and sometimes hail. Thunderstorms are usually short in duration (seldom more than 2 hours). Heavy rains associated with thunderstorms can lead to flash flooding during the wet or dry seasons.

Tornado: A tornado is a violently rotating column of air extending between and in contact with a cloud and the surface of the earth. Tornadoes are often (but not always) visible as funnel clouds. On a local scale, tornadoes are the most intense of all atmospheric circulations, and winds can reach destructive speeds of more than 300 mph. A tornado's vortex is typically a few hundred meters in diameter, and damage paths can be up to 1 mile wide and 50 miles long.

Tropical Storm: A tropical cyclone with maximum sustained surface wind speed (using the U.S. 1-minute average) ranges from 34 kt (39 mph) to 63 kt (73 mph).

Tropical Depression: A tropical cyclone with maximum sustained surface wind speed (using the U.S. 1-minute average) ranges from 4 kt (39 mph) to 63 kt (73 mph).

Values Response Index (VRI): The wildfire VRI reflects a rating of the potential impact of a wildfire on values or assets. The VRI is an overall rating that combines the impact ratings for WUI (housing density) and Pine Plantations (pine age) into a single measure. VRI combines the likelihood of a fire occurring (threat) with those areas of most concern that are adversely impacted by fire to derive a single overall measure of wildfire risk.

Vulnerability: Vulnerability describes how exposed or susceptible an asset is to damage. Vulnerability depends on an asset's construction, contents, and the economic value of its functions. Like indirect damages, the vulnerability of one element of the community is often related to the vulnerability of another. For example, many businesses depend on uninterrupted electrical power. Flooding of an electric substation would affect not only the substation itself but businesses as well. Often, indirect effects can be much more widespread and damaging than direct effects.

Watershed: A watershed is an area that drains downgradient from areas of higher land to areas of lower land to the lowest point, a common drainage basin.

Wildfire: Wildfire refers to any uncontrolled fire occurring on undeveloped land that requires fire suppression. The potential for wildfire is influenced by three factors: the presence of fuel, topography, and air mass. Fuel can include living and dead vegetation on the ground, along the surface as brush and small trees, and in the air such as tree canopies. Topography includes both slope and elevation. Air mass includes temperature, relative humidity, wind speed and direction, cloud cover, precipitation amount, duration, and the stability of the atmosphere at the time of the fire. Wildfires can be ignited by lightning and, most frequently, by human activity including smoking, campfires, equipment use, and arson.

Wildfire Hazard Potential (WHP): The wildfire threat or WHP is the likelihood of a wildfire occurring or burning into an area. Threat is calculated by combining multiple landscape characteristics including surface and canopy fuels, fire behavior, historical fire occurrences, weather observations, terrain conditions, and other factors.

Windstorm: Windstorms are generally short-duration events involving straight-line winds or gusts exceeding 50 mph. These gusts can produce winds of sufficient strength to cause property damage. Windstorms are especially dangerous in areas with significant tree stands, exposed property, poorly constructed buildings, mobile homes (manufactured housing units), major infrastructure, and aboveground utility lines. A windstorm can topple trees and power lines; cause damage to residential, commercial, critical facilities; and leave tons of debris in its wake.

Winter Storm: A storm having significant snowfall, ice, or freezing rain; the quantity of precipitation varies by elevation.

Zoning Ordinance: The zoning ordinance designates allowable land use and intensities for a local jurisdiction. Zoning ordinances consist of two components: a zoning text and a zoning map.

APPENDIX B. LOCAL MITIGATION PLAN REVIEW TOOL

APPENDIX B.
LOCAL MITIGATION PLAN REVIEW TOOL

This appendix presents the local mitigation action review tool for the Matagorda County Hazard Mitigation Plan. The review tool demonstrates how the plan meets federal regulations and offers state and FEMA planners an opportunity to provide feedback on the plan to the community.

LOCAL MITIGATION PLAN REVIEW TOOL

The *Local Mitigation Plan Review Tool* demonstrates how the Local Mitigation Plan meets the regulation in 44 CFR §201.6 and offers States and FEMA Mitigation Planners an opportunity to provide feedback to the community.

- The Regulation Checklist provides a summary of FEMA's evaluation of whether the Plan has addressed all requirements.
- The Plan Assessment identifies the plan's strengths as well as documents areas for future improvement.
- The Multi-jurisdiction Summary Sheet is an optional worksheet that can be used to document how each jurisdiction met the requirements of the each Element of the Plan (Planning Process; Hazard Identification and Risk Assessment; Mitigation Strategy; Plan Review, Evaluation, and Implementation; and Plan Adoption).

The FEMA Mitigation Planner must reference this *Local Mitigation Plan Review Guide* when completing the *Local Mitigation Plan Review Tool*.

Jurisdiction:	**Title of Plan:**	**Date of Plan:**

Local Point of Contact:	**Address:**
Title:	
Agency:	
Phone Number:	**E-Mail:**

State Reviewer:	**Title:**	**Date:**

FEMA Reviewer:	**Title:**	**Date:**
Date Received in FEMA Region ***(insert #)***		
Plan Not Approved		
Plan Approvable Pending Adoption		
Plan Approved		

SECTION 1:
REGULATION CHECKLIST

INSTRUCTIONS: The Regulation Checklist must be completed by FEMA. The purpose of the Checklist is to identify the location of relevant or applicable content in the Plan by Element/sub-element and to determine if each requirement has been 'Met' or 'Not Met.' The 'Required Revisions' summary at the bottom of each Element must be completed by FEMA to provide a clear explanation of the revisions that are required for plan approval. Required revisions must be explained for each plan sub-element that is 'Not Met.' Sub-elements should be referenced in each summary by using the appropriate numbers (A1, B3, etc.), where applicable. Requirements for each Element and sub-element are described in detail in this *Plan Review Guide* in Section 4, Regulation Checklist.

1. REGULATION CHECKLIST **Regulation** (44 CFR 201.6 Local Mitigation Plans)	**Location in Plan (section and/or page number)**	**Met**	**Not Met**
ELEMENT A. PLANNING PROCESS			
A1. Does the Plan document the planning process, including how it was prepared and who was involved in the process for each jurisdiction? (Requirement §201.6(c)(1))			
A2. Does the Plan document an opportunity for neighboring communities, local and regional agencies involved in hazard mitigation activities, agencies that have the authority to regulate development as well as other interests to be involved in the planning process? (Requirement §201.6(b)(2))			
A3. Does the Plan document how the public was involved in the planning process during the drafting stage? (Requirement §201.6(b)(1))			
A4. Does the Plan describe the review and incorporation of existing plans, studies, reports, and technical information? (Requirement §201.6(b)(3))			
A5. Is there discussion of how the community(ies) will continue public participation in the plan maintenance process? (Requirement §201.6(c)(4)(iii))			
A6. Is there a description of the method and schedule for keeping the plan current (monitoring, evaluating and updating the mitigation plan within a 5-year cycle)? (Requirement §201.6(c)(4)(i))			
ELEMENT A: REQUIRED REVISIONS			

1. REGULATION CHECKLIST **Regulation** (44 CFR 201.6 Local Mitigation Plans)	Location in Plan (section and/or page number)	Met	Not Met
ELEMENT B. HAZARD IDENTIFICATION AND RISK ASSESSMENT			
B1. Does the Plan include a description of the type, location, and extent of all natural hazards that can affect each jurisdiction(s)? (Requirement §201.6(c)(2)(i))			
B2. Does the Plan include information on previous occurrences of hazard events and on the probability of future hazard events for each jurisdiction? (Requirement §201.6(c)(2)(i))			
B3. Is there a description of each identified hazard's impact on the community as well as an overall summary of the community's vulnerability for each jurisdiction? (Requirement §201.6(c)(2)(ii))			
B4. Does the Plan address NFIP insured structures within the jurisdiction that have been repetitively damaged by floods? (Requirement §201.6(c)(2)(ii))			
ELEMENT B: REQUIRED REVISIONS			
ELEMENT C. MITIGATION STRATEGY			
C1. Does the plan document each jurisdiction's existing authorities, policies, programs and resources and its ability to expand on and improve these existing policies and programs? (Requirement §201.6(c)(3))			
C2. Does the Plan address each jurisdiction's participation in the NFIP and continued compliance with NFIP requirements, as appropriate? (Requirement §201.6(c)(3)(ii))			
C3. Does the Plan include goals to reduce/avoid long-term vulnerabilities to the identified hazards? (Requirement §201.6(c)(3)(i))			
C4. Does the Plan identify and analyze a comprehensive range of specific mitigation actions and projects for each jurisdiction being considered to reduce the effects of hazards, with emphasis on new and existing buildings and infrastructure? (Requirement §201.6(c)(3)(ii))			
C5. Does the Plan contain an action plan that describes how the actions identified will be prioritized (including cost benefit review), implemented, and administered by each jurisdiction? (Requirement §201.6(c)(3)(iv)); (Requirement §201.6(c)(3)(iii))			
C6. Does the Plan describe a process by which local governments will integrate the requirements of the mitigation plan into other planning mechanisms, such as comprehensive or capital improvement plans, when appropriate? (Requirement §201.6(c)(4)(ii))			
ELEMENT C: REQUIRED REVISIONS			

1. REGULATION CHECKLIST **Regulation** (44 CFR 201.6 Local Mitigation Plans)	Location in Plan (section and/or page number)	Met	Not Met
ELEMENT D. PLAN REVIEW, EVALUATION, AND IMPLEMENTATION (applicable to plan updates only)			
D1. Was the plan revised to reflect changes in development? (Requirement §201.6(d)(3))			
D2. Was the plan revised to reflect progress in local mitigation efforts? (Requirement §201.6(d)(3))			
D3. Was the plan revised to reflect changes in priorities? (Requirement §201.6(d)(3))			
ELEMENT D: REQUIRED REVISIONS			
ELEMENT E. PLAN ADOPTION			
E1. Does the Plan include documentation that the plan has been formally adopted by the governing body of the jurisdiction requesting approval? (Requirement §201.6(c)(5))			
E2. For multi-jurisdictional plans, has each jurisdiction requesting approval of the plan documented formal plan adoption? (Requirement §201.6(c)(5))			
ELEMENT E: REQUIRED REVISIONS			
ELEMENT F. ADDITIONAL STATE REQUIREMENTS (OPTIONAL FOR STATE REVIEWERS ONLY; NOT TO BE COMPLETED BY FEMA)			
F1.			
F2.			
ELEMENT F: REQUIRED REVISIONS d			

SECTION 2:
PLAN ASSESSMENT

INSTRUCTIONS: The purpose of the Plan Assessment is to offer the local community more comprehensive feedback to the community on the quality and utility of the plan in a narrative format. The audience for the Plan Assessment is not only the plan developer/local community planner, but also elected officials, local departments and agencies, and others involved in implementing the Local Mitigation Plan. The Plan Assessment must be completed by FEMA. The Assessment is an opportunity for FEMA to provide feedback and information to the community on: 1) suggested improvements to the Plan; 2) specific sections in the Plan where the community has gone above and beyond minimum requirements; 3) recommendations for plan implementation; and 4) ongoing partnership(s) and information on other FEMA programs, specifically RiskMAP and Hazard Mitigation Assistance programs. The Plan Assessment is divided into two sections:

1. Plan Strengths and Opportunities for Improvement
2. Resources for Implementing Your Approved Plan

Plan Strengths and Opportunities for Improvement is organized according to the plan Elements listed in the Regulation Checklist. Each Element includes a series of italicized bulleted items that are suggested topics for consideration while evaluating plans, but it is not intended to be a comprehensive list. FEMA Mitigation Planners are not required to answer each bullet item, and should use them as a guide to paraphrase their own written assessment (2-3 sentences) of each Element.

The Plan Assessment must not reiterate the required revisions from the Regulation Checklist or be regulatory in nature, and should be open-ended and to provide the community with suggestions for improvements or recommended revisions. The recommended revisions are suggestions for improvement and are not required to be made for the Plan to meet Federal regulatory requirements. The italicized text should be deleted once FEMA has added comments regarding strengths of the plan and potential improvements for future plan revisions. It is recommended that the Plan Assessment be a short synopsis of the overall strengths and weaknesses of the Plan (no longer than two pages), rather than a complete recap section by section.

Resources for Implementing Your Approved Plan provides a place for FEMA to offer information, data sources and general suggestions on the overall plan implementation and maintenance process. Information on other possible sources of assistance including, but not limited to, existing publications, grant funding or training opportunities, can be provided. States may add state and local resources, if available.

A. Plan Strengths and Opportunities for Improvement

This section provides a discussion of the strengths of the plan document and identifies areas where these could be improved beyond minimum requirements.

Element A: Planning Process

How does the Plan go above and beyond minimum requirements to document the planning process with respect to: • *Involvement of stakeholders (elected officials/decision makers, plan implementers, business owners, academic institutions, utility companies, water/sanitation districts, etc.);* • *Involvement of Planning, Emergency Management, Public Works Departments or other planning agencies (i.e., regional planning councils);* • *Diverse methods of participation (meetings, surveys, online, etc.); and* • *Reflective of an open and inclusive public involvement process.*

Element B: Hazard Identification and Risk Assessment

In addition to the requirements listed in the Regulation Checklist, 44 CFR 201.6 Local Mitigation Plans identifies additional elements that should be included as part of a plan's risk assessment. The plan should describe vulnerability in terms of: *1) A general description of land uses and future development trends within the community so that mitigation options can be considered in future land use decisions;* *2) The types and numbers of existing and future buildings, infrastructure, and critical facilities located in the identified hazard areas; and* *3) A description of potential dollar losses to vulnerable structures, and a description of the methodology used to prepare the estimate.* *How does the Plan go above and beyond minimum requirements to document the Hazard Identification and Risk Assessment with respect to:* • *Use of best available data (flood maps, HAZUS, flood studies) to describe significant hazards;* • *Communication of risk on people, property, and infrastructure to the public (through tables, charts, maps, photos, etc.);* • *Incorporation of techniques and methodologies to estimate dollar losses to vulnerable structures;* • *Incorporation of Risk MAP products (i.e., depth grids, Flood Risk Report, Changes Since Last FIRM, Areas of Mitigation Interest, etc.); and* • *Identification of any data gaps that can be filled as new data became available.*

Element C: Mitigation Strategy

How does the Plan go above and beyond minimum requirements to document the Mitigation Strategy with respect to:

- *Key problems identified in, and linkages to, the vulnerability assessment;*
- *Serving as a blueprint for reducing potential losses identified in the Hazard Identification and Risk Assessment;*
- *Plan content flow from the risk assessment (problem identification) to goal setting to mitigation action development;*
- *An understanding of mitigation principles (diversity of actions that include structural projects, preventative measures, outreach activities, property protection measures, post-disaster actions, etc);*
- *Specific mitigation actions for each participating jurisdictions that reflects their unique risks and capabilities;*
- *Integration of mitigation actions with existing local authorities, policies, programs, and resources; and*
- *Discussion of existing programs (including the NFIP), plans, and policies that could be used to implement mitigation, as well as document past projects.*

Element D: Plan Update, Evaluation, and Implementation (*Plan Updates Only*)

How does the Plan go above and beyond minimum requirements to document the 5-year Evaluation and Implementation measures with respect to:

- *Status of previously recommended mitigation actions;*
- *Identification of barriers or obstacles to successful implementation or completion of mitigation actions, along with possible solutions for overcoming risk;*
- *Documentation of annual reviews and committee involvement;*
- *Identification of a lead person to take ownership of, and champion the Plan;*
- *Reducing risks from natural hazards and serving as a guide for decisions makers as they commit resources to reducing the effects of natural hazards;*
- *An approach to evaluating future conditions (i.e. socio-economic, environmental, demographic, change in built environment etc.);*
- *Discussion of how changing conditions and opportunities could impact community resilience in the long term; and*
- *Discussion of how the mitigation goals and actions support the long-term community vision for increased resilience.*

B. Resources for Implementing Your Approved Plan

Ideas may be offered on moving the mitigation plan forward and continuing the relationship with key mitigation stakeholders such as the following:

- *What FEMA assistance (funding) programs are available (for example, Hazard Mitigation Assistance (HMA)) to the jurisdiction(s) to assist with implementing the mitigation actions?*
- *What other Federal programs (National Flood Insurance Program (NFIP), Community Rating System (CRS), Risk MAP, etc.) may provide assistance for mitigation activities?*
- *What publications, technical guidance or other resources are available to the jurisdiction(s) relevant to the identified mitigation actions?*
- *Are there upcoming trainings/workshops (Benefit-Cost Analysis (BCA), HMA, etc.) to assist the jurisdictions(s)?*
- *What mitigation actions can be funded by other Federal agencies (for example, U.S. Forest Service, National Oceanic and Atmospheric Administration (NOAA), Environmental Protection Agency (EPA) Smart Growth, Housing and Urban Development (HUD) Sustainable Communities, etc.) and/or state and local agencies?*

SECTION 3:
MULTI-JURISDICTION SUMMARY SHEET (OPTIONAL)

INSTRUCTIONS: For multi-jurisdictional plans, a Multi-jurisdiction Summary Spreadsheet may be completed by listing each participating jurisdiction, which required Elements for each jurisdiction were 'Met' or 'Not Met,' and when the adoption resolutions were received. This Summary Sheet does not imply that a mini-plan be developed for each jurisdiction; it should be used as an optional worksheet to ensure that each jurisdiction participating in the Plan has been documented and has met the requirements for those Elements (A through E).

MULTI-JURISDICTION SUMMARY SHEET

#	Jurisdiction Name	Jurisdiction Type (city/borough/ township/ village, etc.)	Plan POC	Mailing Address	Email	Phone	Requirements Met (Y/N)					
							A. Planning Process	B. Hazard Identification & Risk Assessment	C. Mitigation Strategy	D. Plan Review, Evaluation & Implementation	E. Plan Adoption	F. State Require-ments
1												
2												
3												
4												
5												
6												
7												
8												
9												

MULTI-JURISDICTION SUMMARY SHEET													
#	Jurisdiction Name	Jurisdiction Type (city/borough/ township/ village, etc.)	Plan POC	Mailing Address	Email	Phone	Requirements Met (Y/N)					
							A. Planning Process	B. Hazard Identification & Risk Assessment	C. Mitigation Strategy	D. Plan Review, Evaluation & Implementation	E. Plan Adoption	F. State Require-ments
10												
11												
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APPENDIX C.
PUBLIC OUTREACH

APPENDIX C.
PUBLIC OUTREACH

This appendix includes the agenda, sign-in sheets, and meeting notes from each of the three Steering Committee Meetings. This appendix also include the results of the Matagorda County Hazard Mitigation Plan questionnaire, as described in Chapter 3.7.2.

Hazard Mitigation Plan Updates

for Colorado, Wharton, Jackson, and Matagorda Counties

Steering Committee Kickoff Meeting

Tuesday, March 10, 2015

9:00 AM

<u>Agenda</u>

1. Welcome and Introductions
2. Steering Committee Purpose and Responsibilities
3. Plan Partners and Signators
4. Purpose and Goals of the Update Process
5. Review and Amend Mitigation Goals and Objectives (in packet)
6. Review Mitigation Actions from TCRFC Hazard Mitigation Plan (in packet)
7. Critical Facilities Discussion
8. Next Steps
    a. Capabilities Assessment
    b. Hazard Analysis Review
    c. Community Participation and Survey (in packet)
9. Next meeting date - ???
10. Adjournment

TCRFC Hazard Mitigation Plan Update - Kickoff Meeting - Group 2B
March 10, 2015

LAST NAME	FIRST NAME	COUNTY	COMMUNITY	EMAIL	SIGN-IN
Gibson	James	**Matagorda**	**Matagorda County**	pct3@co.matagorda.tx.us;	
~~Gonzales~~	~~Ruben~~	~~Matagorda~~	~~Matagorda County~~	~~rgonzales@co.matagorda.tx.us;~~	
Krobot	Lisa	Matagorda	Matagorda County	lkrobot@co.matagorda.tx.us;	Lisa Krobot
Putska	Dan	Matagorda	Matagorda County	mcpct1@sbcglobal.net;	
~~Watts~~	~~Bob~~	~~Matagorda~~	~~Matagorda County~~	~~bwatts1946@yahoo.com;~~	
Emergency MgR. Matthes	Doug	Matagord	" "	dmatthes@co.matagorda.tx.us	
Holub	Marvin	**Wharton**	**City of East Bernard**	mayorholub@gmail.com	
Salcido	John	Wharton	City of East Bernard	AldermanSalcido@gmail.com	
Wessels	~~Audra~~ Audrey	Wharton	City of East Bernard	ebcityhall@elc.net;	
~~Collins~~	~~Anthony~~	~~**Wharton**~~	~~**City of El Campo**~~		
Harris	Clay	Wharton	City of El Campo	charris@cityofelcampo.org	
~~Popp~~	~~Wayne~~	~~Wharton~~	~~City of El Campo~~	~~wpopp@cityofelcampo.org;~~	
Snyder	Mindi	Wharton	City of El Campo	msnyder@cityofelcampo.org;	Mindi Snyder
Young	Richard	Wharton	City of El Campo	ryoung@cityofelcampo.org;	
Williamson	Gary	Wharton	"	gwilliamson@cityofelcampo.org	
Staff	Liz	Wharton	"	lstaff@cityofelcampo.org	

TCRFC Hazard Mitigation Plan Update - Kickoff Meeting - Group 2B
March 10, 2015

LAST NAME	FIRST NAME	COUNTY	COMMUNITY	EMAIL	SIGN-IN
Stein	Ford	**Colorado**	**City of Columbus**	secretary@columbustexas.net;	
Warschak	Donald	Colorado	City of Columbus	drw89@columbustexas.net;	
Cooper	Michael	**Colorado**	**City of Eagle Lake**	mcooper450@aol.com	
~~Parr~~	~~Mary~~	~~Colorado~~	City of Eagle Lake	mparrformayor@aol.com	Dan Clark
Rucka	Sylvia	Colorado	City of Eagle Lake	citymanager@coeltx.net	Sylvia Rucka
Freeman	David	Colorado	City of EaglLak	Police@coeltx.net	[illegible]
koller	Milton	**Colorado**	**City of Weimar**	mayor@weimartexas.org	
Miller	Ray	Colorado	City of Weimar	citymgr@weimartexas.org	
Stoever	Dolores	Colorado	City of Weimar	citysec@weimartexas.org;	
		Jackson	City of Edna	smiller@cityofedna.com	[illegible]
Hermes	Joe D.	**Jackson**	**City of Edna**	joehermescpa@yahoo.com	
Ryan	Brad	Jackson	City of Edna	bryan@cityofedna.com	[illegible]

TCRFC Hazard Mitigation Plan Update - Kickoff Meeting - Group 2B
March 10, 2015

LAST NAME	FIRST NAME	COUNTY	COMMUNITY	EMAIL	SIGN-IN
McLennan	Lori	**Jackson**	**Jackson County**	l.mclennan@co.jackson.tx.us	Lori McLennan
Simons	Dennis	Jackson	Jackson County	d.simons@co.jackson.tx.us	
Friedrich	Allen	✓	–	jceoc@co.jackson.Tx.us	A Friedrich
Bricker	Mark	**Matagorda**	**City of Bay City**	mbricker@cityofbaycity.org	
Clegg	Rhonda	Matagorda	City of Bay City	rjones@cityofbaycity.org	
Jasek	Marla	Matagorda	City of Bay City	mjasek@cityofbaycity.org	Marla Jasek
Kocurek	David	**Matagorda**	**City of Palacios**	dkocurek@cityofpalacios.org	
Garrett	Robert	Matagorda	City of Palacios	rlgarrett@hotmail.com	Robert L Garrett

TCRFC Hazard Mitigation Plan Update - Kickoff Meeting - Group 2B
March 10, 2015

LAST NAME	FIRST NAME	COUNTY	COMMUNITY	EMAIL	SIGN-IN
Jimenez	Brandi			bjimenez@cityofwharton.com	[signature]
Andel	JoAN			jandel@cityofwharton.com	[signature]
Bollom	Ronnie	**Wharton**	**City of Wharton**	rbollom@cityofwharton.com;	[signature]
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LYNCH	TERRY	WHARTON	CITY OF WHARTON	TDLYNCH@CITYOFWHARTON.COM	[signature]
Kowalik	John	" "	" "	JKowalik@cityofwharton.com	[signature]
Dettling	Leroy	**Wharton**	**Wharton County**	leroy.dettling@co.wharton.tx.us;	
Johnson	Stephen	Wharton	Wharton County	sjohnson@cityofwharton.com	[signature]
King	Chris	Wharton	Wharton County	d.chris@co.wharton.tx.us;	
Kirkland	Andy	Wharton	Wharton County	andy.kirkland@co.wharton.tx.us; ✓	[signature]
Martin	Monica	Wharton	Wharton County	monica.martin@co.wharton.tx.us;	
MARCHANT	KYLE	WHARTON	CITY OF WHARTON	kmarchant@cityofwharton.com	[signature]

TCRFC Hazard Mitigation Plan Update - Kickoff Meeting - Group 2
March 24, 2015

LAST NAME	FIRST NAME	COUNTY	COMMUNITY	Email	SIGN - IN
Dowell	John	Lee	City of Giddings	johndowell@giddings.net	
Jones	Fred	Lee	City of Giddings	DeeDeeJones2@verizon.net;	
Jorgensen	Ricky	Lee	City of Giddings	citymanager@giddings.net	
Schneider	Spencer	Lee	City of Giddings	sschneider@giddings.net;	on other sheet
Zgabay	Jeffrey	Lee	City of Giddings	jzgabay@giddings.net;	
Lacy	Kerry	Bastrop	City of Elgin	klacy@ci.elgin.tx.us	
Alvarez	Lucretia	Bastrop	City of Elgin	lalvararez@ci.elgin.tx.us	
Van Landingh	Stacey	Bastrop	City of Elgin		
Cazares	Jim	Bastrop	City of Elgin	jcazares@ci.elgin.tx.us	
Cooke	Gary	Bastrop	City of Elgin	gcooke@ci.elgin.tx.us;	
Cox	Pam	Lee	City of Lexington	cityoflexington@reveillebroadband.com;	
Wooldaldge	Johnny	Lee	City of Lexington	CPTWooldaldge@LexingtonPDTX.org	[illegible]
HOOPER	CHARLOTTE	LEE	CITY OF LEXINGTON	CITYOFLEXMAYOR@gmail.com	Charlotte Hooper

TCRFC Hazard Mitigation Plan Update - Kickoff Meeting - Group 2

March 24, 2015

LAST NAME	FIRST NAME	COUNTY	COMMUNITY	Email	SIGN - IN
Carrigan	Jant	Fayette	Fayette County	janet.carrigan@co.fayette.tx.us	[signature]
Rost	Jeff	Fayette	City of La Grange	jrost@cityoflg.com	Jeff Rost
Fischer	Paul E.	Lee	Lee County	paul.fischer@co.lee.tx.us;	
Hartfield	Douglas	Lee	Lee County	commissionerpct2@co.lee.tx.us;	
Pitts	Maurice	Lee	Lee County		
Kieschnick	Hilary	Lee	Lee County	hilary.kieschnick@co.lee.tx.us;	
PESCHKE	DELYNN	LEE	LEE COUNTY	EMC@CO.LEE.TX.US	[signature]
MASON	DAVID	Colorado	City of Weimar	citytreasurer@weimartexas.org	[signature]
Stoever	Dolores	Colorado	City of Weimar	citysec@weimartexas.org;	
Miller	Ray	Colorado	City of Weimar	citymgr@weimartexas.org	
koller	Milton	Colorado	City of Weimar	mayor@weimartexas.org	
Box	Vickie	BASTROP Co.	Bastrop County	vickie.box@co.bastrop.tx.us	Vickie Box
Dommert	Blake	Bastrop	Bastrop County	blake.dommert@co.bastrop.tx.us	Blake Dommert
Wilson	Tom	Bas	Bas Cnty	tom.wilson@co.bastrop.tx.us	[signature]
Spooner	William	Bastrop	BAS CNTY	William.spooner@co.bastrop.	[signature]
Merritt	David	Jackson	City of Ganado	ganadopd401@cityofganado.com	[signature]
CAZARES	JAMES	BASTROP	Elgin	JCAZARES@CI.ELGIN.TX.US	[signature]

Colorado, Jackson, Matagorda, and Wharton Counties, TX

Hazard Mitigation Plan Updates
Kickoff Meeting – Meeting Notes

Caney Creek Church, Wharton, TX
9:00am – 11:00am
Tuesday, March 10, 2015

- Welcome and Introductions – Mickey Reynolds (Texas Colorado River Floodplain Coalition [TCRFC]) welcomed everyone and introduced the planning team of Jeff Ward (JSW), Cindy Engelhardt (Halff Associates), Laura Johnston (Tetra Tech), Krista Jack(Tetra Tech), and Diane MacMillan (Tetra Tech). See sign in sheet for a complete list of attendees.
    1. Jeff Ward (JSW) provided the group with an overview of the Mitigation Plan Update process. TCRFC Basin and Planning Group was funded under the Pre-Disaster Mitigation Grant, which was awarded in Fall 2014 to update Hazard Mitigation Plans (HMP).
    2. Jeff explained the roles and responsibilities of Halff and Tetra Tech. Halff will complete the hazard risk assessment and GIS mapping of hazards. Tetra Tech will complete the planning portions, including leading the steering committee meetings, and write the plan.
    3. Jeff stated that Halff will distribute a spreadsheet and instructions to attendees to document their time for these meetings for the in-kind 25% soft match.
    4. Laura Johnston (Tetra Tech) requested introductions of each of the attendees and the organization or municipality they represent.
    5. Laura provided an overview of the mitigation plan process, FEMA requirements, and the benefits to the counties and participating communities. Laura stated that a partnership with FEMA and the state is important to the planning and implementation of the HMP. Representatives from FEMA Region 6 and the State of Texas were invited to the meeting but could not attend.
- Each attendee was provided a folder, tailored to their specific community and county, with handouts, a copy of the presentation slides, and contact information for the planning team.
- Laura reviewed the purpose and responsibilities of the Steering Committee. Steering Committee members:
    1. Are leaders involved in the development of the plan
    2. Provide guidance on their specific community

3. Carry information from the meetings to their community
4. Represent all community stakeholders (residents and businesses)
5. Attend and actively participate in all three committee meetings (including this one)

- One attendee participated in the development of the current HMP that is being updated. Laura stated that the purpose of the plan is to identify practical, implementable, politically viable, and fundable mitigation action. Laura noted that the hazard mitigation actions from the current plan are robust.
- Laura discussed Planning Partners and Signators. Each Planning Partner must actively participate in the Steering Committee meetings and formally adopt the plan. The sign-in sheets will be attached to the plan to demonstrate participation. Laura presented a list of participating communities within each plan and asked if the list was comprehensive. No other jurisdictions attended the kick-off meeting.
- Laura presented the goals for each meeting of the Steering Committee:
  1. The goal of the kick-off meeting is to review the goals and objectives, briefly discuss past mitigation actions, discuss critical facilities, and review the natural hazards as ranked in the current plan;
  2. The goal of the second meeting is to present the results of the hazard risk assessment and to complete the hazard ranking process; and
  3. The goal of the third meeting is to identify actions that mitigate the identified hazards and to rank those hazards.
- Laura discussed the project schedule.
- Laura reviewed differentiation between goals, objectives, and mitigation actions.
  1. Laura gave attendees several minutes to review the existing goals and objectives in their current plans (provided in their folder) and make comments on these. She asked that if there are mitigation actions that the counties want to include, the attendees should make a note of those too as they go through this multi-month process because these actions will be presented and discussed in the third meeting.
- Laura reviewed the goals and objectives from the current regional HMP and stated the updated plan would only address natural hazards. Objective 3.1 would be modified to remove the reference to "man-made" hazards. Laura read through each goal and objective and asked for comments. No comments were received during the meeting so Laura asked that *any changes or suggestions for goals and objectives should be submitted to the planning team by Friday, March 20, 2015*.
  1. Mr. Allen Friedrich (Jackson) stated that Jackson County is under a different Council of Governments (COG) and has a separate HMP. Jackson County will provide the previous plan to Cindy so it can be referenced into the HMP update.
  2. Laura stated that there will be local and county-wide mitigation actions. For the local mitigation, the local jurisdiction prioritizes the mitigation actions. FEMA and the State of Texas require HMPs be reviewed annually but updated every 5 years. However, the HMP can be updated anytime (live, dynamic document).
  3. Jeff clarified that a current HMP is necessary for counties and communities to receive FEMA grant funding.
  4. Laura encouraged attendees after the meeting to review the handout containing sample mitigation goals, objectives, and actions as well as the Mitigation Ideas document from FEMA.

- Laura explained the handout entitled Project Implementation Worksheet, which documents mitigation actions prioritized in the current plan. Laura requested that attendees update the mitigation action status spreadsheet provided in the packet. This includes updating the project status and funding. There is no punitive action from FEMA for "incomplete" or "no longer applicable" mitigation actions update. Going forward, we want only practical, fundable, and implementable mitigation actions for the HMP update. More information on the previous mitigation actions is in the 2011 TCRFC HMP, which is available on the TCRFC website. Laura asked that the *updates to the mitigation action table are returned to the team by March 20, 2015.*
- Laura explained that FEMA requires a minimum of two mitigation actions for each hazard profiled in the plan and that they must be unique to each participating community.
    1. There will be community-specific and county-wide mitigation actions. The local jurisdiction prioritizes the community-specific mitigation actions. County-wide mitigation actions will be ranked by all those representing entities within the County.
    2. Mitigation actions must be supported by at least one goal/objective. However, mitigation actions can fall under multiple goals and objectives. Mitigation actions are more likely to be funded if under more than one goal/objective.
- Laura reviewed the critical facilities analysis.
    1. There was a brief discussion on the definition of "Critical Facilities." Laura shared the Community Rating System's (CRS) definition of Critical Facilities because there is no definition of critical facilities in the current regional HMP nor the State of Texas HMP. Laura has a draft list of critical facilities obtained from FEMA's HAZUS defaults but this needs to be updated.
    2. Laura handed out draft lists of the critical facilities in each county to Lisa Krobot (Matagorda County), Andy Kirkland (Wharton), Lori McLennan (Jackson), and other attendees to pass on to Chuck Rodgers, the Colorado County Emergency Manager. These points of contact will *review/update the lists and return to Laura in the next six weeks.*
    3. This updated information is needed to map the critical facilities for each jurisdiction to determine if these facilities are located in high risk areas and how they overlap with hazards. Cindy Engelhardt (Halff Associates) will provide the mapped information to the counties once completed as this detailed list of critical facilities will not be included in the HMP.
- Laura reviewed the next steps: (1) capabilities assessment; (2) hazard analysis; and (3) community participation and survey.
    1. Laura provided an overview of capabilities assessment. Jeremy Kaufman is Tetra Tech's lead for this element. He will be contacting each of the participating jurisdictions. Tetra Tech will initiate online research and then contact the local communities to further document and verify the current resources of each county/community. This is used to determine the strengths and opportunities related to the community's ability to implement the future mitigation actions.
    2. Halff Associates will conduct the hazards analysis in the next few months. During the next (second) meeting, the results of the hazards analysis will be presented and the attendees will rank these hazards during next meeting.
        - When ranking hazards, perception and reality are not one and the same. Perception (especially community perception) can be skewed based on recent event, even if event

is not local. When ranking hazards, we need to consider reality on a community-specific basis. Laura further explained that the hazard assessment will analyze historical information and data, rate of occurrence, and future projected losses, etc. We will provide hazard-specific information for the members to determine a prioritization ranking of high, medium, or low. Community perception will be uncovered, in part, through the community survey. However, ranking process is still subjective.

3. Laura discussed how community participation (including the online survey) is an integral part of this HMP update process. Laura discussed the benefits of full community participation in order to produce a true community plan.
    - The online surveys are already live and consists of 35 questions. There are separate surveys for each county. The survey were set up for community input; the links to the surveys were provided in the handout packets.
    - Need to get the word out into the communities. Suggest to put on local websites, TCRFC's website, mention in meetings, post announcement, word of mouth, etc.

- Laura reviewed the action items for the Steering Committee members, including:
    1. Review/update goals and objectives by March 20, 2015
    2. Update mitigation action table with current status of actions by March 20, 2015
    3. Publicize community survey link to community through website posting and other media
    4. Community points of contact will review and update as necessary the list of critical facilities and return to Laura in 6 weeks.
- The date for the next meeting of the Steering Committee has not been determined but is anticipated to be in May/April. Meeting details will be forthcoming.
- Adjournment

Colorado, Jackson, Matagorda, and Wharton County

Hazard Mitigation Plan Updates

Steering Committee Meeting 2

Tuesday, June 2, 2015

9:00 AM

Agenda

1. Welcome and Introductions
2. Reminder: What is Hazard Mitigation and Why?
3. Reminder: Steering Committee Purpose and Responsibilities
4. Review of Completed Items
    a. Final Goals and Objectives (in packet)
    b. Updated Mitigation Actions (in packet)
    c. Capabilities Assessment
5. Hazard Analysis
    a. Community Participation and Survey Results (in packet)
    b. Hazard Analysis Review
    c. Hazard Ranking Exercise (in packet)
6. Mitigation Action Worksheet (in packet)
7. Next Meeting Date – August 11, 2015
8. Action Items
9. Adjournment

Hazard Mitigation Group	Last Name	First Name	County	Organization	Title	Sign In	Date
2B	Snyder	Mindi	Wharton	City of El Campo	City Manager	Mindi Snyder	6/2/2015
2B	Staff	Liz	Wharton	City of El Campo	Bldg Official	[illegible]	6/2/2015
2B	Williamson	Gary	Wharton	City of El Campo			6/2/2015
2B	Young	Richard	Wharton	City of El Campo			6/2/2015
							6/2/2015
							6/2/2015
							6/2/2015
							6/2/2015
2B	Bollom	Ronnie	Wharton	City of Wharton	CFM, Building Official	R Bollom	6/2/2015
2B	Garza	Andres	Wharton	City Wharton	City Manager		6/2/2015
	Urbanovsky	Cheryl	"	City of Wharton	Asst to City Mgr - Special Projects	Cheryl Urbanovsky	6/2/2015
							6/2/2015
							6/2/2015
	Coleman	Richard	Wharton	City of Wharton	Ast. Chief	[illegible]	6/2/2015
2B	Awdel	Joan	Wharton	Wharton County			6/2/2015
2B	Bergstrom	Amy	Wharton	Wharton County			6/2/2015
2B	Dettling	Leroy	Wharton	Wharton County			6/2/2015
2B	Jimenez	Brandi	Wharton	Wharton County			6/2/2015
2B	Johnson	Stephen	Wharton	Wharton County	EMC	Stephen Johnson	6/2/2015

Wharton County Continued on next page

HMP Meeting Round 2 Group 2B

Hazard Mitigation Group	Last Name	First Name	County	Organization	Title	Sign In	Date
2B	King	Chris	Wharton	Wharton County			6/2/2015
2B	Kirkland	Andy	Wharton	Wharton County			6/2/2015
2B	Kowalik	John	Wharton	Wharton County			6/2/2015
2B	Lynch	Terry	Wharton	Wharton County			6/2/2015
2B	Marchant	Kyle	Wharton	Wharton County			6/2/2015
2B	Martin	Monica	Wharton	Wharton County	Floodplain Administrator	[illegible]	6/2/2015

HMP Meeting Round 2 Group 2B

Hazard Mitigation Group	Last Name	First Name	County	Organization	Title	Sign In	Date
2B	McLennan	Lori	Jackson	Jackson County	FPA	Lori McLennan	6/2/2015
2B	Simons	Dennis	Jackson	Jackson County	County Judge		6/2/2015
	Friedrich	Allen	Jackson	EMC	EMC	Allen Friedrich	6/2/2015
							6/2/2015
							6/2/2015
							6/2/2015
2B	Miller	S	Jacson	City of Edna			6/2/2015
							6/2/2015
							6/2/2015
2B	Bricker	Mark	Matagorda	City of Bay City	Mayor		6/2/2015
2B	Clegg	Rhonda	Matagorda	City of Bay City	City Secretary		6/2/2015
2B	Jasek	Marla	Matagorda	City of Bay City	Floodplain Administrator	Marla Jasek	6/2/2015
							6/2/2015
							6/2/2015
							6/2/2015
2B	Miles ~~Garrett~~	David ~~Robert~~	Matagorda	City of Palacios	Chief of Police	[illegible]	6/2/2015
2B	Kocurek	David	Matagorda	City of Palacios	City Manager	David Kocurek	6/2/2015
							6/2/2015
							6/2/2015
							6/2/2015

Hazard Mitigation Group	Last Name	First Name	County	Organization	Title	Sign In	Date
							6/2/2015
							6/2/2015
2B	Gertson	Darrell	Colorado	Colorado County	Commissioner		6/2/2015
2B	Kotzebue	David	Colorado	Colorado County	Floodplain Administrator		6/2/2015
2B	Kubesch	Darrell	Colorado	Colorado County	Commissioner		6/2/2015
2B	Rogers	Chuck	Colorado	Colorado County	Emergency Management Coordinator		6/2/2015
							6/2/2015
							6/2/2015
							6/2/2015
							6/2/2015
2B	Hermes	Joe D.	Jackson	City of Edna	Mayor		6/2/2015
2B	Ryan	Brad	Jackson	City of Edna	Public Works Director		6/2/2015
	Wooldridge	Clinton	Jackson	City of Edna	Chief of Police		6/2/2015
							6/2/2015
							6/2/2015
							6/2/2015
2B	Merrit	David	Jackson	City of Ganado	Police Dept		6/2/2015
	MARTIN	CURTIS	JACKSON	CITY OF GANADO	DIRECTOR OF PUBLIC WORKS		6/2/2015
							6/2/2015
2B	Friednich	Allen	Jackson	Jackson County			6/2/2015

HMP Meeting Round 2 Group 2B

Hazard Mitigation Group	Last Name	First Name	County	Organization	Title	Sign In	Date
2B	Stein	Ford	Colorado	City of Columbus	City Inspector		6/2/2015
2B	Warschak	Donald	Colorado	City of Columbus	City Manager		6/2/2015
	Lattimore	William	Colorado	City of Columbus	Chief of Police		6/2/2015
							6/2/2015
							6/2/2015
							6/2/2015
2B	Cooper	Michael	Colorado	City of Eagle Lake			6/2/2015
2B	Freeman	David	Colorado	City of Eagle Lake		[illegible]	6/2/2015
2B	Parr	Mary	Colorado	City of Eagle Lake	Mayor		6/2/2015
2B	Rucka	Sylvia	Colorado	City of Eagle Lake	City Manager	Sylvia Rucka	6/2/2015
	Clark	Dan	"	Director of Public Works		Dan Clark	6/2/2015
							6/2/2015
							6/2/2015
							6/2/2015
2B	koller	Milton	Colorado	City of Weimar	Mayor		6/2/2015
2B	Mason	David	Colorado	City of Weimar	City Treasurer		6/2/2015
2B	Miller	Ray	Colorado	City of Weimar	City Manager		6/2/2015
2B	Stoever	Dolores	Colorado	City of Weimar	City Secretary		6/2/2015
							6/2/2015
							6/2/2015

HMP Meeting Round 2 Group 2B

Hazard Mitigation Group	Last Name	First Name	County	Organization	Title	Sign In	Date
2B	Gibson	James	Matagorda	Matagorda County	County Commissioner Prec. 3		6/2/2015
2B	Gonzales	Ruben	Matagorda	Matagorda County	Environmental Health Director		6/2/2015
2B	Krobot	Lisa	Matagorda	Matagorda County	Floodplain Administrator	Lisa Krobot	6/2/2015
2B	Matthes	Doug	Matagorda	Matagorda County			6/2/2015
2B	Putska	Dan	Matagorda	Matagorda County	County Commissioner Prec. 1		6/2/2015
2B	Watts	Bob	Matagorda	Matagorda County	Emergency Management Coordinator		6/2/2015
							6/2/2015
							6/2/2015
							6/2/2015
							6/2/2015
2B	Holub	Marvin	Wharton	City of East Bernard			6/2/2015
2B	Salcido	John	Wharton	City of East Bernard			6/2/2015
2B	Wessels	~~Audra~~ Audrey	Wharton	City of East Bernard	City Secretary	Audrey [illegible]	6/2/2015
							6/2/2015
							6/2/2015
							6/2/2015
							6/2/2015
2B	~~Collins~~	~~Anthony~~	Wharton	City of El Campo	Not on Council		6/2/2015
2B	Harris	Clay	Wharton	City of El Campo			6/2/2015
2B	~~Popp~~	~~Wayne~~	Wharton	City of El Campo	~~Building Official, CFM~~ Retired		6/2/2015

TCRFC Group 2B Round 2 Meeting
June 2, 2015 @ 9:00 AM
Caney Creek Church
Wharton, Texas

Introductions were made by Mickey Reynolds and Laura Johnston. For participates to get to know one another we let the group introduce themselves one at a time.

Last 10 days have reminded us why we actively attempt to mitigate hazards and plan for those hazards.

Agenda - Laura explained the agenda, purpose of hazard mitigation planning and the active participation requirement.

Goals and Objectives - Very little changes from the TCRFC plan. Those are provided in the packet.

Hazard Mitigation Action Update - Missing Wharton County's status. If the packet included a completed form, we have received your information and it is recorded as shown.

Capabilities Assessment - Laura handed out the assessment and needs those back by June 14.

Today Hazard Analysis is our focus.

Community Participation - Wharton and Matagorda have comments. Colorado only has 2 and Jackson has 0 responses to date. Please post these in your community for your plan. Will be active for another month.

Hazard Analysis - Cindy went through all Hazards and the Risk Assessment of each. Explained that HAZUS was used where applicable and non-HAZUS hazards were profiled using historical information. NOAA and NCDC data was utilized to assess historical annual losses.

1. Coastal Erosion - Study from GLO and only Matagorda lists impacts and it was noted that Jackson County had bay areas that could be at risk of coastal erosion.

2. Flood - Discussed area within floodplain, # structures at risk, value of structures at risk.

3. Hurricane -Historical paths tracks were displayed and discussed HAZUS estimation of damages.

4. Dam/Levee - Displayed the inventory and discussed some of high or significant hazard structures. Lisa Krobot indicated that Matagorda ring levee needs to be included in levee/dam. Colorado County, Chuck Rogers indicated that there was a significant hazard dam that should also be included in the listing of dams/levees.

5. Drought and Extreme Temps –Briefly review previous drought record and discussed current rainfall and new drought indication.

6. Severe Weather (Hail / Wind) - Explained historical records as indicated by insurance claims of damages. There are most likely more events that are not recorded.

7. Tornados – Briefly discussed the historical F2 or higher events.

8. Wildfire based on the Texas Wildfire Risk Analysis Portal (TxWRAP) and then checked with the Community Wildfire Protection Plans were available. Explained the various levels of risk associated with wildfire and potential damages within these categories.

Ranking Hazards - Laura explained the process and asked that they all rank their hazards. They are welcome to complete individually and submit or one for each community/county.
(Gave 15 minutes for participants to complete their hazard ranking.)

Time keeping - Handed out a blank timesheet to help obtain in-kind efforts for participants and explained the importance of the in-kind documentation.

New Mitigation Actions - Laura explained the new process is 2 actions per hazard. She explained that high ranking hazards may have a few more actions indicated. She explained the actions must be actionable actions. One action may cover multiple hazards. These are due back to Laura by June 30.

Colorado, Jackson, Matagorda, and Wharton County

Hazard Mitigation Plan Updates

Steering Committee Meeting 3

Tuesday, August 11, 2015

9:00 AM

Agenda

- Welcome and Introductions
- Review and Reminders
  - What is Hazard Mitigation?
  - Steering Committee Purpose and Responsibilities
  - Mitigation Goals and Objectives (In Packet)
  - Final Hazard Ranking (In Packet)
- Review of Survey Results (Handouts)
  - Question #24 Results
- Mitigation Actions
  - General Guidelines and Requirements
  - Summary Table and Worksheets (In Packet)
  - Review and Presentation of Actions
- Review Goals and Objectives – Any Changes Needed?
- Ranking of Mitigation Actions
  - Rank Actions
  - Identify Medium and Low Ranked Actions
- Next Steps
- Adjournment

TEXAS COLORADO RIVER FLOODPLAIN COALITION

Group 2B Round 3

							8/11/2015
							8/11/2015
2B	Bricker	Mark	Matagorda	City of Bay City	Mayor		8/11/2015
2B	Clegg	Rhonda	Matagorda	City of Bay City	City Secretary		8/11/2015
2B	Jasek	Marla	Matagorda	City of Bay City	Floodplain Administrator	Marla Jasek	8/11/2015
							8/11/2015
							8/11/2015
							8/11/2015
2B	Garrett	Robert	Matagorda	City of Palacios			8/11/2015
2B	Kocurek	David	Matagorda	City of Palacios	City Manager	David Kocurek	8/11/2015
							8/11/2015
							8/11/2015
							8/11/2015
2B	Gibson	James	Matagorda	Matagorda County	County Commissioner Prec. 3		8/11/2015
2B	Gonzales	Ruben	Matagorda	Matagorda County	Environmental Health Director		8/11/2015
2B	Krobot	Lisa	Matagorda	Matagorda County	Floodplain Administrator	Lisa Krobot	8/11/2015
2B	Matthes	Doug	Matagorda	Matagorda County	EMC		8/11/2015
2B	Putska	Dan	Matagorda	Matagorda County	County Commissioner Prec. 1		8/11/2015
2B	~~Watts~~	~~Bob~~	~~Matagorda~~	~~Matagorda County~~	~~Emergency Management Coordinator~~		8/11/2015
							8/11/2015
							8/11/2015

Group 2B Round 3

2B	Holub	Marvin	Wharton	City of East Bernard			8/11/2015
2B	Salcido	John	Wharton	City of East Bernard			8/11/2015
2B	Wessels	Audra	Wharton	City of East Bernard	City Secretary		8/11/2015
	Cenko	Debbie	Wharton	City of EB	Wharton Cty DEMC	Debbie Cenko	8/11/2015
							8/11/2015
							8/11/2015
2B	Harris	Clay	Wharton	City of El Campo	Public Works Director	[illegible]	8/11/2015
2B	Snyder	Mindi	Wharton	City of El Campo	City Manager		8/11/2015
2B	Staff	Liz	Wharton	City of El Campo	Building Official	Liz Staff	8/11/2015
2B	Williamson	Gary	Wharton	City of El Campo	Gary [illegible]		8/11/2015
2B	Young	Richard	Wharton	City of El Campo			8/11/2015
							8/11/2015
							8/11/2015
							8/11/2015
2B	Bollom	Ronnie	Wharton	City of Wharton	CFM, Building Official	[illegible]	8/11/2015
2B	Garza	Andres	Wharton	City of Wharton	City manager		8/11/2015
2B	Urbanosky	Cheryl	Wharton	City of Wharton			8/11/2015
2B	Coleman	Richard	Whaton	City of Wharton	Police		8/11/2015
							8/11/2015

Group 2B Round 3

2B	Gertson	Darrell	Colorado	Colorado County	Commissioner		8/11/2015
2B	~~Kotzebue~~	~~David~~	Colorado	Colorado County	Floodplain Administrator		8/11/2015
2B	Kubesch	Darrell	Colorado	Colorado County	Commissioner		8/11/2015
2B	Rogers	Chuck	Colorado	Colorado County	Emergency Management Coordinator		8/11/2015
	Rucka	Sylvia	Colorado	Colorado County	Rep.		8/11/2015
							8/11/2015
2B	Hermes	Joe D.	Jackson	City of Edna	Mayor		8/11/2015
2B	Miller	S	Jackson	City of Edna			8/11/2015
2B	Ryan	Brad	Jackson	City of Edna			8/11/2015
2B	Wooldridge	Clinton	Jackson	City of Edna			8/11/2015
	Jackson	Lori	Jackson	City of Edna			8/11/2015
							8/11/2015
							8/11/2015
2B	Martin	Curtis	Jackson	City of Ganado			8/11/2015
2B	Merrit	David	Jackson	City of Ganado	PD Chief		8/11/2015
							8/11/2015
							8/11/2015
2B	~~Friednich~~	Allen	Jackson	Jackson County			8/11/2015
2B	Friendrich	Allan	Jackson	Jackson County			8/11/2015
2B	McLennan	Lori	Jackson	Jackson County	FPA		8/11/2015
2B	Simons	Dennis	Jackson	Jackson County	County Judge		8/11/2015

Group 2B Round 3

Hazard Mitigation Group	Last Name	First Name	County	Organization	Title	Sign In	Date
2B	Lattimore	Williams	Colorado	City of Columbus			8/11/2015
2B	Stein	Ford	Colorado	City of Columbus	City Inspector		8/11/2015
2B	Warschak	Donald	Colorado	City of Columbus	City Manager	Don Warschak	8/11/2015
							8/11/2015
							8/11/2015
							8/11/2015
2B	Clark	Dan	Colorado	City of Eagle Lake	Director of Public Works	Dan Clark	8/11/2015
2B	Cooper	Michael	Colorado	City of Eagle Lake	BLDG		8/11/2015
2B	Freeman	David	Colorado	City of Eagle Lake		[illegible]	8/11/2015
2B	Parr	Mary	Colorado	City of Eagle Lake	Mayor		8/11/2015
2B	Rucka	Sylvia	Colorado	City of Eagle Lake	City Manager	Sylvia Rucka	8/11/2015
							8/11/2015
							8/11/2015
							8/11/2015
2B	koller	Milton	Colorado	City of Weimar	Mayor		8/11/2015
2B	Mason	David	Colorado	City of Weimar	City Treasurer		8/11/2015
2B	Miller	Ray	Colorado	City of Weimar	City Manager		8/11/2015
2B	Stoever	Dolores	Colorado	City of Weimar	City Secretary		8/11/2015
							8/11/2015
							8/11/2015

Group 2B Round 3

2B	Awdel	Joan	Wharton	Wharton County			8/11/2015
2B	Bergstrom	Amy	Wharton	Wharton County			8/11/2015
2B ✓	Dettling	Leroy	Wharton	Wharton County	PCT 1	[illegible]	8/11/2015
2B	Jimenex	Brandi	Wharton	Wharton County			8/11/2015
2B	Johnson	Stephen	Wharton	City of Wharton ~~Wharton County~~	EMC	[illegible]	8/11/2015
2B	King	Chris	Wharton	Wharton County			8/11/2015
2B	Kirkland	Andy	Wharton	Wharton County	EMC	[illegible]	8/11/2015
2B	Kowalik	John	Wharton	Wharton County			8/11/2015
2B	Lynch	Terry	Wharton	Wharton County			8/11/2015
2B	Marchant	Kyle	Wharton	Wharton County			8/11/2015
2B	Martin	Monica	Wharton	Wharton County	Floodplain Administrator	[illegible]	8/11/2015
	Cenko	Debbie	Wharton	Wharton Co	DEMC	[illegible]	8/11/2015
	Williamson	Gary	El Campo	Wharton County			8/11/2015
							8/11/2015
							8/11/2015
							8/11/2015
							8/11/2015

Colorado, Jackson, Matagorda, and Wharton Counties, TX

Hazard Mitigation Plan Updates
Kickoff Meeting – Meeting Notes

Caney Creek Church, Wharton, TX
9:00am – 11:00am
Tuesday, August 11, 2015

- Welcome and Introductions – Mickey Reynolds (Texas Colorado River Floodplain Coalition [TCRFC]) welcomed everyone and introduced the planning team: Cindy Engelhardt (Halff Associates), Laura Johnston (Tetra Tech), Diane MacMillan (Tetra Tech), and Krista Jack (Tetra Tech). See sign in sheet for a complete list of attendees.
  1. Sign-in sheet and timesheets are required and necessary part of getting credit for participating (in-kind) in this project. Cindy handed out the timesheets and Laura requested everyone sign in for today's meeting.
  2. Each attendee was provided a folder, tailored to their specific community and county, with handouts, a copy of the presentation slides, and contact information for the planning team.
  3. Representatives from Weimer were not present today.
  4. There are more hard copies of the survey if attendees want a copy.
  5. This is the last of three meetings. After these series of meetings, the draft plan will be finalized and will be submitted to the State of Texas and subsequently submitted to FEMA. All 16 plans are planned to be submitted to the State of Texas by January 2016.
- Laura reviewed what hazard mitigation is and why this is important; the steering committee purpose and responsibilities; the final mitigation goals and objectives; and the final hazard rankings. Ranking is different than in other states because in Texas you have to develop two mitigation actions regardless of whether a hazard is ranked high, medium, or low. Only "Non Applicable" (NA) ranking is not required to have two mitigation actions. However, if there are too many NA rankings, you will need to defend these rankings to the State of Texas and FEMA reviewers.
  1. David Merritt from City of Ganado said flooding should be ranked high but it shows medium on the chart. Laura will have this change made.
  2. Under the City of Eagle Lake, the "0" ranking (for earthquake and expansive soils) should all be "NA". Laura said this will be changed.

- Laura reviewed the number of responses for each jurisdiction. One question from the survey was reviewed in particular: "What types of projects do you believe the county, state, and federal government agencies should be doing in order to reduce damage and disruption from hazard events within XXXX County? Please rank each option as a high, medium, or low priority." Laura reviewed the slides for each jurisdiction. Acquisition of properties is usually either high or low, usually not in the middle.
- Key point from these surveys is to keep in mind what your citizens felt were most important. This will be important when the jurisdictions are prioritizing the mitigation actions later on during this meeting.
- Mitigation Actions – you need a minimum of two actions per ranked hazard. You can have more than two actions. This is encouraged especially on medium and high ranked hazards. Carrie Valentine has been working to get these mitigation actions ready for this meeting.
- The Mitigation Action Spreadsheet is in the individual folders for each jurisdiction. This lists the projects which attendees will rank during today's meeting. Laura reviewed the significance of each column on the spreadsheet. The action number is simply a reference number, not a ranking number. The mitigation actions from the existing plan were handed out at the first meeting. The jurisdictions had previously marked whether mitigation actions would be carried forward and any actions carried forward are included in this spreadsheet. The priority column is per the mitigation action worksheet scoring that each jurisdiction prepared previously. Each jurisdiction may or may not rank these similar today, based in part on public feedback from survey. The estimated cost column is a ballpark figure. The responsible party should be a department or agency instead of an individual.
- Laura reviewed a chart showing each county and where goals or objectives were not supported by mitigation actions. Laura said if any jurisdiction within the county had an action that addressed that goal or objective then this was sufficient. Matagorda County had mitigation actions to address all the goals and objectives. Laura asked the remaining counties (Colorado, Jackson and Wharton) what they preferred:
  - Do you want to add another action to meet/address the goal or objective, or
  - Do you want to delete a goal or objective?
- Laura handed out sheets for each county that may have goals or objectives that were not addressed in mitigation actions. Carrie Valentine had already reviewed the mitigation actions from the counties and if the actions addressed goals and objectives that the counties did not mark, then then were added.
- Steve Johnson (Wharton County) said that he felt some of the mitigation actions did address certain goals and objectives. Laura said if Wharton County wants to revisit the existing mitigation actions and goals/objectives, they can revisit with Carrie Valentine.
- Jackson County and Colorado County decided to strike goals and objectives unsupported by mitigation actions rather than add additional mitigation actions. .
- Andy Kirkland (Wharton County EMC) reviewed a copy of their mitigation action with Laura. Mr. Kirkland marked up the spreadsheet and send back to Laura to show where mitigation actions cover the existing goals and objectives. Laura reminded attendees that there is no optimal number of goals or objectives so don't try and make the mitigation actions retrofit the goals and objectives.

- Laura thanked Wharton County for the changes to the mitigation actions/goals/objectives; and said the goals/objectives will be edited for Jackson and Colorado Counties as reflected in the handout striking goals/objectives.
- Laura explained that one mitigation action can cover several hazards. Sometimes Tetra Tech combined several mitigation actions to make them a clearer, actionable action. Laura said if these modifications are not accurate to let Laura know. She reminded the attendees they can update the mitigation action list anytime up until submittal and can also modify the plan at any point after the plan is adopted.
- Cindy handed out a copy of the Mitigation Action Worksheet for Colorado County at their request (Sylvia Rucka, City of Eagle Lake) for modification. Laura said that she needs this Mitigation Action Worksheet back by the end of this week, Friday, August 14.
- Mitigation Actions – Ranking Process. Laura instructed the attendees how to rank the mitigation actions with 1 as the highest. Laura asked the jurisdictions to rank numerically all the mitigation actions.
    - For ranking: Only community representatives can vote for the mitigation actions for that community. For the county, either only the county representatives can vote, or the communities and county representatives can vote. This decision is up to each county.
    - Lisa Krobat (Matagorda County) asked if there is a mitigation action that isn't reflected on the spreadsheet what should be done. Laura said to write in the name of the project and this will be added to spreadsheet later.
    - The attendees broke into small groups. Afterwards, Laura collected all the ranked spreadsheets and said this data would be compiled.
- Next Steps in the Plan Development
    - Between September 18 and October 9 a draft plan will be submitted to the counties for their review. The counties will have two weeks to review. The tight turn-around time was dictated by a schedule set by the lapsing of the existing plan and grant delays. The schedule was not dictated by the TCRFC planning team. Laura reviewed the specific dates the plans will be given to each county.
    - Laura alerted the attendees to watch for an email with a link to an FTP site to download the draft plan.
    - The draft plan will be approximately 350 pages and is based on FEMA requirements. All State of Texas and FEMA requirements must be met in the plan.
    - The State of Texas may ask for clarification or additional questions once reviewed. Therefore, the time it takes for the state to review is outside of the planning team's control.
    - Marla (Bay City) asked if the plan has to be adopted by the jurisdiction. Laura said once the plan is accepted by the State of Texas, it is sent to FEMA for review and approval. Once FEMA approves the plan, the plan is granted an Approval Pending Adoption (APA) status. This letter usually comes from FEMA to the State, and then the State sends the letter to the county top elected official. Once this APA status is granted, there is a 6-month period during which the jurisdiction has to officially adopt the plan. According to current regulations, each participating jurisdiction has to officially adopt the plan. This adoption documentation must be submitted to FEMA within that 6-month period. Allan Fredrich (Jackson City) asked about school districts

needing to adopt the plan. Laura said that only participating jurisdictions need to approve the plan.

- Mr. Kirkland asked approximately when this APA status might be coming. Laura said usually FEMA takes 45 days to review the plans (barring a major disaster requiring response).
- Laura said the state review time is variable. Since the 16 plans are based on a similar template, the first plan hopefully will tease out issues that can be applied to the remaining 15 plans. However, since there are 16 plans being submitted at approximately the same time there may be a delay with both the State of Texas and FEMA reviews.
- If there is a disaster during this timeframe that affects the participating counties, the requirement is there is a plan in place during the release of federal funding in order to receive this particular federal disaster funding.

- Monica Martin (Wharton County) asked who to send the timesheets to. Laura said to send them to Hope Marquez with Jeff Ward's office but anyone on the team can get the timesheet to Ms. Marquez.
- Laura thanked all the attendees for coming to these meetings and all the work that the jurisdictions have done during this process. This is the last of three meetings.
- Adjournment

Matagorda County Communities, Hazard Mitigation Plan

Public Involvement/Participation

A partnership of local governments and other stakeholders in Matagorda County are working together to create a Matagorda County Hazard Mitigation Plan. Community input and involvement is instrumental in the development of a mitigation plan update that truly reflects the perceptions and needs of Matagorda County residents.

We have developed a community survey and would like as much input from Matagorda County residents, businesses, and interested citizens as possible. Please take a few minutes to fill out this survey so that your ideas may become a part of the plan to make Matagorda County a safer and more resilient county!

Community Survey Link:

https://www.surveymonkey.com/s/MatagordaCountyHMPCommunitySurvey

If you have any questions, please don't hesitate to contact:

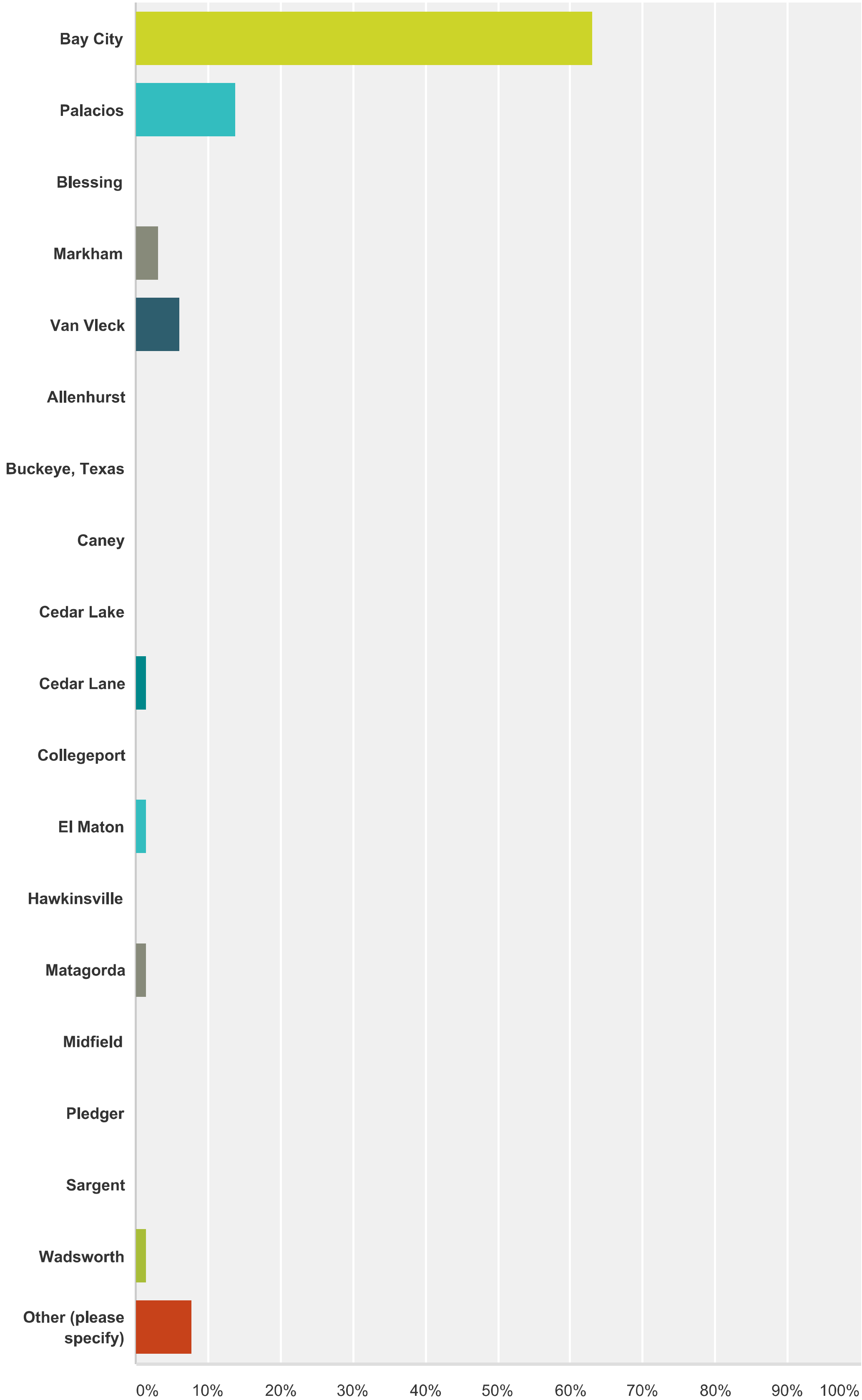
Laura Johnston at laura.johnston@tetratech.com or 303-312-8807

TEXAS COLORADO RIVER FLOODPLAIN COALITION

Q1 Where in Matagorda County do you live?

Answered: 65 Skipped: 0

Matagorda County TX HMP Update Survey

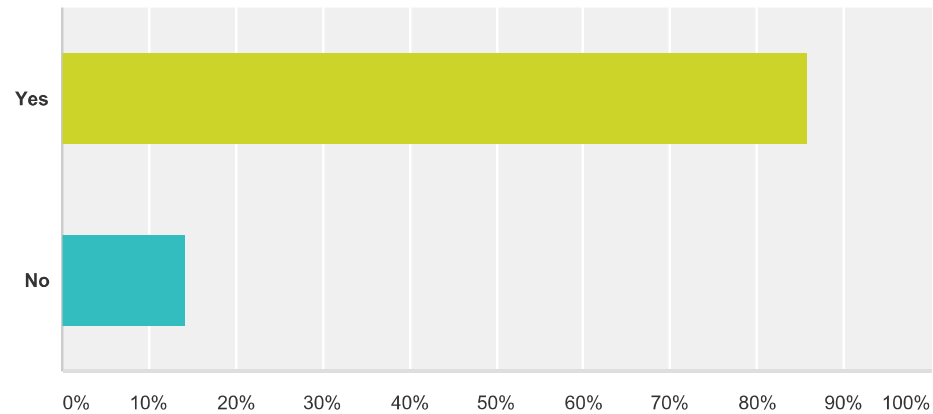


Answer Choices	Responses	
Bay City	**63.08%**	41

Palacios	**13.85%**	9
Blessing	**0.00%**	0
Markham	**3.08%**	2
Van Vleck	**6.15%**	4
Allenhurst	**0.00%**	0
Buckeye, Texas	**0.00%**	0
Caney	**0.00%**	0
Cedar Lake	**0.00%**	0
Cedar Lane	**1.54%**	1
Collegeport	**0.00%**	0
El Maton	**1.54%**	1
Hawkinsville	**0.00%**	0
Matagorda	**1.54%**	1
Midfield	**0.00%**	0
Pledger	**0.00%**	0
Sargent	**0.00%**	0
Wadsworth	**1.54%**	1
Other (please specify)	**7.69%**	5
Total		**65**

Q2 Do you work in Matagorda County?

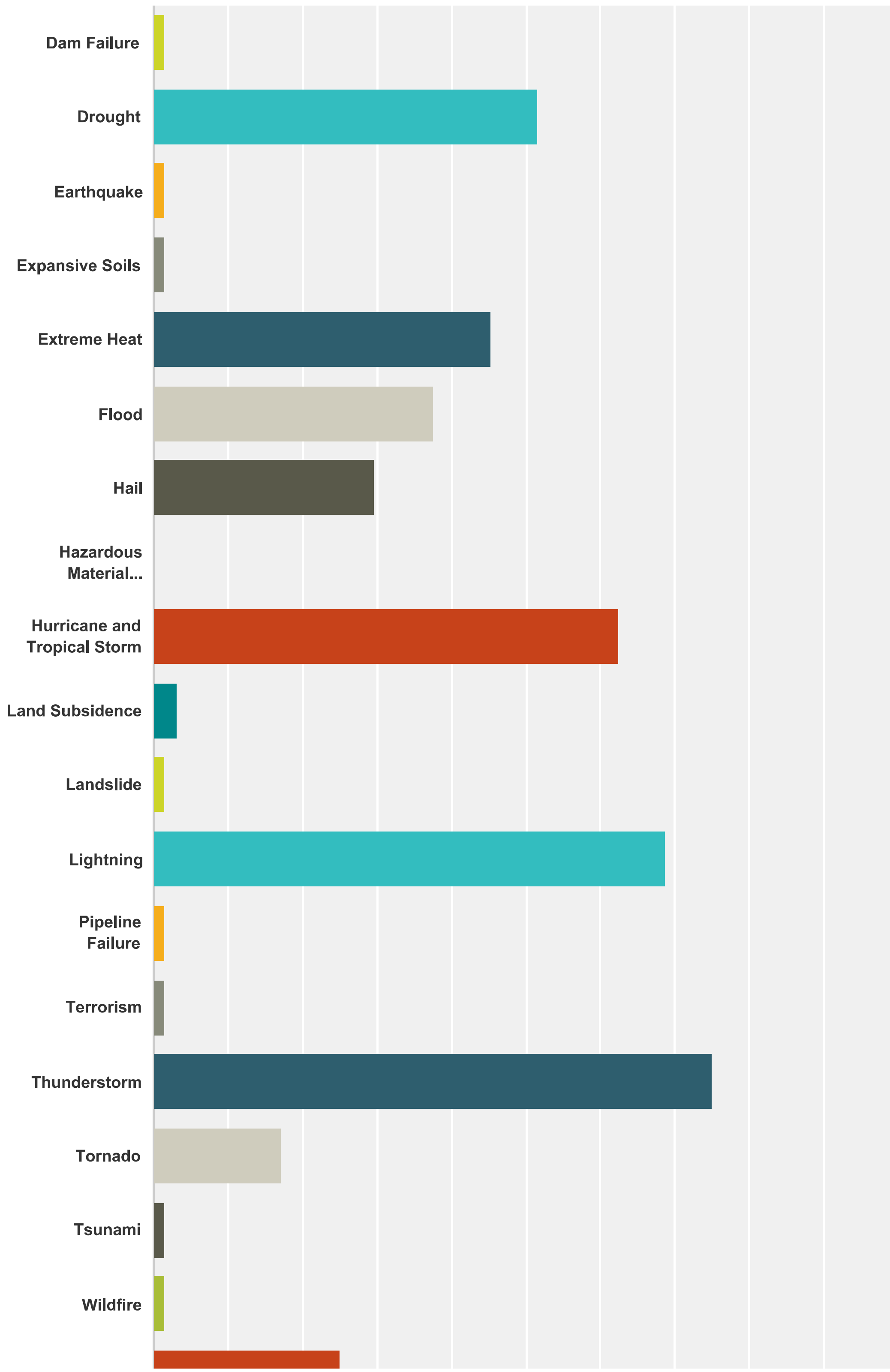
Answered: 63 Skipped: 2



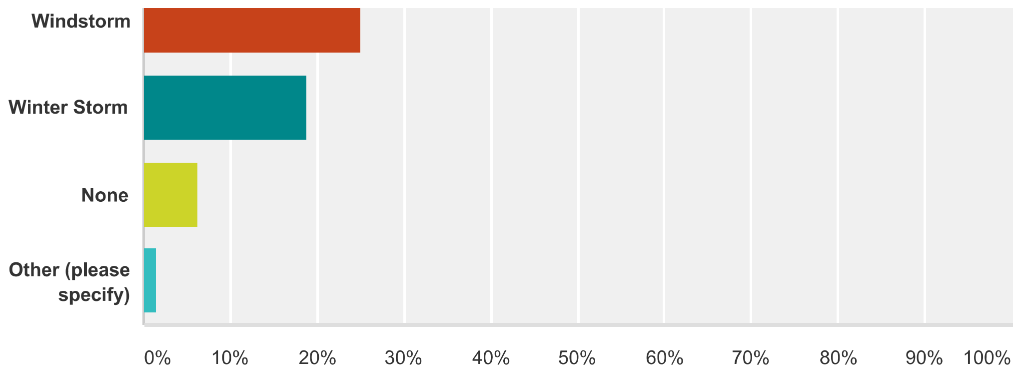
Answer Choices	Responses	
Yes	**85.71%**	54
No	**14.29%**	9
Total		**63**

Q3 Which of the following hazard events have you or has anyone in your household experienced in the past 20 years within Matagorda County? (Check all that apply)

Answered: 64 Skipped: 1



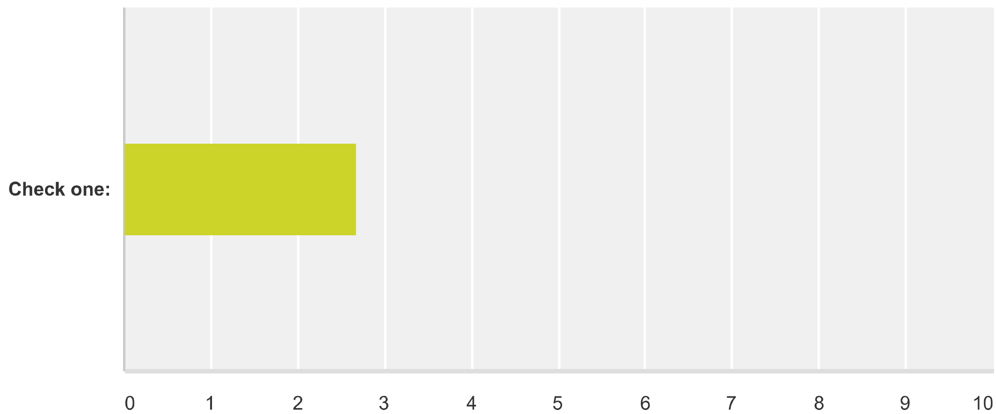
Matagorda County TX HMP Update Survey



Answer Choices	Responses	
Dam Failure	**1.56%**	1
Drought	**51.56%**	33
Earthquake	**1.56%**	1
Expansive Soils	**1.56%**	1
Extreme Heat	**45.31%**	29
Flood	**37.50%**	24
Hail	**29.69%**	19
Hazardous Material Release	**0.00%**	0
Hurricane and Tropical Storm	**62.50%**	40
Land Subsidence	**3.13%**	2
Landslide	**1.56%**	1
Lightning	**68.75%**	44
Pipeline Failure	**1.56%**	1
Terrorism	**1.56%**	1
Thunderstorm	**75.00%**	48
Tornado	**17.19%**	11
Tsunami	**1.56%**	1
Wildfire	**1.56%**	1
Windstorm	**25.00%**	16
Winter Storm	**18.75%**	12
None	**6.25%**	4
Other (please specify)	**1.56%**	1
Total Respondents: 64		

Q4 How prepared is your household to deal with a natural hazard event?

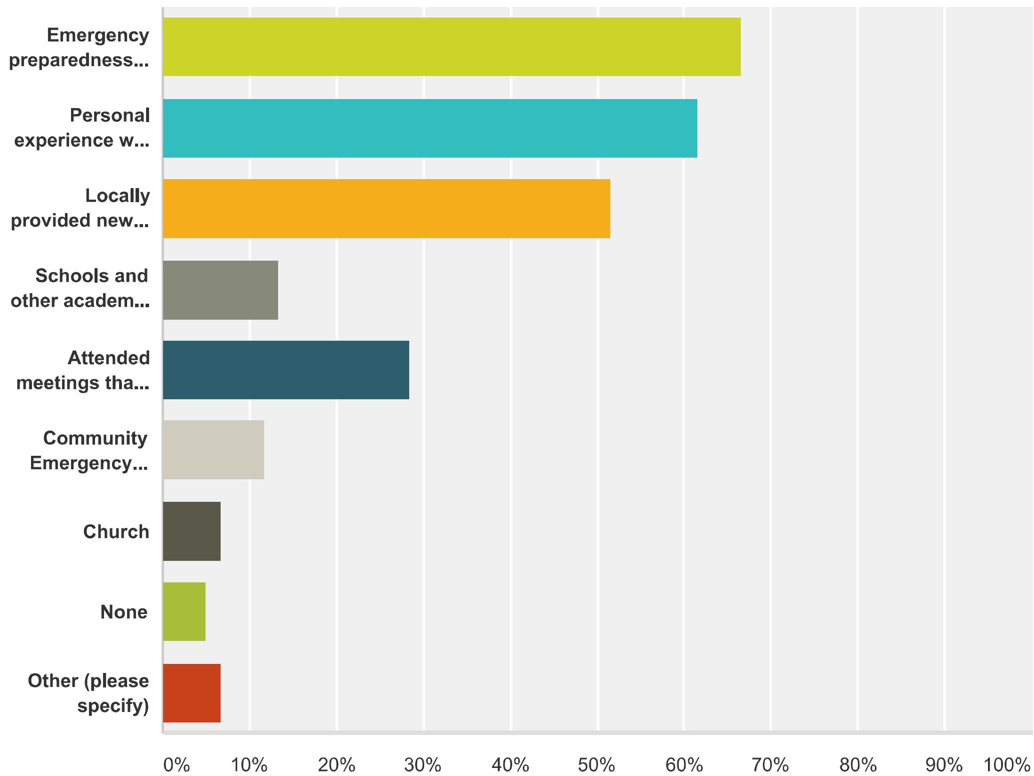
Answered: 60 Skipped: 5



	Not at all prepared	Somewhat prepared	Adequately prepared	Well prepared	Very well prepared	Total	Weighted Average
Check one:	**6.67%** 4	**45.00%** 27	**26.67%** 16	**16.67%** 10	**5.00%** 3	60	2.68

Q5 Which of the following have provided you with useful information to help you be prepared for a natural hazard event? (Check all that apply)

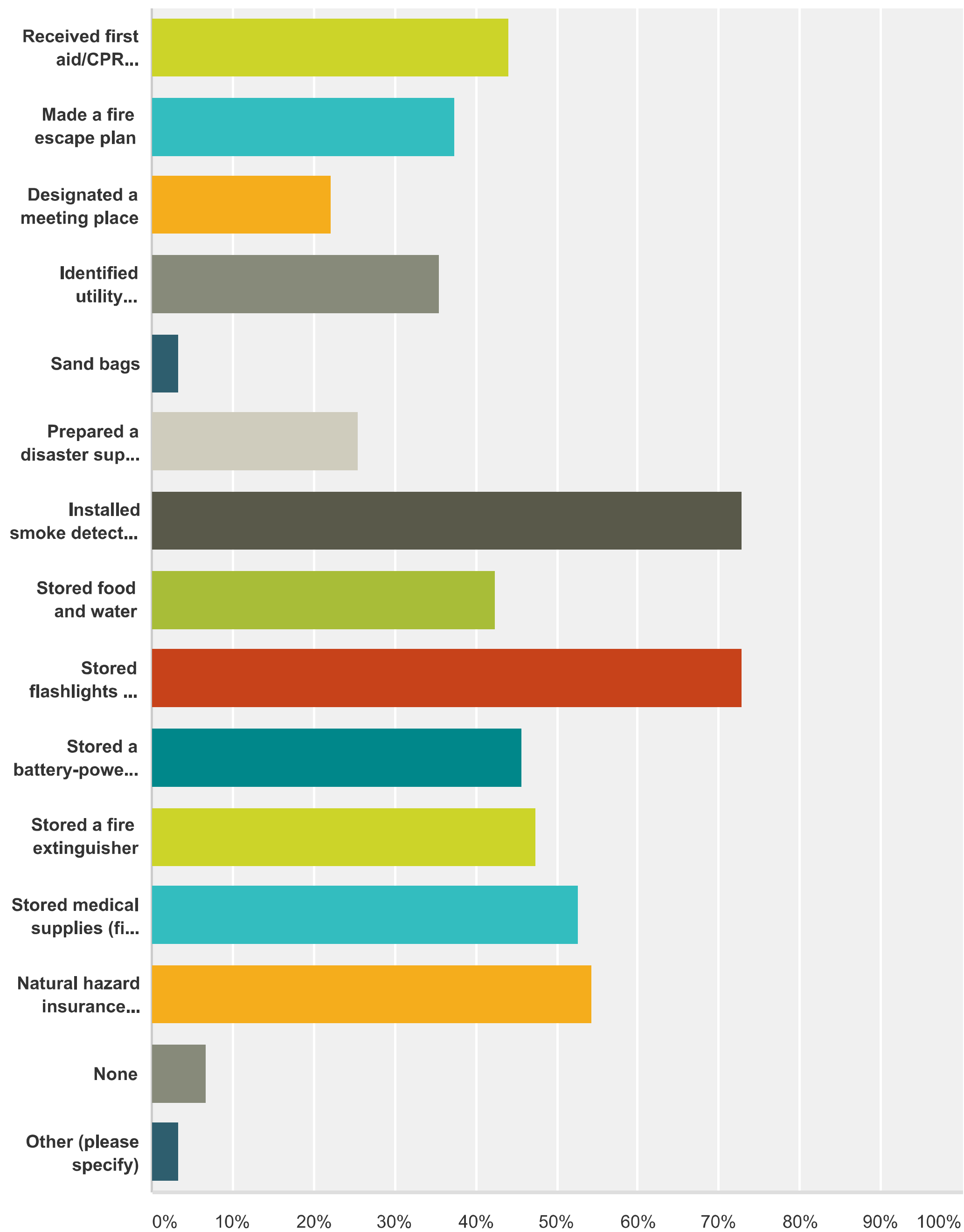
Answered: 60 Skipped: 5



Answer Choices	Responses	
Emergency preparedness information from a government source (e.g., federal, state, or local emergency management)	**66.67%**	40
Personal experience with one or more natural hazards/disasters	**61.67%**	37
Locally provided news or other media information	**51.67%**	31
Schools and other academic institutions	**13.33%**	8
Attended meetings that have dealt with disaster preparedness	**28.33%**	17
Community Emergency Response Training (CERT)	**11.67%**	7
Church	**6.67%**	4
None	**5.00%**	3
Other (please specify)	**6.67%**	4
Total Respondents: 60		

Q6 Which of the following steps has your household taken to prepare for a natural hazard event? (Check all that apply)

Answered: 59 Skipped: 6

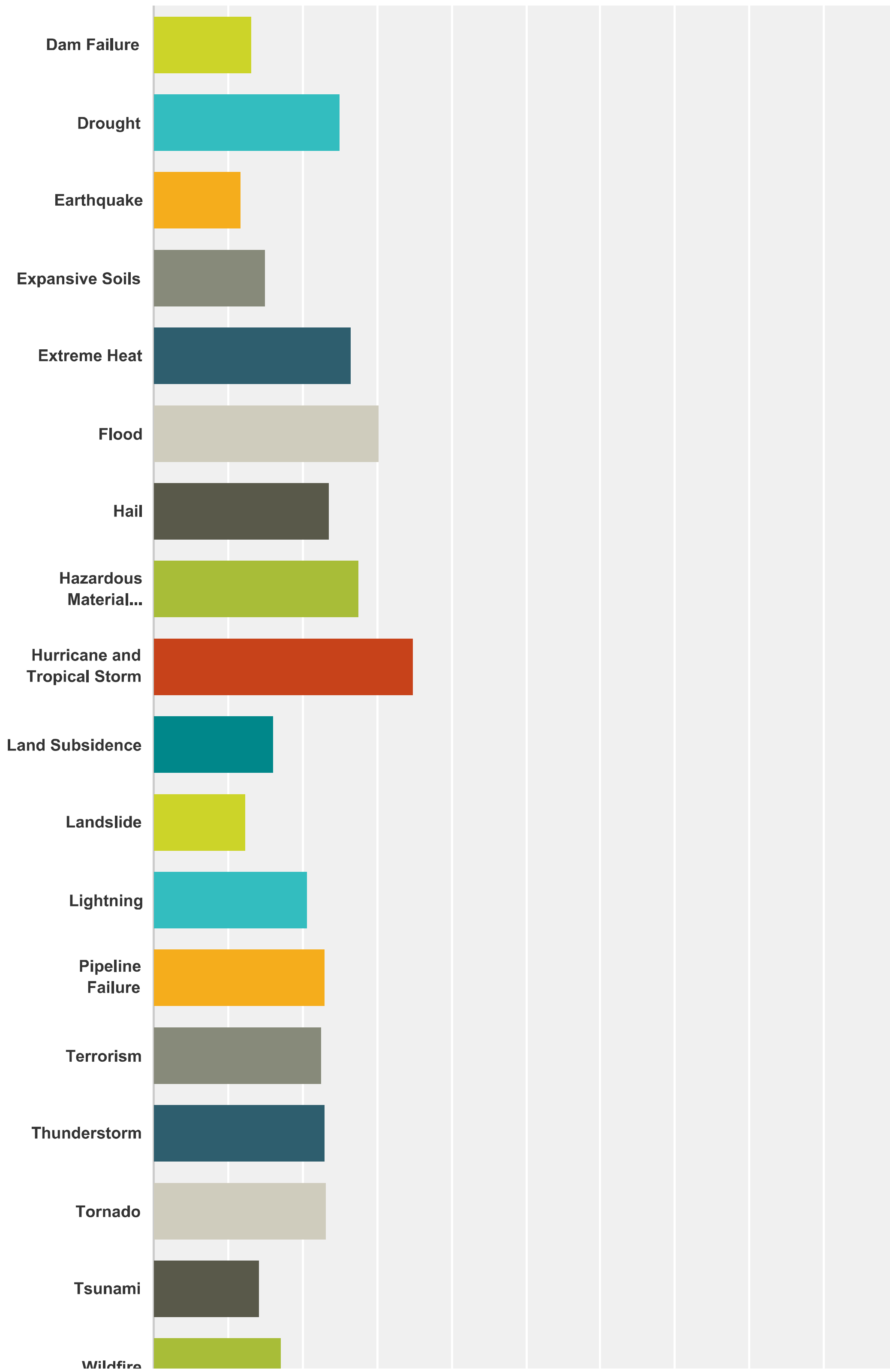


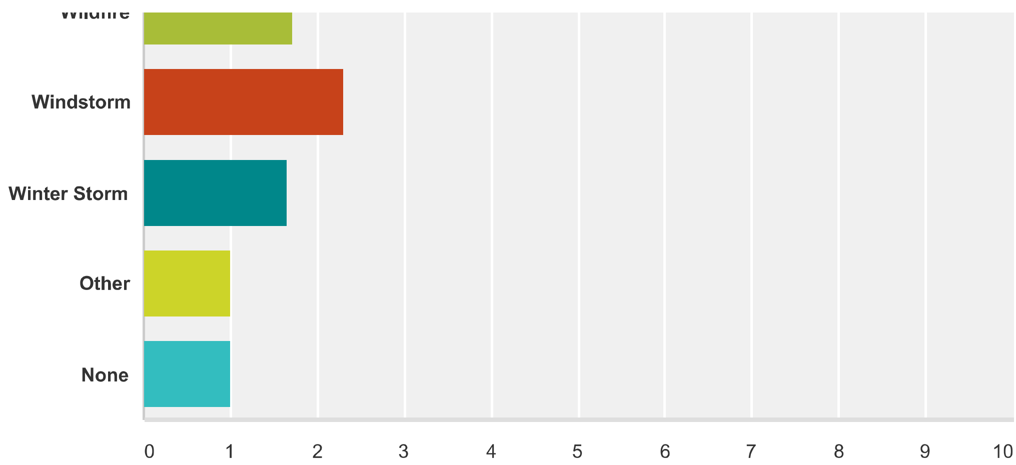
Answer Choices	Responses	
Received first aid/CPR training	**44.07%**	26
Made a fire escape plan	**37.29%**	22
Designated a meeting place	**22.03%**	13

Identified utility shutoffs	**35.59%**	21
Sand bags	**3.39%**	2
Prepared a disaster supply kit	**25.42%**	15
Installed smoke detectors on each level of the house	**72.88%**	43
Stored food and water	**42.37%**	25
Stored flashlights and batteries	**72.88%**	43
Stored a battery-powered radio	**45.76%**	27
Stored a fire extinguisher	**47.46%**	28
Stored medical supplies (first aid kit, medications)	**52.54%**	31
Natural hazard insurance (Flood, Earthquake, Wildfire)	**54.24%**	32
None	**6.78%**	4
Other (please specify)	**3.39%**	2
Total Respondents: 59		

Q7 How concerned are you about the following natural hazards in Matagorda County? (Check one response for each hazard)

Answered: 60 Skipped: 5



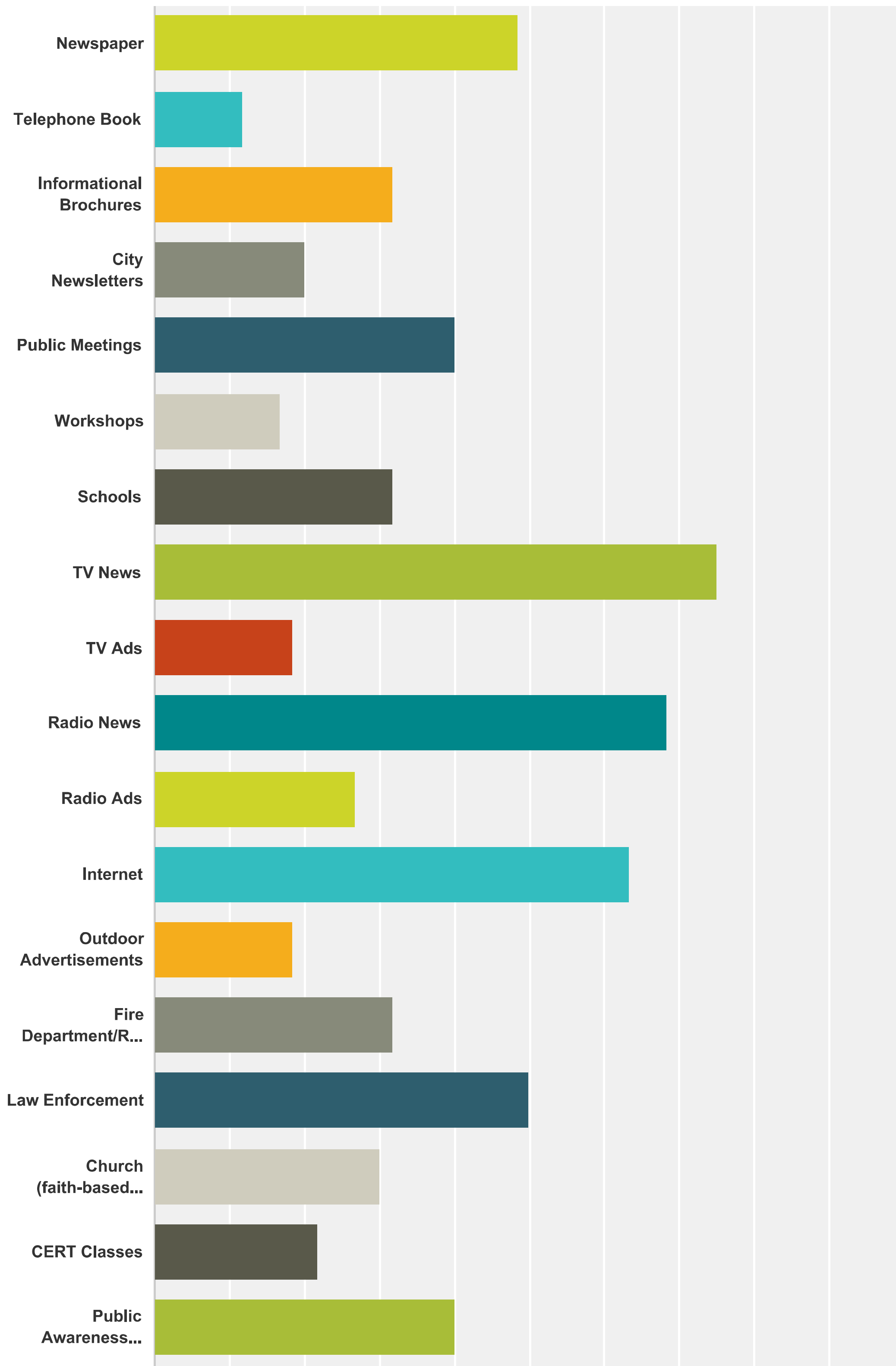


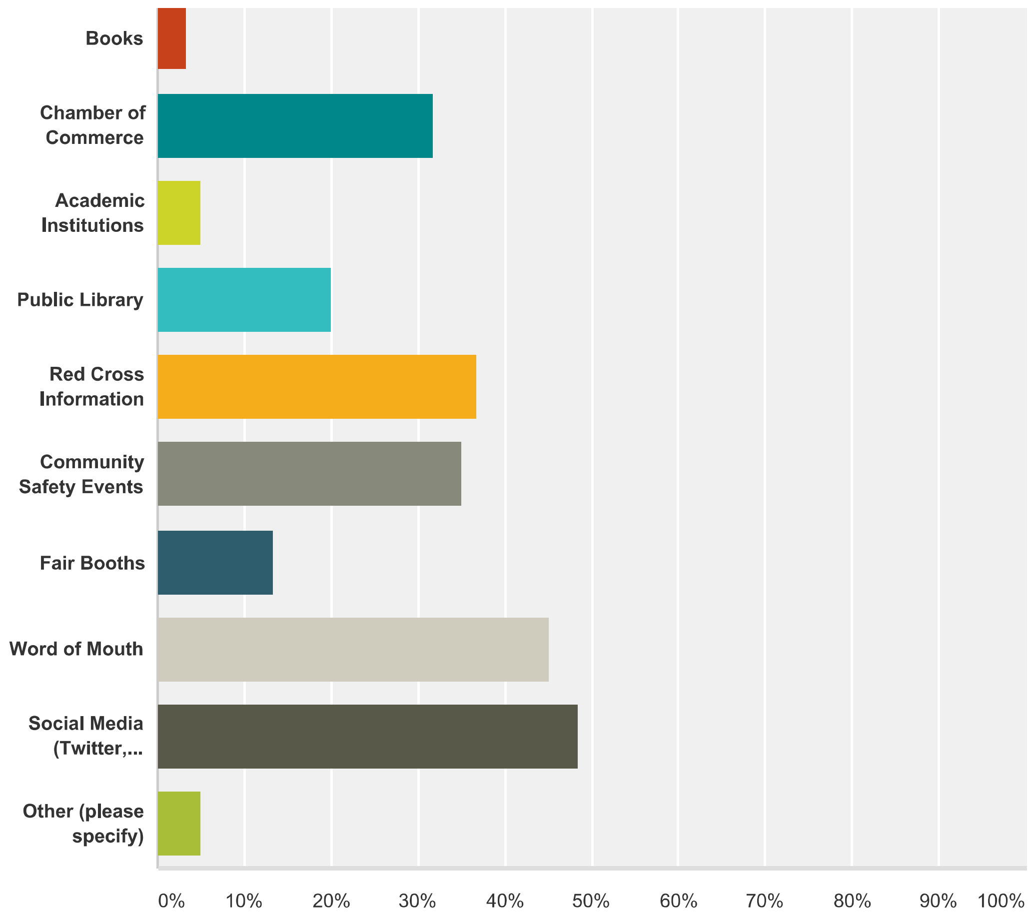
	Not Concerned	Somewhat Concerned	Concerned	Very Concerned	Extremely Concerned	Total	Weighted Average
Dam Failure	**81.03%** 47	**13.79%** 8	**1.72%** 1	**0.00%** 0	**3.45%** 2	58	1.31
Drought	**26.32%** 15	**26.32%** 15	**24.56%** 14	**15.79%** 9	**7.02%** 4	57	2.51
Earthquake	**89.09%** 49	**9.09%** 5	**0.00%** 0	**0.00%** 0	**1.82%** 1	55	1.16
Expansive Soils	**67.86%** 38	**25.00%** 14	**0.00%** 0	**3.57%** 2	**3.57%** 2	56	1.50
Extreme Heat	**21.05%** 12	**26.32%** 15	**28.07%** 16	**15.79%** 9	**8.77%** 5	57	2.65
Flood	**10.53%** 6	**22.81%** 13	**29.82%** 17	**28.07%** 16	**8.77%** 5	57	3.02
Hail	**22.81%** 13	**38.60%** 22	**21.05%** 12	**15.79%** 9	**1.75%** 1	57	2.35
Hazardous Material Release	**23.21%** 13	**25.00%** 14	**21.43%** 12	**14.29%** 8	**16.07%** 9	56	2.75
Hurricane and Tropical Storm	**12.07%** 7	**8.62%** 5	**24.14%** 14	**29.31%** 17	**25.86%** 15	58	3.48
Land Subsidence	**57.14%** 32	**30.36%** 17	**8.93%** 5	**1.79%** 1	**1.79%** 1	56	1.61
Landslide	**85.71%** 48	**8.93%** 5	**3.57%** 2	**0.00%** 0	**1.79%** 1	56	1.23
Lightning	**29.82%** 17	**42.11%** 24	**19.30%** 11	**8.77%** 5	**0.00%** 0	57	2.07
Pipeline Failure	**28.07%** 16	**36.84%** 21	**17.54%** 10	**12.28%** 7	**5.26%** 3	57	2.30
Terrorism	**32.14%** 18	**35.71%** 20	**16.07%** 9	**7.14%** 4	**8.93%** 5	56	2.25
Thunderstorm	**25.00%** 14	**33.93%** 19	**30.36%** 17	**8.93%** 5	**1.79%** 1	56	2.29
Tornado	**28.07%** 16	**31.58%** 18	**24.56%** 14	**12.28%** 7	**3.51%** 2	57	2.32

Tsunami	**78.57%** 44	**10.71%** 6	**3.57%** 2	**5.36%** 3	**1.79%** 1	56	1.41
Wildfire	**62.50%** 35	**17.86%** 10	**10.71%** 6	**3.57%** 2	**5.36%** 3	56	1.71
Windstorm	**36.36%** 20	**20.00%** 11	**29.09%** 16	**7.27%** 4	**7.27%** 4	55	2.29
Winter Storm	**58.18%** 32	**23.64%** 13	**14.55%** 8	**1.82%** 1	**1.82%** 1	55	1.65
Other	**100.00%** 21	**0.00%** 0	**0.00%** 0	**0.00%** 0	**0.00%** 0	21	1.00
None	**100.00%** 12	**0.00%** 0	**0.00%** 0	**0.00%** 0	**0.00%** 0	12	1.00

Q8 Which of the following methods do you think are most effective for providing hazard and disaster information? (Check all that apply)

Answered: 60 Skipped: 5



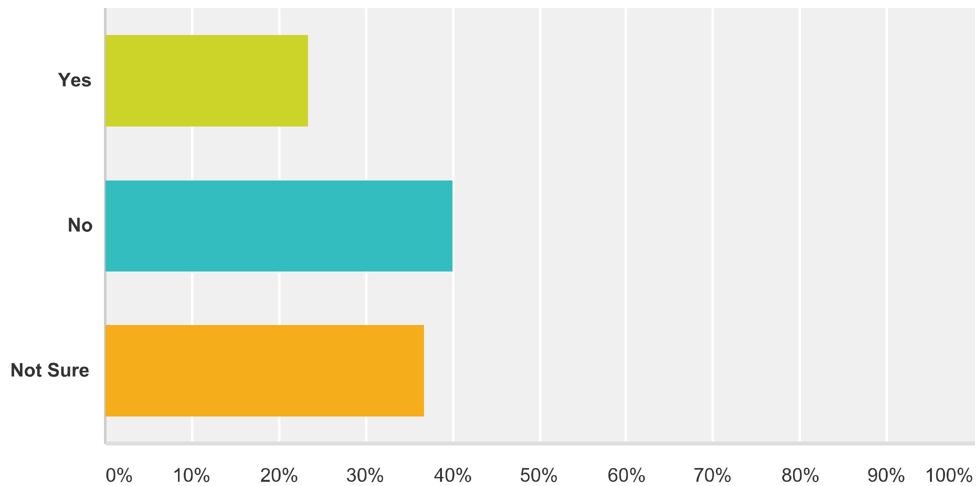


Answer Choices	Responses	
Newspaper	**48.33%**	29
Telephone Book	**11.67%**	7
Informational Brochures	**31.67%**	19
City Newsletters	**20.00%**	12
Public Meetings	**40.00%**	24
Workshops	**16.67%**	10
Schools	**31.67%**	19
TV News	**75.00%**	45
TV Ads	**18.33%**	11
Radio News	**68.33%**	41
Radio Ads	**26.67%**	16
Internet	**63.33%**	38
Outdoor Advertisements	**18.33%**	11
Fire Department/Rescue	**31.67%**	19
Law Enforcement	**50.00%**	30

Church (faith-based institutions)	**30.00%**	18
CERT Classes	**21.67%**	13
Public Awareness Campaign (e.g., Flood Awareness Week, Winter Storm Preparedness Month)	**40.00%**	24
Books	**3.33%**	2
Chamber of Commerce	**31.67%**	19
Academic Institutions	**5.00%**	3
Public Library	**20.00%**	12
Red Cross Information	**36.67%**	22
Community Safety Events	**35.00%**	21
Fair Booths	**13.33%**	8
Word of Mouth	**45.00%**	27
Social Media (Twitter, Facebook, Linkdin)	**48.33%**	29
Other (please specify)	**5.00%**	3
Total Respondents: 60		

Q9 Is your property located in or near a FEMA designated floodplain?

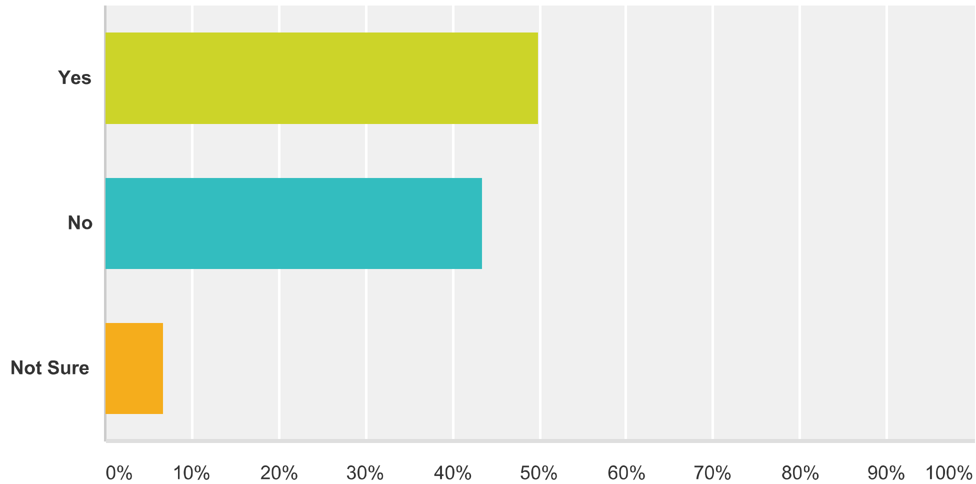
Answered: 60 Skipped: 5



Answer Choices	Responses	
Yes	**23.33%**	14
No	**40.00%**	24
Not Sure	**36.67%**	22
Total		**60**

Q10 Do you have flood insurance?

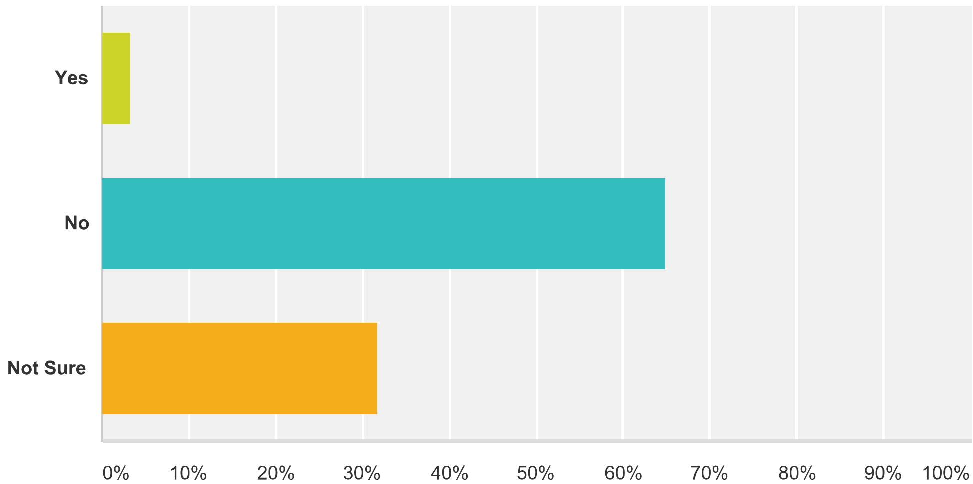
Answered: 60 Skipped: 5



Answer Choices	Responses	
Yes	**50.00%**	30
No	**43.33%**	26
Not Sure	**6.67%**	4
Total		**60**

Q11 Is your property located near an earthquake fault?

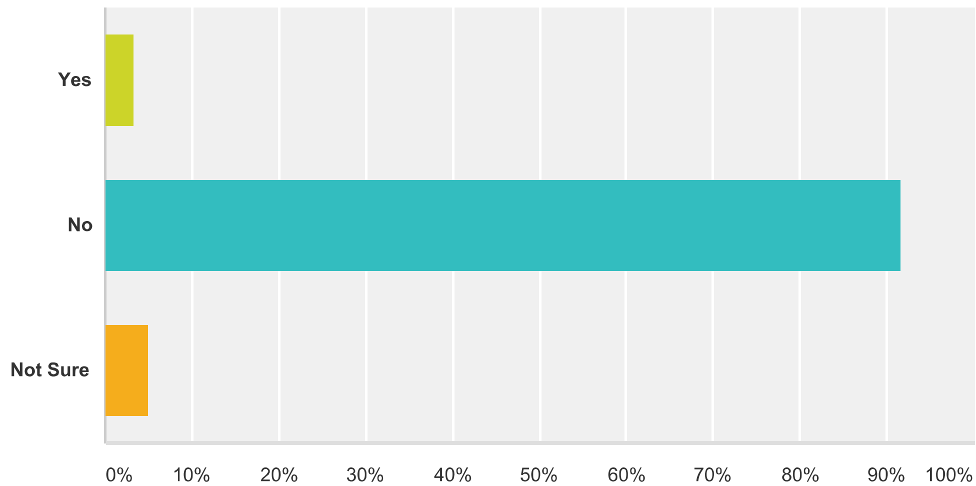
Answered: 60 Skipped: 5



Answer Choices	Responses	
Yes	**3.33%**	2
No	**65.00%**	39
Not Sure	**31.67%**	19
Total		**60**

Q12 Do you have earthquake insurance?

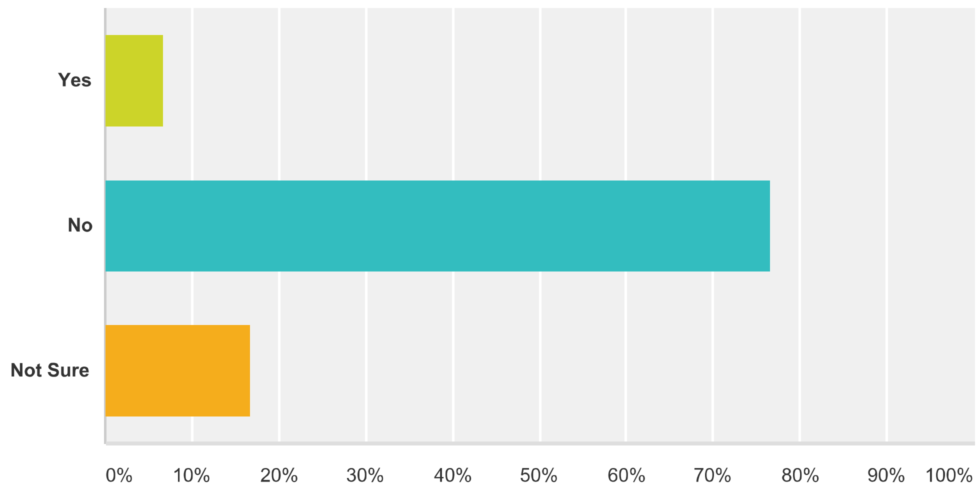
Answered: 60 Skipped: 5



Answer Choices	Responses	
Yes	**3.33%**	2
No	**91.67%**	55
Not Sure	**5.00%**	3
Total		**60**

Q13 Is your property located in an area at risk for wildfires?

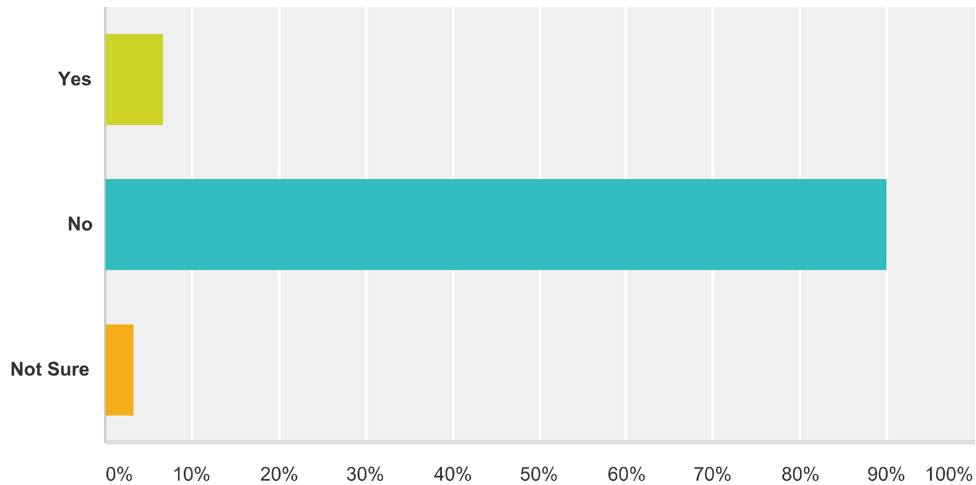
Answered: 60 Skipped: 5



Answer Choices	Responses	
Yes	**6.67%**	4
No	**76.67%**	46
Not Sure	**16.67%**	10
Total		**60**

Q14 Have you ever had problems getting homeowners or renters insurance due to risks from natural hazards?

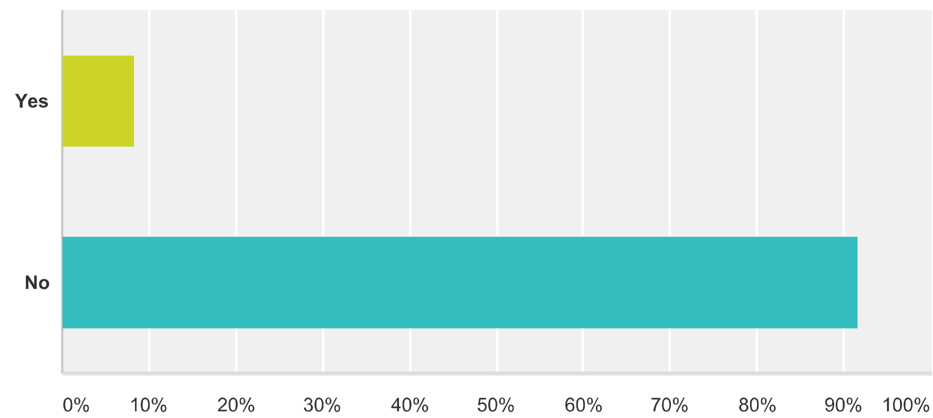
Answered: 60   Skipped: 5



Answer Choices	Responses	
Yes	**6.67%**	4
No	**90.00%**	54
Not Sure	**3.33%**	2
Total		**60**

Q15 Do you have any special access or functional needs within your household that would require early warning or specialized response during disasters?

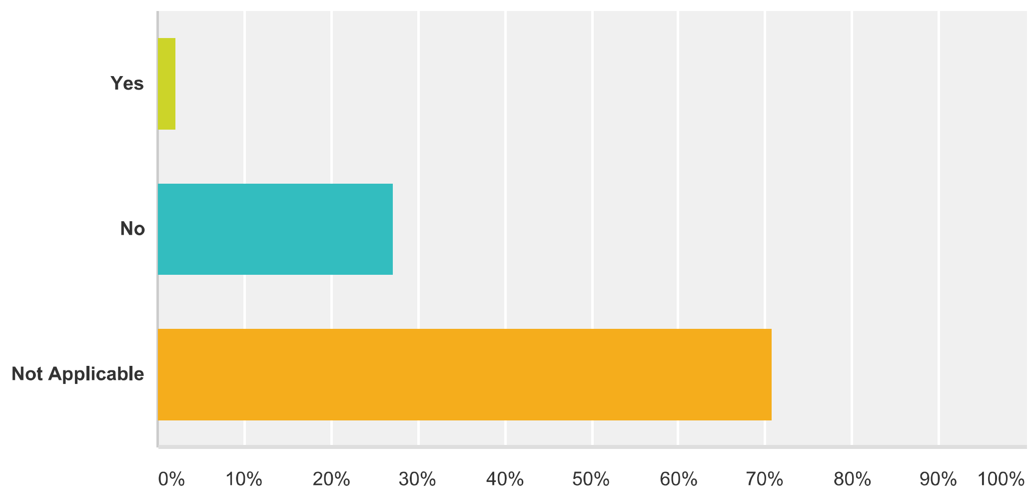
Answered: 60   Skipped: 5



Answer Choices	Responses	
Yes	**8.33%**	5
No	**91.67%**	55
Total		**60**

Q16 If the answer to question # 15 was yes, would you like County Emergency Management personnel to contact you regarding your access and functional needs? If yes, please enter your contact information in the following text box.

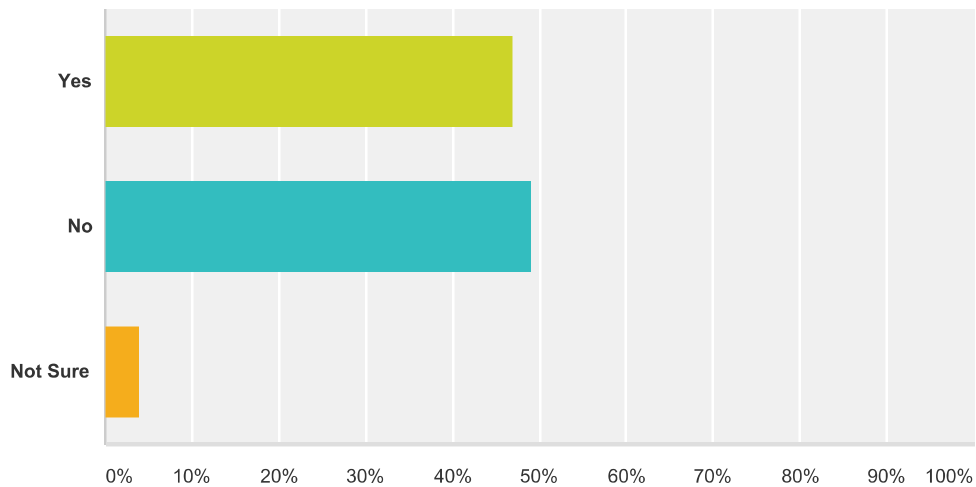
Answered: 48 Skipped: 17



Answer Choices	Responses	
Yes	**2.08%**	1
No	**27.08%**	13
Not Applicable	**70.83%**	34
Total		**48**

Q17 When you moved into your home, did you consider the impact a natural disaster could have on your home?

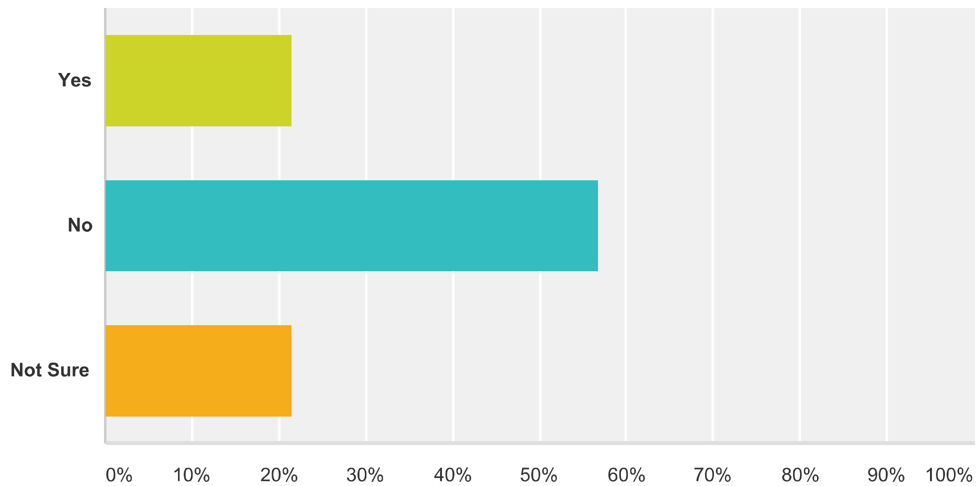
Answered: 51 Skipped: 14



Answer Choices	Responses	
Yes	**47.06%**	24
No	**49.02%**	25
Not Sure	**3.92%**	2
Total		**51**

Q18 Was the presence of a natural hazard risk zone (e.g., dam failure zone, flood zone, landslide hazard area, high fire risk area) disclosed to you by a real estate agent, seller, or landlord before you purchased or moved into your home?

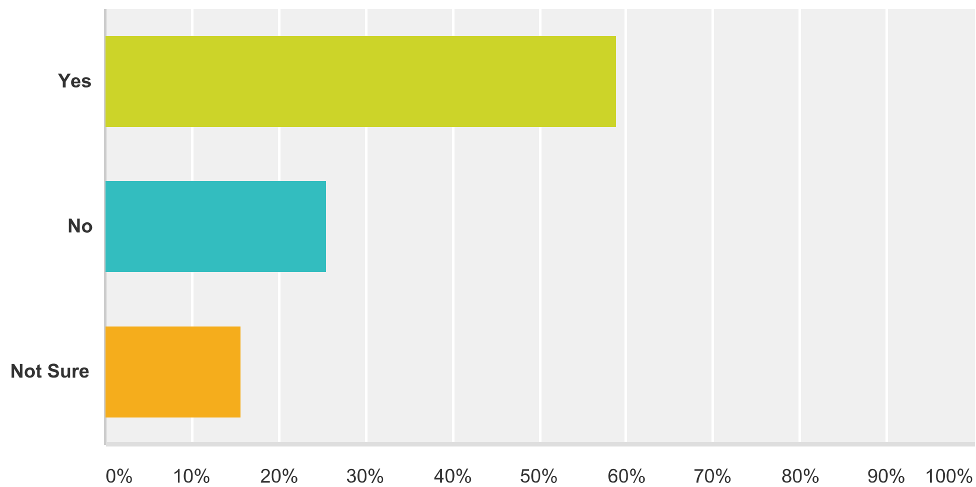
Answered: 51 Skipped: 14



Answer Choices	Responses	
Yes	**21.57%**	11
No	**56.86%**	29
Not Sure	**21.57%**	11
Total		**51**

Q19 Would the disclosure of this type of natural hazard risk information influence your decision to buy or rent a home?

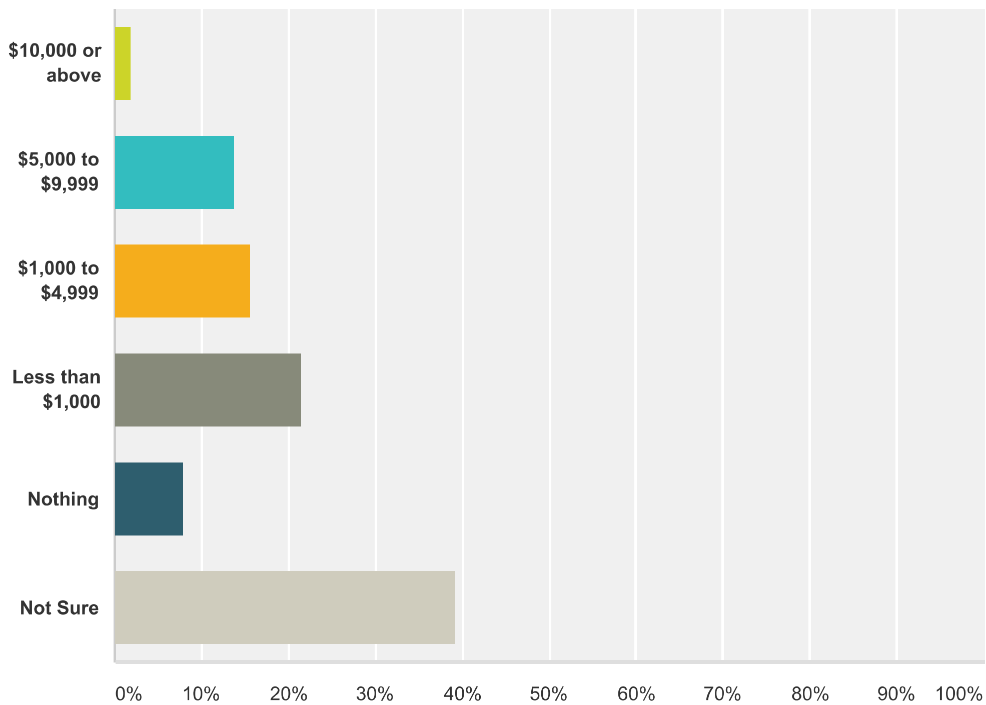
Answered: 51 Skipped: 14



Answer Choices	Responses	
Yes	**58.82%**	30
No	**25.49%**	13
Not Sure	**15.69%**	8
Total		**51**

Q20 How much money would you be willing to spend to retrofit your home to reduce risks associated with natural disasters? (for example, by clearing brush and plant materials from around your home to create a "defensible space" for wildfire, performing seismic upgrades, or replacing a combustible roof with non-combustible roofing)

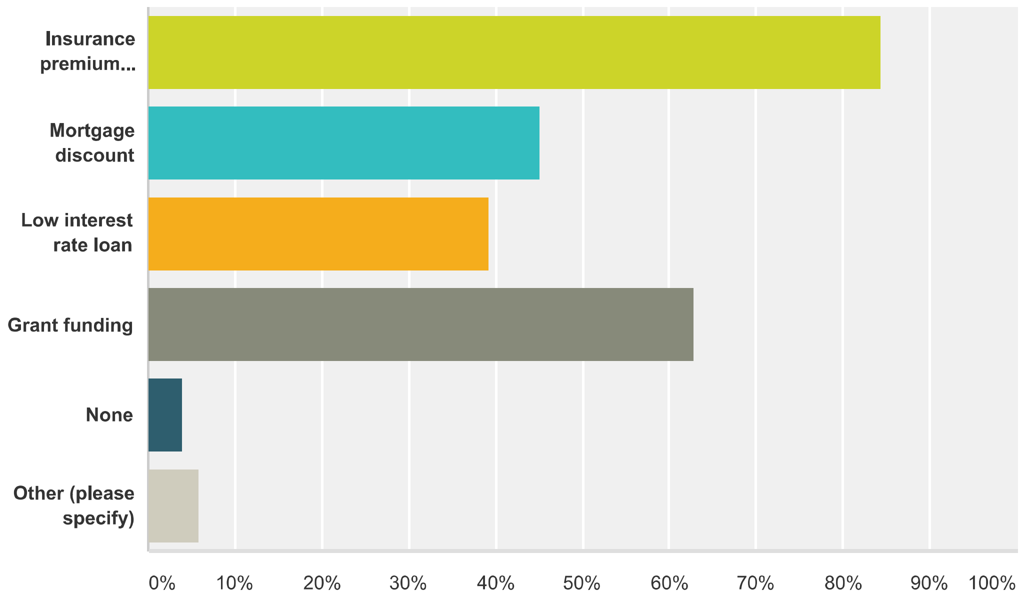
Answered: 51 Skipped: 14



Answer Choices	Responses	
$10,000 or above	**1.96%**	1
$5,000 to $9,999	**13.73%**	7
$1,000 to $4,999	**15.69%**	8
Less than $1,000	**21.57%**	11
Nothing	**7.84%**	4
Not Sure	**39.22%**	20
Total		**51**

Q21 Which of the following incentives would encourage you to spend money to retrofit your home to protect against natural disasters? (Check all that apply)

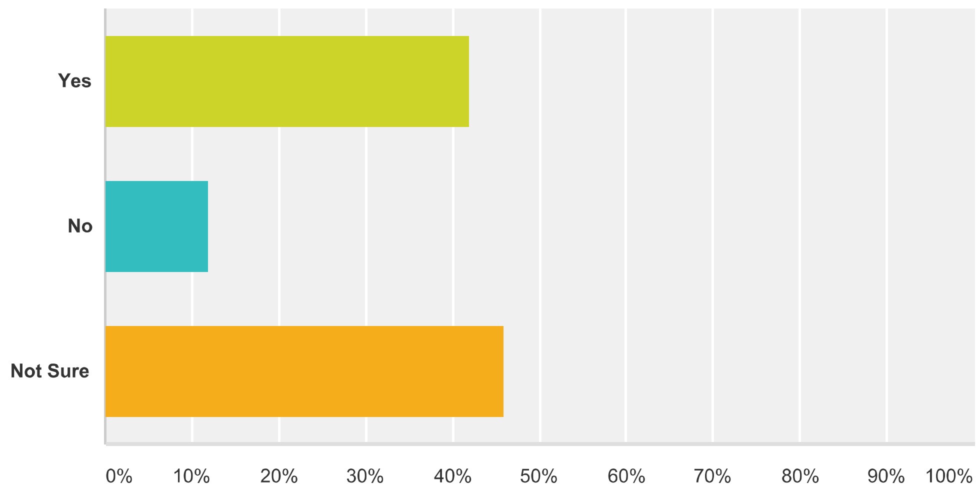
Answered: 51 Skipped: 14



Answer Choices	Responses	
Insurance premium discount	**84.31%**	43
Mortgage discount	**45.10%**	23
Low interest rate loan	**39.22%**	20
Grant funding	**62.75%**	32
None	**3.92%**	2
Other (please specify)	**5.88%**	3
Total Respondents: 51		

Q22 If your property were located in a designated "high hazard" area or had received repetitive damages from a natural hazard event, would you consider a "buyout" offered by a public agency?

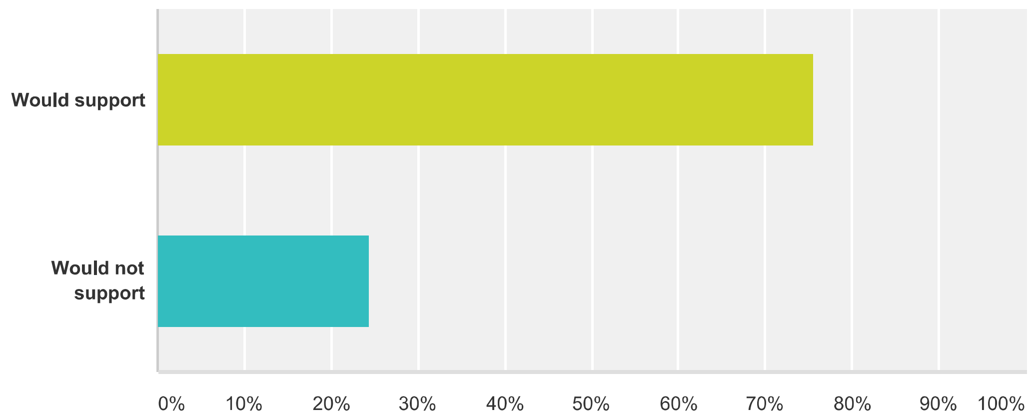
Answered: 50 Skipped: 15



Answer Choices	Responses	
Yes	**42.00%**	21
No	**12.00%**	6
Not Sure	**46.00%**	23
Total		**50**

Q23 Would you support the regulation (restriction) of land uses within known high hazard areas?

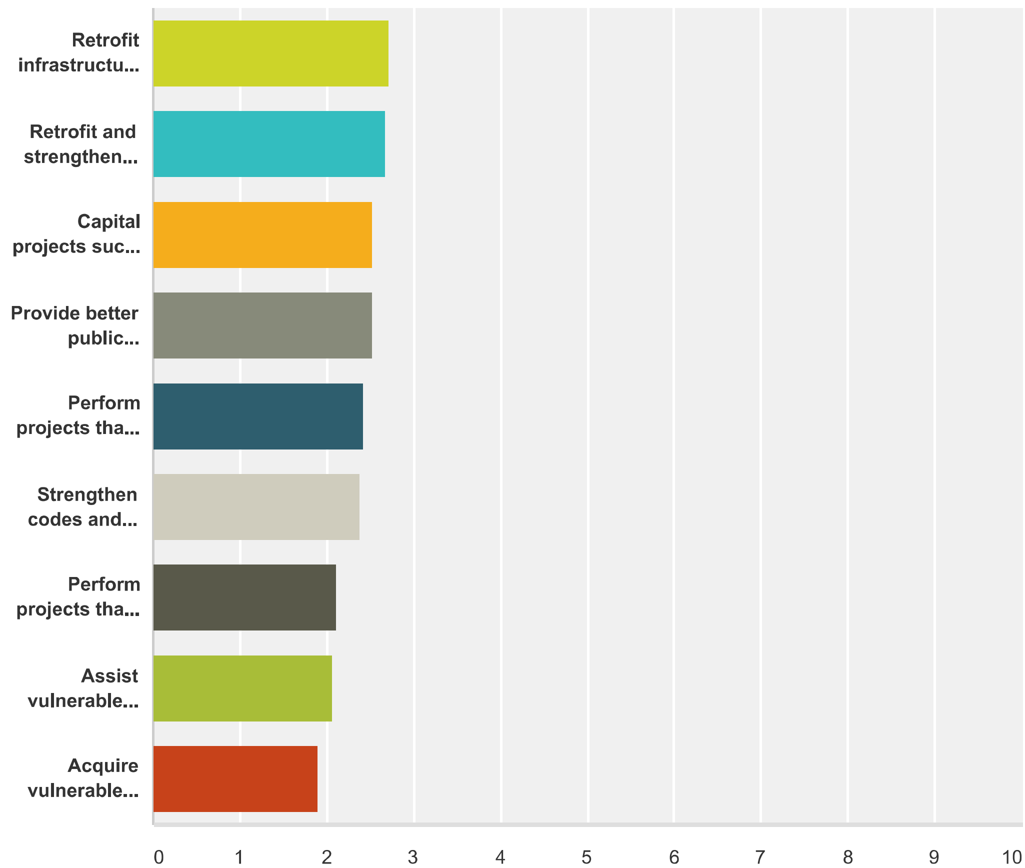
Answered: 49 Skipped: 16



Answer Choices	Responses	
Would support	**75.51%**	37
Would not support	**24.49%**	12
Total		**49**

Q24 What types of projects do you believe the County, State or Federal government agencies should be doing in order to reduce damage and disruption from hazard events within Matagorda County? Please rank each option as a high, medium or low priority.

Answered: 51 Skipped: 14

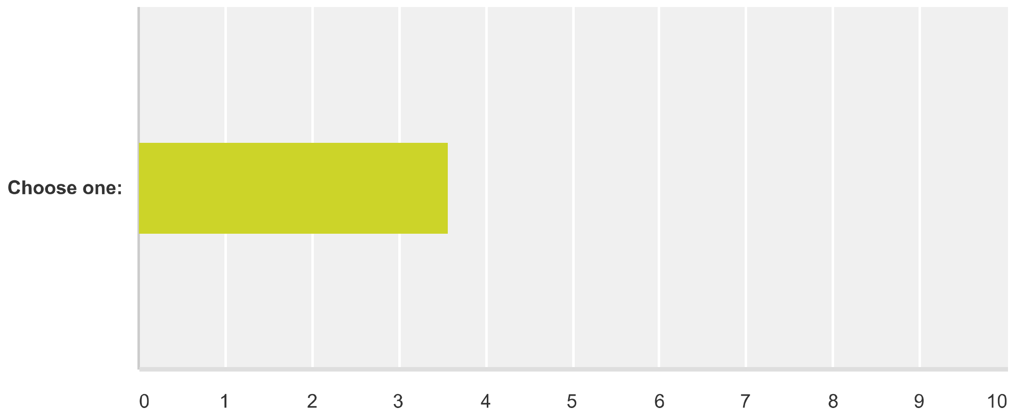


	High	Medium	Low	Total	Weighted Average
Retrofit infrastructure such as roads, bridges, drainage facilities, levees, water supply, waste water and power supply facilities.	77.55% 38	16.33% 8	6.12% 3	49	2.71
Retrofit and strengthen essential facilities such as police, fire, schools and hospitals.	70.00% 35	28.00% 14	2.00% 1	50	2.68
Capital projects such as dams, levees, flood walls, drainage improvements and bank stabilization projects.	56.00% 28	40.00% 20	4.00% 2	50	2.52
Provide better public information about risk, and the exposure to hazards within the operational area.	62.00% 31	28.00% 14	10.00% 5	50	2.52
Perform projects that restore the natural environments capacity to absorb the impacts from natural hazards.	52.00% 26	38.00% 19	10.00% 5	50	2.42
Strengthen codes and regulations to include higher regulatory standards in hazard areas.	51.02% 25	36.73% 18	12.24% 6	49	2.39

Perform projects that mitigate the potential impacts from climate change.	**34.69%** 17	**40.82%** 20	**24.49%** 12	49	2.10
Assist vulnerable property owners with securing funding for mitigation.	**26.53%** 13	**53.06%** 26	**20.41%** 10	49	2.06
Acquire vulnerable properties and maintain as open space.	**27.66%** 13	**36.17%** 17	**36.17%** 17	47	1.91

Q25 Please indicate how you feel about the following statement:It is the responsibility of government (local, state and federal) to provide education and programs that promote citizen actions that will reduce exposure to the risks associated with natural hazards.

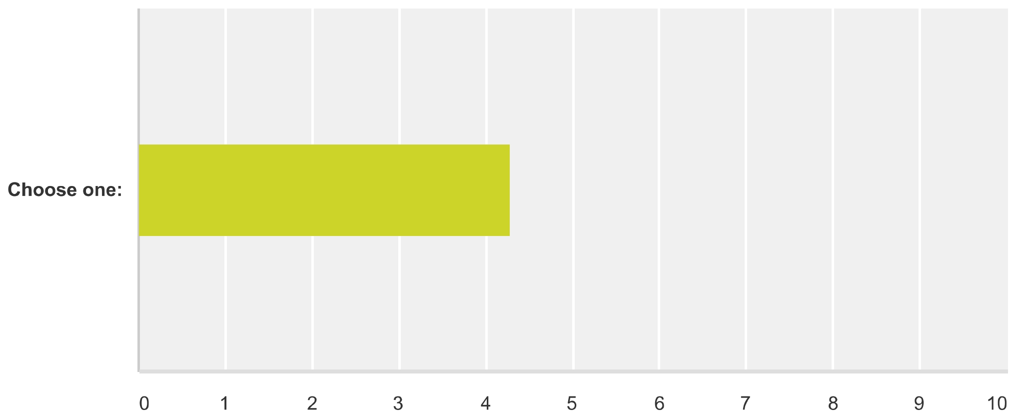
Answered: 50 Skipped: 15



	Strongly Disagree	Somewhat Disagree	Neither Agree nor Disagree	Somewhat Agree	Strongly Agree	Total	Weighted Average
Choose one:	**8.00%** 4	**10.00%** 5	**22.00%** 11	**36.00%** 18	**24.00%** 12	50	3.58

Q26 Please indicate how you feel about the following statement:It is my responsibility to educate myself and take actions that will reduce my exposure to the risks associated with natural hazards.

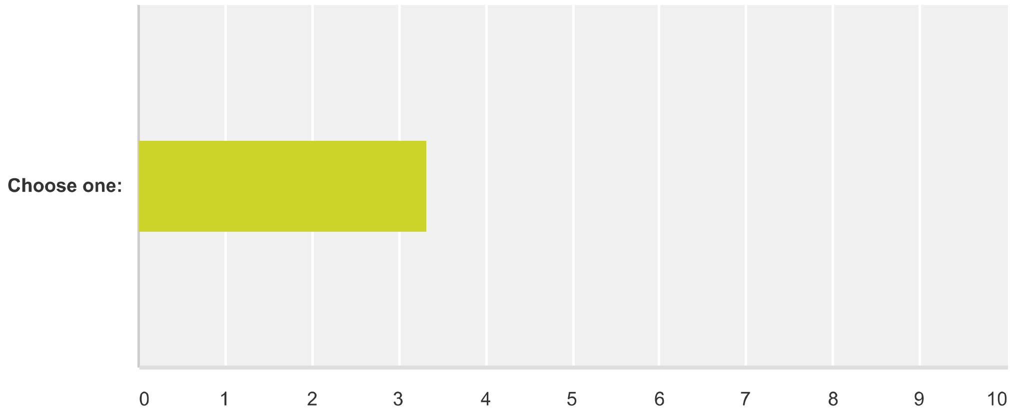
Answered: 51 Skipped: 14



	Strongly Disagree	Somewhat Disagree	Neither Agree nor Disagree	Somewhat Agree	Strongly Agree	Total	Weighted Average
Choose one:	**3.92%** 2	**3.92%** 2	**9.80%** 5	**23.53%** 12	**58.82%** 30	51	4.29

Q27 Please indicate how you feel about the following statement:Information about the risks associated with natural hazards is readily available and easy to locate.

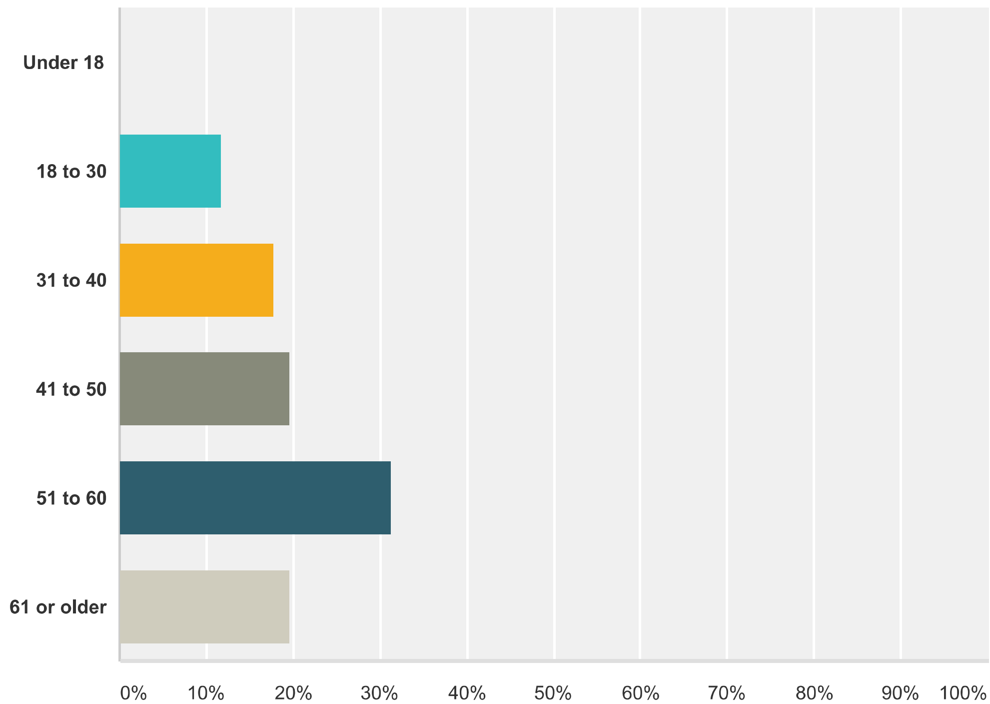
Answered: 51 Skipped: 14



	Strongly Disagree	Somewhat Disagree	Neither Agree nor Disagree	Somewhat Agree	Strongly Agree	Total	Weighted Average
Choose one:	**3.92%** 2	**21.57%** 11	**27.45%** 14	**33.33%** 17	**13.73%** 7	51	3.31

Q28 Please indicate your age range:

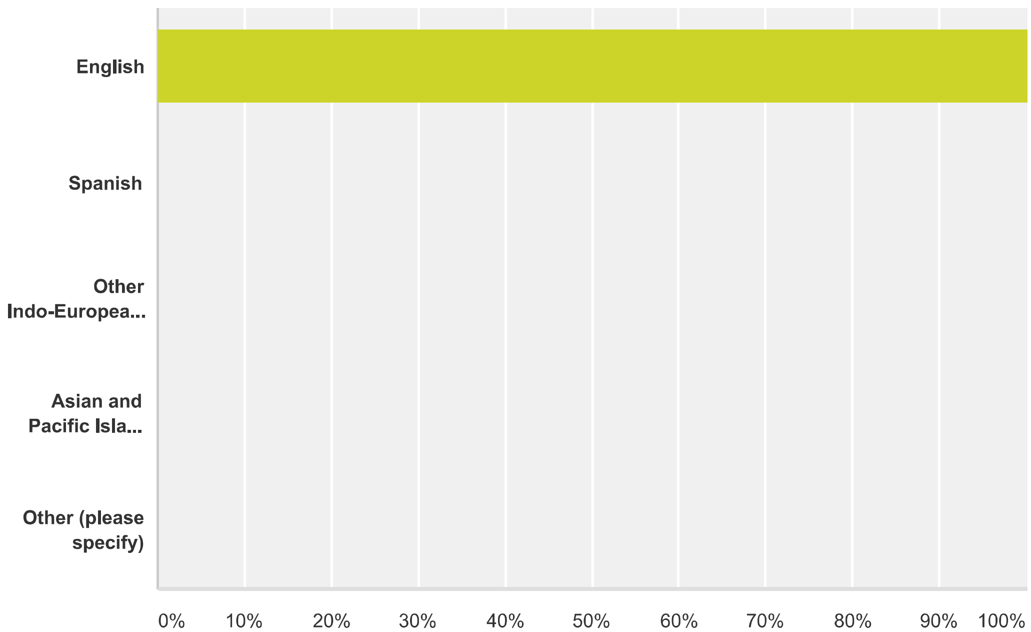
Answered: 51 Skipped: 14



Answer Choices	Responses	
Under 18	**0.00%**	0
18 to 30	**11.76%**	6
31 to 40	**17.65%**	9
41 to 50	**19.61%**	10
51 to 60	**31.37%**	16
61 or older	**19.61%**	10
Total		**51**

Q29 Please indicate the primary language spoken in your household.

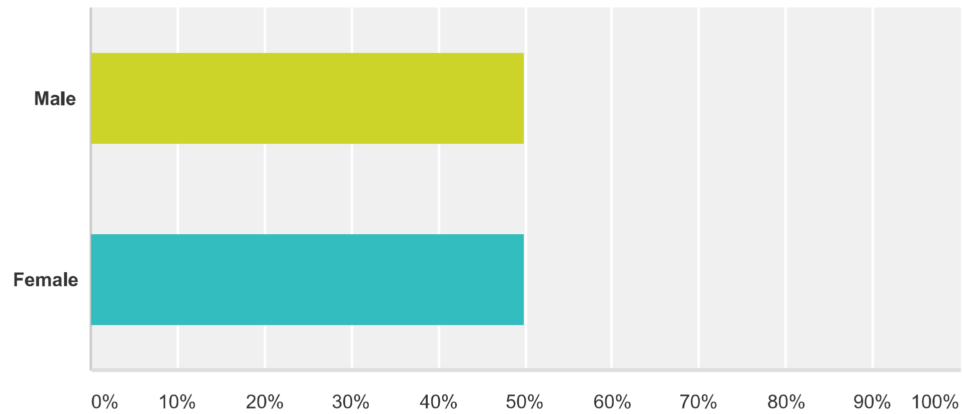
Answered: 51 Skipped: 14



Answer Choices	Responses	
English	**100.00%**	51
Spanish	**0.00%**	0
Other Indo-European Languages	**0.00%**	0
Asian and Pacific Island Languages	**0.00%**	0
Other (please specify)	**0.00%**	0
Total		**51**

Q30 Please indicate your gender:

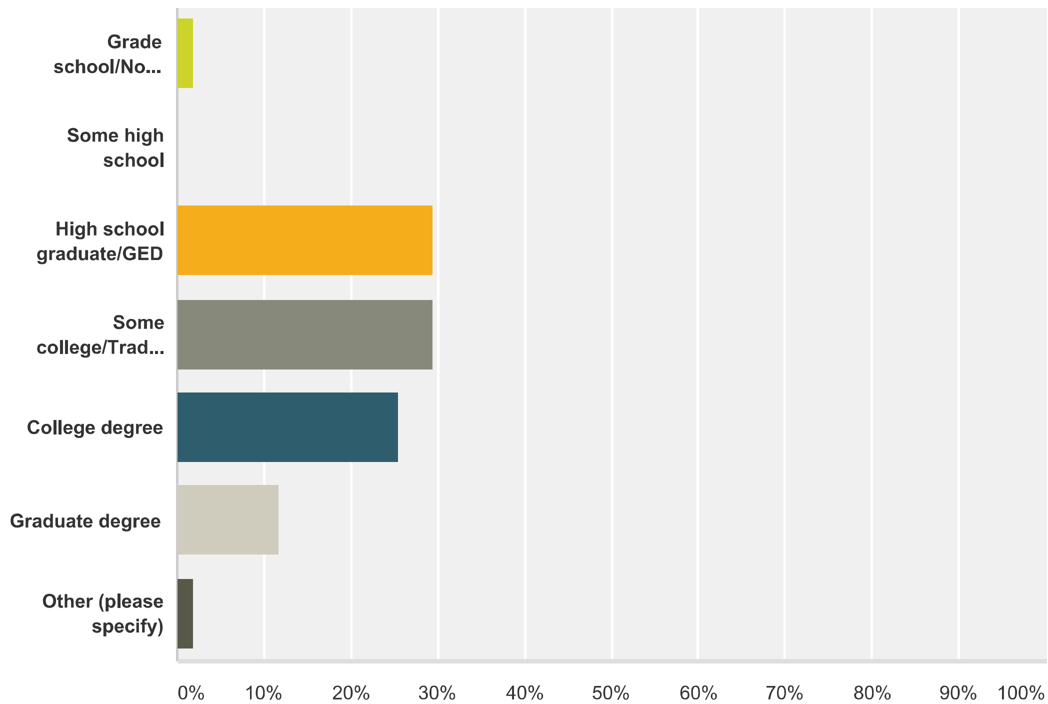
Answered: 50   Skipped: 15



Answer Choices	Responses	
Male	**50.00%**	25
Female	**50.00%**	25
Total		**50**

Q31 Please indicate your highest level of education.

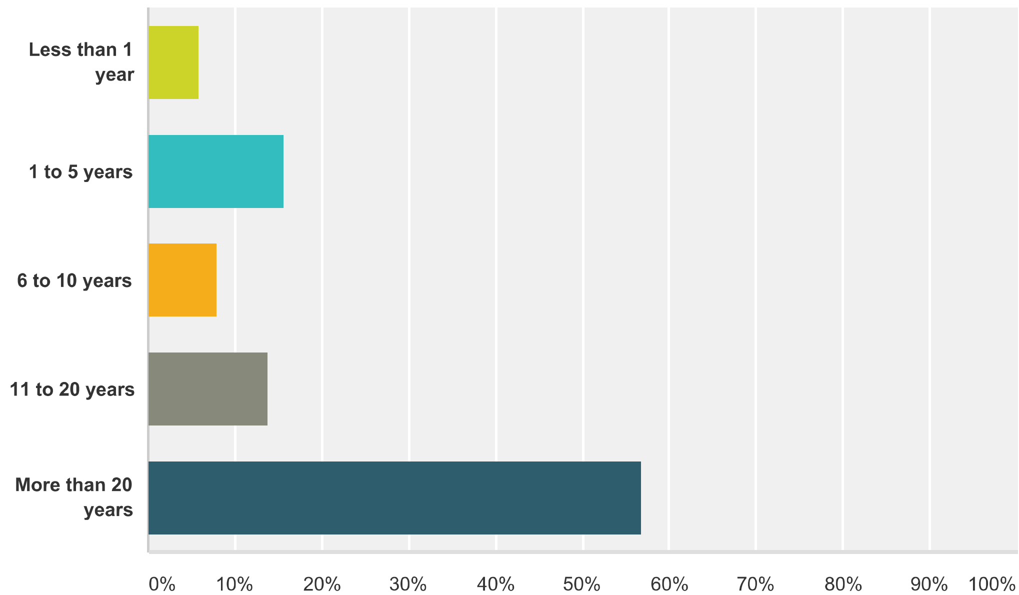
Answered: 51 Skipped: 14



Answer Choices	Responses	
Grade school/No schooling	1.96%	1
Some high school	0.00%	0
High school graduate/GED	29.41%	15
Some college/Trade school	29.41%	15
College degree	25.49%	13
Graduate degree	11.76%	6
Other (please specify)	1.96%	1
Total		**51**

Q32 How long have you lived in Matagorda County?

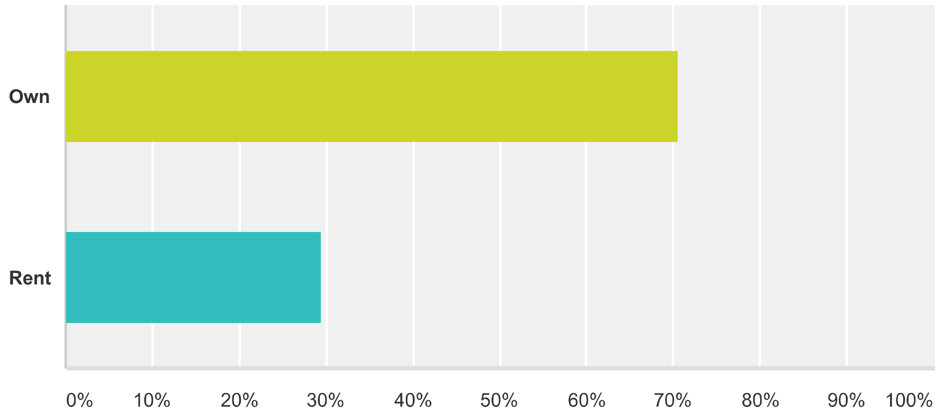
Answered: 51 Skipped: 14



Answer Choices	Responses	
Less than 1 year	**5.88%**	3
1 to 5 years	**15.69%**	8
6 to 10 years	**7.84%**	4
11 to 20 years	**13.73%**	7
More than 20 years	**56.86%**	29
Total		**51**

Q33 Do you own or rent your place of residence?

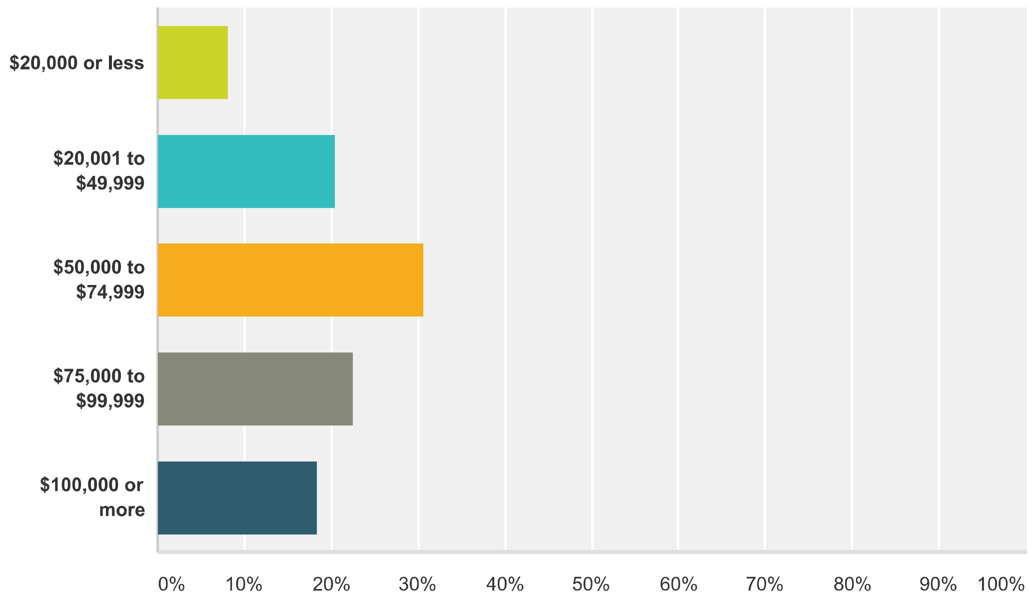
Answered: 51 Skipped: 14



Answer Choices	Responses	
Own	**70.59%**	36
Rent	**29.41%**	15
Total		**51**

Q34 How much is your gross household income?

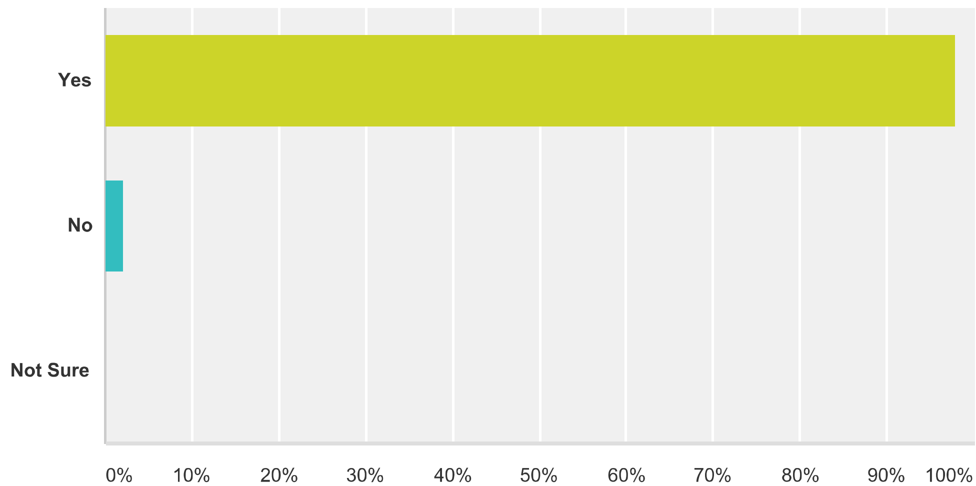
Answered: 49 Skipped: 16



Answer Choices	Responses	
$20,000 or less	**8.16%**	4
$20,001 to $49,999	**20.41%**	10
$50,000 to $74,999	**30.61%**	15
$75,000 to $99,999	**22.45%**	11
$100,000 or more	**18.37%**	9
Total		**49**

Q35 Do you have regular access to the Internet?

Answered: 49 Skipped: 16



Answer Choices	Responses	
Yes	**97.96%**	48
No	**2.04%**	1
Not Sure	**0.00%**	0
Total		**49**

Q36 Comments

Answered: 5 Skipped: 60

APPENDIX D.
PLAN ADOPTION RESOLUTIONS FROM PLANNING PARTNERS

APPENDIX D.
PLAN ADOPTION RESOLUTIONS FROM PLANNING PARTNERS

RESOLUTION NO. R-2017-06

WHEREAS, Section 322 of the Stafford Disaster Relief and Emergency Assistance Act (42 U.S.C. 5165) requires local governments to develop a hazardous mitigation plan as a condition for receiving certain types of non-emergency disaster assistance, including funding for mitigation projects; and,

WHEREAS, the Code of Federal Regulations (CFR) at Title 44, Chapter 1, part 201, requires the City to prepare and adopt a local mitigation plan every five years; and,

WHEREAS, a steering committee comprised of members of the County, and the City of Bay City, selected and deemed appropriate by the Commissioners Court in his authority to do so as granted by the people, as well as the City's leadership was convened in order to assess the risks of hazards facing the County and the City, and to make recommendations on actions to be taken to mitigate these hazards; and,

WHEREAS, a request for proposals was issued through the Texas Colorado Regional Floodplain Coalition to hire an experienced consulting firm to work with the County to update a comprehensive hazard mitigation plan for the County and the City of Bay City; and,

WHEREAS, the plan incorporates the comments, ideas and concerns of the community and of the public in general, which this plan is designed to protect, ascertained through a series of public meetings, publication of the draft plan, press releases, and other outreach activities; and

NOW THEREFORE, BE IT RESOLVED by the City Council of the City of Bay City that the 2016 Matagorda County, Texas Hazard Mitigation Plan, dated October 2016 is hereby approved and adopted by the City Council of the City of Bay City and resolves to execute the actions in the plan.

This Resolution shall take effect immediately without reconsideration.

A copy of the plan is available in the City Secretary's Office.

ADOPTED by the City Council of the City of Bay City on this 23rd day of March 2017.

APPROVED:

Mark Bricker, Mayor
City of Bay City

ATTEST:

Rhonda Clegg

Rhonda Clegg, City Secretary

APPROVED AS TO FORM:

M. [illegible]

M. Shannon Kackley, Assistant City Attorney
City of Bay City
DENTON, NAVARRO, ROCHA,
BERNAL, HYDE & ZECH, P.C.

U.S. Department of Homeland Security
Region VI
800 N. Loop 288
Denton, TX 76209-3698

FEMA

February 16, 2017

Ms. Sandra Fulenwider
State of Texas
Texas Division of Emergency Management
P.O. Box 4087
Austin, TX 78773-0220

RE: Approvable Pending Adoption of the Matagorda County, Texas Multi-Jurisdiction Hazard Mitigation Plan.
Funding Source: PDM; 2013

Dear Ms. Fulenwider:

This office has concluded its review of the referenced plan, in conformance with the Final Rule on Mitigation Planning (44 CFR Part 201.6). Formal approval of this plan is contingent upon the adoption by resolution by the participants on Enclosure A, as well as the receipt of a CD containing all components of this plan.

Adopting resolutions must be submitted to this agency for review and approval no later than 90 days from the date of this letter. Failure to submit these resolutions in a timely manner could lead to a required update of the plan prior to FEMA approval.

Once this final requirement has been met, a letter of official approval will be generated. The Local Hazard Mitigation Planning Tool, with the reviewer's comments has been enclosed to further assist the jurisdictions in complying with planning requirements.

If you have any questions, please contact Jamie Leigh Price, HM Community Planner, at (940) 898-5440.

Sincerely,

Ronald C. Wanhanen
Chief, Risk Analysis Branch

Enclosure

cc: Marty Chester, R6-MT-HM

Enclosure A

Matagorda County, Texas
Multi-Jurisdiction
Hazard Mitigation Plan Participants

Attached is the list of approved participating governments included in the February 16, 2017 review of the referenced Hazard Mitigation plan.

	Community Name
1)	Bay City city
2)	Matagorda County
3)	Palacios city

Adoption Submittal (Final)

Region 6 recommends that all jurisdictions refrain from adopting a plan until it has received an Approvable Pending Adoption status from FEMA. Following the issuance of Approvable Pending Adoption letter, all participants are provided 90 days to adopt the plan and submit it through the state to FEMA. For multi-jurisdictional plans, multiple adoptions should be submitted as a complete package as outlined below.

- Include a state transmittal letter containing:
  - Plan name, sub-grantee, FEMA funding source, grant or disaster number, and project number, as applicable.
  - Information on enclosed adoptions.
- Include an electronic (CD) version containing the final plan formatted as a single document, and all signed resolutions as an additional single document on the disk.
  - Track changes, strikethroughs, highlights must be removed from the final plan.
  - A bound paper copy of the plan is not required for this submittal.
  - Plan must be dated to final adoption month and year.
- E-mail submittals will not be accepted.
- Submittals which do not conform to the above requirements will be returned to the State for resubmission.

MATAGORDA COUNTY COMMISSIONERS' COURT

RESOLUTION

WHEREAS, Section 322 of the Stafford Disaster Relief and Emergency Assistance Act (42 U.S.C. 5165) requires local governments to develop a hazardous mitigation plan as a condition for receiving certain types of non-emergency disaster assistance, including funding for mitigation projects; and

WHEREAS, the Code of Federal Regulations (CFR) at Title 44, Chapter 1, part 201, requires the City to prepare and adopt a local mitigation plan every five years; and,

WHEREAS, a steering committee comprised of members of the County, and participating incorporated areas within, selected and deemed appropriate by the Commissioner's Court in his authority to do so as granted by the people, as well as the local participating governments' leadership was convened in order to assess the risks of hazards facing the County and the Communities, and to make recommendations on actions to be taken to mitigate these hazards; and

WHEREAS, a request for proposals was issued through the Texas Colorado Regional Floodplain Coalition to hire an experienced consulting firm to work with the County to update a comprehensive hazard mitigation plan for the County and the participating jurisdictions; and,

WHEREAS, the plan incorporates the comments, ideas and concerns of the community and of the public in general, which this plan is designed to protect, ascertained through a series of public meetings, publication of the draft plan , press releases, and other outreach activities; and,

NOW, THEREFORE, BE IT RESOLVED, by the **Matagorda County Commissioners Court** that the 2016 Matagorda County, Texas Hazard Mitigation Plan, is hereby approved and adopted by the Commissioners Court of Matagorda County and resolves to execute the actions in the plan.

This Resolution shall take effect immediately without reconsideration.

PASSED AND APPROVED on this the 27 day of February, 2017.

Attest:

Janet Hickl, County Clerk

Approved:

Nate McDonald, County Judge

Gary Graham, Commissioner Precinct #1

Kent Pollard, Commissioner, Precinct #2

James Gibson, Commissioner, Precinct #3

Charles Frick, Commissioner, Precinct #4

Resolution No. 2017-R-3

A RESOLUTION OF THE CITY OF PALACIOS, TEXAS, APPROVING THE ADOPTION OF THE 2016 MATAGORDA COUNTY, TEXAS MULTI-JURISDICTION HAZARD MITIGATION PLAN. FUNDING SOURCE: PDM; 2013

WHEREAS, Section 322 of the Stafford Disaster Relief and Emergency Assistance Act (42 U.S.C. 5165) requires local governments to develop a hazardous mitigation plan as a condition for receiving certain types of non-emergency disaster assistance, including funding for mitigation projects; and,

WHEREAS, the Code of Federal Regulations (CFR) at Title 44, Chapter 1, part 201, requires the City to prepare and adopt a local mitigation plan every five years; and,

WHEREAS, a steering committee comprised of members of the County, and the City of Palacios City, selected and deemed appropriate by the Commissioners Court in his authority to do so as granted by the people, as well as the City's leadership was convened in order to assess the risks of hazards facing the County and the City, and to make recommendations on actions to be taken to mitigate these hazards; and,

WHEREAS, a request for proposals was issued through the Texas Colorado Regional Floodplain Coalition to hire an experienced consulting firm to work with the County to update a comprehensive hazard mitigation plan for the County and the City of Palacios City; and,

WHEREAS, the plan incorporates the comments, ideas and concerns of the community and of the public in general, which this plan is designed to protect, ascertained through a series of public meetings, publication of the draft plan, press releases, and other outreach activities; and

NOW THEREFORE, BE IT RESOLVED by the City Council of the City of Palacios City that the 2016 Matagorda County, Texas Hazard Mitigation Plan, dated October 2016 is hereby approved and adopted by the City Council of the City of Palacios City and resolves to execute the actions in the plan.

This Resolution shall take effect immediately wi
thout reconsideration.

A copy of the plan is attached to this resolution.

ADOPTED, PASSED AND APPROVED on this 28th day of Feb. 2017.

Mayor, Glen Smith

ATTEST

City Secretary, Angela Flores

THE CITY OF PALACIOS TEXAS

APPENDIX E.
EXAMPLE PROGRESS REPORT

APPENDIX E.
EXAMPLE PROGRESS REPORT

Matagorda County
Hazard Mitigation Plan Update
Annual Progress Report

Reporting Period: 2016-2020

Background: Matagorda County and the Cities of Bay City and Palacios developed a hazard mitigation plan to reduce risk from all hazards by identifying resources, information, and strategies for risk reduction. The federal Disaster Mitigation Act of 2000 requires state and local governments to develop hazard mitigation plans as a condition for federal disaster grant assistance. To prepare the plan, the participating partners organized resources, assessed risks from natural hazards within the planning area, developed planning goals and objectives, reviewed mitigation alternatives, and developed an action plan to address probable impacts from natural hazards. By completing this process, these jurisdictions maintained compliance with the Disaster Mitigation Act, achieving eligibility for mitigation grant funding opportunities afforded under FEMA's Hazard Mitigation Assistance grants. The plan can be viewed on-line at:

http://www.co.matagorda.tx.us/

Summary Overview of the Plan's Progress: The performance period for the Hazard Mitigation Plan became effective on ____, 2016, with the final approval of the plan by FEMA. The initial performance period for this plan will be 5 years, with an anticipated update to the plan to occur before ______, 2020. As of this reporting period, the performance period for this plan is considered to be __% complete. The Hazard Mitigation Plan has targeted 54 hazard mitigation actions to be pursued during the 5-year performance period. As of the reporting period, the following overall progress can be reported:

- __ out of __ actions (__%) reported ongoing action toward completion
- __ out of __ actions (__%) were reported as being complete
- __ out of __ actions (___%) reported no action taken

Purpose: The purpose of this report is to provide an annual update on the implementation of the action plan identified in the Matagorda County Hazard Mitigation Plan Update. The objective is to ensure that there is a continuing and responsive planning process that will keep the Hazard Mitigation Plan dynamic and responsive to the needs and capabilities of the partner jurisdictions. This report discusses the following:

- Natural hazard events that have occurred within the last year
- Changes in risk exposure within the planning area (all of Matagorda County)
- Mitigation success stories
- Review of the action plan
- Changes in capabilities that could impact plan implementation
- Recommendations for changes/enhancement
- Monitor the incorporation of the Mitigation Plan into planning mechanisms.

The Hazard Mitigation Plan Steering Committee: The Hazard Mitigation Plan Steering Committee, made up of planning partners and stakeholders within the planning area, reviewed and approved this progress report at its annual meeting held on _____, 201_. It was determined through the plan's development process that a Steering Committee would remain in service to oversee maintenance of the plan. At a minimum, the Steering Committee will provide technical review and oversight on the development of the annual progress report. It is anticipated that there will be turnover in the membership annually, which will be documented in the progress reports. For this reporting period, the Steering Committee membership is as indicated in Table 1.

TABLE 1.
STEERING COMMITTEE MEMBERS

Name	Title	Jurisdiction/Agency

Natural Hazard Events within the Planning Area: During the reporting period, there were __ natural hazard events in the planning area that had a measurable impact on people or property. A summary of these events is as follows:

- ____________________________
- ____________________________

Changes in Risk Exposure in the Planning Area: *(Insert brief overview of any natural hazard event in the planning area that changed the probability of occurrence or ranking of risk for the hazards addressed in the hazard mitigation plan)*

Mitigation Success Stories: *(Insert brief overview of mitigation accomplishments during the reporting period)*

Review of the Action Plan: Table 2 reviews the action plan, reporting the status of each action. Reviewers of this report should refer to the Hazard Mitigation Plan for more detailed descriptions of each action and the prioritization process.

Address the following in the "status" column of the following table:

- Was any element of the action carried out during the reporting period?
- If no action was completed, why?
- Is the timeline for implementation for the action still appropriate?

If the action was completed, does it need to be changed or removed from the action plan?

TABLE 2.
ACTION PLAN MATRIX

Action No.	Title	Action Taken? (Yes or No)	Timeline	Priority	Status	Status (√, O, X)
MATAGORDA COUNTY						
1	Install automated Flood Warning Systems					
2	Construct tornado and hurricane safe rooms					
3	Waterproofing Ordinance					
4	Education on hail damage					
5	Build new water reservoirs for water supply					
6	Education on tornado awareness and knowledge of insurance needs					
7	Develop a Beach Restorations Program					
8	Design & construct drainage improvement projects					
9	Expand rainfall observer program through CoCoRaHS					
10	Purchase and install generators including auto switch.					
11	Conduct outreach and educate public about natural hazards					
12	Flood Insurance					
13	Update the Matagorda County Flood Insurance Study and FIRMs					
14	Provide support to the TCRFC for flood reduction projects					

TABLE 2.
ACTION PLAN MATRIX

Action No.	Title	Action Taken? (Yes or No)	Timeline	Priority	Status	Status (√, O, X)
15	Install Reverse 911 Emergency Notifications System					
16	Inspect, improve, and certify Flood Protection Levees					
17	Establish Burning Ordinance					
CITY OF BAY CITY						
1	Update Building Codes					
2	Drought and Expansive Soils Contingency Plan					
3	Adopt sediment control regulations.					
4	Master Generator Plan & Purchase Generators					
5	Construct Regional Detention					
6	Retrofit water supply system					
7	Education on natural hazards affecting homeowners					
8	Adopt Tree Ordinance					
9	Institute a buy-out program after enactment of building codes and ordinances					
10	City's floodplain management ordinance					
11	Flood insurance					
12	Design, construct, and maintain drainage improvement projects					

TABLE 2.
ACTION PLAN MATRIX

Action No.	Title	Action Taken? (Yes or No)	Timeline	Priority	Status	Status (√, O, X)
13	Provide training for CFM and CEM.					
14	Participate in FEMA’s CRS					
15	Inspect, improve, and certify flood protection levees and seawalls in Bay City					
16	Raise bridges above the BFE					
CITY OF PALACIOS						
1	Construct new Emergency Operation Center					
2	Install generators at City Hall complex and critical facilities					
3	Construct bulkhead along the west end of Tres Palacios Bay					
4	Extend breakwater jetty and groins to prevent damage to facilities and marina					
5	Purchase NOAA all-hazard radios					
6	Educate builders and homeowners of foundation shifting due to expansive soils					
7	Prevention of utility failures					
8	Bury electrical lines to critical facilities					
9	Building design and construction of roofs and pre-engineered windows					
10	Education on hail damage					
11	Institute ordinances for tie-down requirements.					

TABLE 2.
ACTION PLAN MATRIX

Action No.	Title	Action Taken? (Yes or No)	Timeline	Priority	Status	Status (√, O, X)
12	Raise bridges above the BFE					
13	Increase drainage for airport property					
14	Relocate Police Station outside Flood Zone B					
15	Promote flood insurance					
16	Design, construct and maintain drainage improvement projects					
17	Adopt "Higher Standard" riverine flood damage prevention ordinances and standards					
18	Provide training for CFMs and CEMs.					
19	Participate in FEMA's CRS					
20	Construct cover over Park N Ride Parking Lot					
21	Public information on how to reduce water usage					

Completion status legend:

✓= Project Completed

O = Action ongoing toward completion

X = No progress at this time

Changes That May Impact Implementation of the Plan: (*Insert brief overview of any significant changes in the planning area that would have a profound impact on the implementation of the plan. Specify any changes in technical, regulatory and financial capabilities identified during the plan's development)*

Recommendations for Changes or Enhancements: Based on the review of this report by the Hazard Mitigation Plan Steering Committee, the following recommendations will be noted for future updates or revisions to the plan:

- ______________________________
- ______________________________
- ______________________________
- ______________________________
- ______________________________

Public review notice: *The contents of this report are considered to be public knowledge and have been prepared for total public disclosure. Copies of the report have been provided to the governing boards of all planning partners and to local media outlets and the report is posted on the Matagorda County Hazard Mitigation Plan website. Any questions or comments regarding the contents of this report should be directed to:*

Insert Contact Info Here