HAZARD MITIGATION PLAN

Wharton County

September 2021

Prepared For:

Wharton County

Office of Emergency Management

Wharton County
HAZARD MITIGATION PLAN UPDATE

Prepared for:

Wharton County Office of Emergency Management
315 E. Elm Street
Wharton, TX 77488

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Acknowledgments and Contacts

Wharton County:

Andy Kirkland

Emergency Management Coordinator

Phone: (979)-532-1123

Email: andy.kirkland@co.wharton.tx.us

Scheibe Consulting:

Eric Scheibe, PE, CFM

President

Phone: (512) 263-0418

Email: escheibe@scheibeconsulting.com

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 the 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 the 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.

Wharton 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. This plan is regularly updated every 5 years to ensure the document remains current and to comply with 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.

Wharton County and its communities participated in previous hazard mitigation plans as part of the Texas Colorado River Floodplain Coalition (TCRFC). In accordance with the Federal Emergency Management Agency (FEMA) guidelines that require individual hazard mitigation plans for each county and Texas Division of Emergency Management's 2010 "two-county maximum" policy, an update was developed to be specific to Wharton County and its participating communities: the Cities of East Bernard, El Campo, and Wharton.

In accordance with update requirements, this update to *Wharton County Hazard Mitigation Plan Update 2016* was conducted. Specifically, this update encompasses the hazard mitigation analysis of Wharton County and its participating communities.

The development of this hazard mitigation plan update 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 Scheibe Consulting representatives, key county and city staff. 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 East Bernard, El Campo, and Wharton. 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 *Wharton County Hazard*

Mitigation Plan Update 2016 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 encouraged 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 Wharton County Hazard Mitigation Plan Update is as follows:

To reduce or eliminate the long-term risks to loss of life and property damage in Wharton County from the full range of 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 the 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 the 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 HAZARD OF CONCERN

For this plan, the Steering Committee considered the full range of hazards that could impact the planning area and then listed hazards that present the greatest concern to the county and participating cities. The process incorporated a 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:

- Dam/Levee Failure
- Drought
- Expansive Soils
- Extreme Heat
- Earthquake
- Flood
- Hail
- Hazardous Materials
- Hurricane and Tropical Storm
- Land Subsidence
- Lightning
- Pandemic
- Tornado
- Wildfire
- Wind
- Winter Weather

MITIGATION ACTIONS

Mitigation actions presented in this plan update are activities designed to reduce or eliminate losses resulting from hazards. The update process resulted in the identification of 68 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 in Months	Benefit
WHARTON COUNTY										
1	Improve drainage infrastructure throughout the County (Bridge, culvert, channel, levee, and dam projects)	Install larger drainage improvements throughout the county. During flood and hurricane events the streams overflow. There are areas that do not pass the required flow needed for emergency access during flood events.	1	SIP	G1, G2, G6	Drainage Department	>$100,000	Road and Bridge Fund, State/Federal Grants	60	High
2	Update and adopt the Wharton County Flood Insurance Study and FIRM	Updated and adopt a new Flood Insurance Study and FIRM. This would prevent new properties from developing on the floodway.	8	LPR, EAP	G2	Commissioners Court	>$100,000	Road and Bridge Fund, State/Federal Grants, TWDB	60	Hight
3	Adopt "Higher Standard" Riverine Flood Damage Prevention Ordinances and Standards	This would result in a discount on insurance for new and existing properties and mitigate damages for both new and existing structures.	9	LPR	G2, G3, G6	Drainage Department	<$10,000	Road and Bridge Fund	24	High
4	Join FEMA's CRS Program	Complete the initial steps to join FEMA's CRS program and reduce the cost of insurance for new and existing buildings. It is better to protect existing properties through the development of CRS activities.	17	LPR, EAP	G4, G6	Development Department	$10,000 to $100,000	County funds	60	Low
5	Create/Maintain a Wharton Disaster Response Team	Having a disaster response team in place that can respond quickly to a natural or man-caused event would prevent damage to existing buildings.	10	EAP	G1, G2, G6	Emergency Management	<$10,000	County funds	60	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 in Months	Benefit
6	Implement a Wharton County Flood Warning/Monitoring System	Wharton County experiences flooding at low-water crossing which can lead to injuries and even fatalities.	2	SIP	G1, G2	Commissioners Court	>$100,000	HGAC, State/Federal Grants	36	High
7	Install emergency backup generators at critical facilities	Install emergency back-up generators at critical facilities to provide backup power from hazard events.	3	SIP	G1, G3, G6	Commissioners Court	>$100,000	County funds, State/Federal grants	36	High
8	Educate the community on hazards	Educate the community on the hazards they are exposed to and how to mitigation their homes from hazards on the county website and public forums.	15	EAP	G1, G2, G3, G4, G5	Emergency Management	<$10,000	County funds	60	Medium
9	Drainage Master Plan Update	Develop an update the 2010 DMP needed to identify and prioritize drainage improvements County-Wide	7	LPR	G2, G4, G5	Commissioners Court	$10,000 to $100,000	County funds, State/Federal grants	60	Medium
10	Update Subdivision Ordinance	Update development regulations to resolve loop holes in standards and improve clarity	4	LPR	G2, G4, G5	Drainage Department	$10,000 to $100,000	County funds	24	High
11	Collaborate with Regional Flood Planning Group	Coordinate with RFPG to ensure projects are identified in their plan for future grant funding	5	LPR, EAP	G4, G5, G6	Drainage Department	<$10,000	County funds	60	High
12	Collaborate with local canal owners to identify funding to improve and expand existing infrastructure	Coordinate with LCRA primarily as it relates to existing canal systems that may have leaks or seepages issues. Develop a plan to resolve these problems to help reduce water loss during droughts.	14	SIP	G1, G2, G4, G6	Commissioners Court	$10,000 to $100,000	County funds, State/Federal grants	60	Low

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 in Months	Benefit
13	Collaborate with local MUD Districts to establish/implement drought/expansive soils contingency plan	Coordinate with MUD districts on water, wastewater, and soil expansion plan. Identify projects for funding.	6	LPR	G3, G4, G5	Emergency Management	<$10,000	County funds, State/federal grans	60	Low
14	Develop a plan to improve Pandemic response	Coordinate with regional partners to develop a regional plan to improve future Pandemic response.	12	LRP	G1, G4	Emergency Management	$10,000 to $100,000	County funds, State/federal grans	60	Medium
15	Conduct after-action report and improvement plan meeting in regard to COVID-19 Pandemic	Conduct "lessons learned" meetings related to the pandemic and compile a report.	11	LPR, EAP	G1, G4	Emergency Management	<$10,000	County funds	12	Medium
16	Collaborate with local groundwater district to monitor land subsidence	This effort will include coordination and monitoring related to known subsidence issues. This may also include coordination with LCRA on known subsidence issues near the Lane City Gage.	16	LPR	G4	Emergency Management	<$10,000	County funds	60	Low
17	Establish a county-wide hazardous material response team	Develop a county-wide hazard response team and coordinate a regional response plan.	13	LPR, EAP	G4	Emergency Management	<$10,000	County funds	60	Medium
CITY OF EAST BERNARD										
1	Purchase Public Hazard Alert System	The city will purchase a public hazard alert system so that the city may provide warning to the citizens during a hazard event.	8	SIP	G1	Emergency Management	<$10,000	City 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 in Months	Benefit
2	Organize outreach program for vulnerable populations	We will use several media outlets to promote accessible heating and cooling centers and education of flood and hurricane hazards to vulnerable populations.	10	EAP	G1, G3, G4, G6	Emergency Management	<$10,000	Information Technology	60	Medium
3	Prepare and adopt a stormwater drainage plan and ordinance	Prepared and adopt a stormwater drainage plan and ordinance needed to prioritize and identify funding needed to implement the plan.	1	LPR	G1, G2, G3, G4, G5	City Secretary	$10,000 to $100,000	City Funds	36	High
4	Update emergency response plan	Form a committee to update the emergency response plan for emergency officials and personnel to use.	7	LPR	G1, G4	Emergency Management	<$10,000	City and County funds	24	Medium
5	Improve drainage infrastructure throughout the city (Bridge, culvert, channel, levee, and dam projects)	Conduct a regional drainage assessment, develop a plan, and begin implementation of identified and prioritized projects.	2	SIP	G1, G2, G6	Public Works	<$100,000	City and County funds	60	High
6	Install emergency generators at critical facilities	Install emergency generators at key critical facilities to provide back-up power during/post hazardous events.	3	SIP	G1, G2	Public Works	<$100,000	WCID Funds, State/Federal Grants	60	Medium
7	Implementation of Zoning Ordinance	Develop a zoning ordinance to better regulate development throughout the city. Zoning will be used to manage congestion and develop in a sustainable way.	6	LPR	G2, G4, G5	City Secretary	$10,000 to $100,000	City Funds	60	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 in Months	Benefit
8	Update Comprehensive Plan	Update comprehensive plan to help guide city staff on the direction forward.	4	LPR	G1, G2, G4, G5	City Secretary	$10,000 to $100,000	City Funds	36	High
9	Develop a plan to improve Pandemic response	Develop a plan based on "lessons learned" from the pandemic. Coordinate with regional partners.	13	LPR	G1, G4	Emergency Management	<$10,000	City and County funds	60	Medium
10	Conduct after-action report and improvement plan meeting in regard to COVID-19 Pandemic	Develop an after-action report based on COVID-19 lessons learned.	12	LRP, EAP	G1, G4	Emergency Management	<$10,000	City and County funds	60	Medium
11	Collaborate with local MUD Districts to establish/implement drought/expansive soils contingency plan	Collaborate with local MUD districts on water, wastewater, and expansive soils plan. This plan is needed to identify and prioritize water, wastewater, and similar improvements.	11	LPR	G3, G4, G5	City Secretary	$10,000 to $100,000	WCID Funds, State/Federal Grants	60	Medium
12	Collaborate with local groundwater district to monitor land subsidence	This effort will include coordination and monitoring related to known subsidence issues.	14	LPR	G4	Emergency Management	<$10,000	City and County funds	60	Medium
13	GIS Mapping	Develop a City-Wide GIS web map for use in maintaining City-Wide data.	5	LPR	G1, G2	City Secretary	$10,000 to $100,000	City Funds, State/Federal Grants	60	Medium
14	Establish a hazardous material response team	Develop a county-wide hazard response team and coordinate a regional response plan.	9	LRP, EAP	G4	Emergency Management	<$10,000	City and County funds	60	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 in Months	Benefit
CITY OF EL CAMPO										
1	Provide education on water conservation techniques	Provide water conservation measures low-flow plumbing, etc., as mail inserts with utility bills and discuss with local media outlets.	8	EAP	G3, G4, G6	Utility Department	<$10,000	Utility Revenue	36	High
2	Improve drainage infrastructure throughout the city (Bridge, culvert, channel, levee, and dam projects)	Implement drainage improvements to culverts, bridges, channels, detention facilities, and levees as needed.	4	SIP	G1, G2, G6	Public Works	>$100,000	City funds, State/Federal Grants	60	High
3	Adopt freeboard ordinance	Adopt freeboard ordinance to reduce flood risk of structures.	17	LPR	G2, G3, G4, G5	Building Department	<$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 in Months	Benefit
4	Adopt IBC and IRC	Adopt the latest IBC and IRC that go to mitigated identified hazards, such as a tornado, high wind, and impact-resistant materials (windows, doors, roof bracing); dry-proofing public buildings for flooding; upgrading to higher standard insulation for extreme heat and winter storms; installing lightning rods and grounding systems on public buildings; retrofitting to low-flow plumbing and replacing landscaping with drought and fire resistant plant; stricter codes for hail and fire-resistant roofing and siding; implementing higher standards for foundations, and upgrading requirements for construction beams, breakers and foundation to mitigate impacts of earthquake and expansive soils.	6	LPR	G1, G2, G4, G5	Building Department	<$10,000	City Funds	24	High
5	GIS mapping	Use GIS mapping to overlay properties with known hazards of expansive soils, flood, and wildland interface areas. Then notify residents of at-risk structures to help residents mitigate the hazards around their property.	7	LPR	G1, G2	Public Works	$10,000 to $100,000	Information Technology	36	Medium
6	Outreach to vulnerable populations regarding extreme and adverse weather/conditions	We will use several media outlets to promote accessible heating and cooling centers and education of flood and hurricane hazards to vulnerable populations.	9	EAP	G1, G3, G4	Emergency Management	<$10,000	City Funds	60	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 in Months	Benefit
7	Implement Master Drainage Plan (7 projects)	Seven areas of the city are known to be subject to flood damage because of inadequate storm drainage. Install larger storm drainage and reduce flood damage.	11	SIP	G1, G2, G4, G6	Public Works	>$100,000	City funds, State/Federal Grants	60	High
8	Educate community on all hazards	Educate the community on the hazards they are exposed to and how to mitigation their homes from hazards on the county website and public forums.	12	EAP	G1, G3, G4, G6	Emergency Management	<$10,000	City Funds	60	Medium
9	Alternative notification /alert system	Develop and implement an alternative system to assist with emergency response despite the loss of power and internet for the community and staff.	5	LPR, EAP	G1	Emergency Management	$10,000 to $100,000	Information Technology	36	high
10	Establish Post Disaster Temporary Transfer Center	This activity may include identification of a Transfer Center, construction of a Transfer Center, and/or setup of a Transfer Center	16	LPR	G4	Emergency Management	>$100,000	City Funds, State/Federal Grants, Cost Sharing	60	Medium
11	Establish/implement drought/expansive soils contingency plan	Develop and implement a drought and expansive soils contingency plan that addresses mitigation measures for drought, extreme heat, and expansive soils.	14	LPR, EAP	G1, G3, G4, G5, G6	Utility Department	<$10,000	City funds, State/Federal Grants	36	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 in Months	Benefit
12	Update Drainage master plan	Update 2004 Drainage Master Plan to help direct the City forward with regard to planning and drainage improvements	13	LPR	G1, G2, G3, G4, G5	Public Works	>$100,000	City funds, State/Federal Grants	60	High
13	Develop a plan to improve Pandemic response	Develop a plan based on "lessons learned" from the pandemic. Coordinate with regional partners.	3	LPR	G1, G4	Emergency Management	<$10,000	City Funds	24	Medium
14	Conduct after-action report and improvement plan meeting in regard to COVID-19 Pandemic	Develop an after-action report based on COVID-19 lessons learned.	1	LPR, EAP	G1, G4	Emergency Management	<$10,000	City Funds	24	Medium
15	Collaborate with local groundwater district to monitor land subsidence	This effort will include coordination and monitoring related to known subsidence issues.	15	LPR	G4	Emergency Management	<$10,000	City Funds	60	Medium
16	Establish an all hazards response team	Develop a county-wide hazard response team and coordinate on a regional response plan.	10	LPR, EAP	G4	Emergency Management	<$10,000	City Funds	60	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 in Months	Benefit
17	Install emergency generators at critical facilities	Install emergency generators at key critical facilities to provide back-up power during/post hazardous events.	2	SIP	G1, G2	Public Works	>$100,000	City Funds, State/Federal Grants, Cost Share	60	High
CITY OF WHARTON										
1	Clean and repair storm drains routinely	Citywide cleaning and repairing of storm drains.	3	SIP	G1, G2	Public Works	>$100,000	Public Works Fund	60	High
2	Increase freeboard requirements for permitting structures in the floodplain	Adopt ordinance to increase freeboard requirement in the 100-year floodplain. This action will result in safer structures, and thus, fewer flood damages.	13	SIP	G2, G3, G4, G5, G6	Floodplain Management	<$10,000	City Funds	12	High
3	Implement a comprehensive watershed ordinance for new development	This ordinance will help to reduce flood risk to new development.	4	LPR	G2, G5, G6	Floodplain Management	$10,000 to $100,000	Watershed Funds	24	High
4	Acquire, reuse, and preserve open spaces adjacent to flood-prone areas	Acquire, reuse, and preserve open spaces adjacent to flood-prone areas	11	LPR	G2, G4, G5, G6	City Public Works	>$100,000	FMA, PDM, HMGP	36	High
5	Educate the community on the hazards	We will use several media outlets to promote accessible heating and cooling centers and education of flood and hurricane hazards to vulnerable populations.	15	EAP	G1, G3, G5, G6	Planning Dept.	<$10,000	City Funds	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 in Months	Benefit
6	Minimize the impact of flooding by installing berms and levees where appropriate	Coordinate with the USACE and other entities to implement levee improvements, etc.	1	SIP	G1, G2, G4, G6	Floodplain Administrator	>$100,000	City Funds, State/Federal Grants	60	High
7	Develop flood-reduction / stream restoration/channelization projects to ensure adequate drainage/diversion of stormwater	Projects may include channel improvements to Caney Creek, Peach Creek, Baughman Slough, the Colorado River, and/or other minor channels throughout the City limits and ETJ.	5	SIP	G1, G2, G4, G6	Planning Dept.	>$100,000	City Funds, State/Federal Grants	60	High
8	Establish a reserve fund for emergency and public mitigation measures	Coordinate with City Council to establish this fund.	7	LPR, EAP	G2, G3, G4, G5, G6	Planning Dept.	<$10,000	City Funds	60	high
9	Strengthen and harden at-risk critical facilities	This effort will focus on Water Treatment, Wastewater Treatment, electric, water supply, and other similar facilities	2	LPR	G1, G6	Emergency Management	>$100,000	City Funds	48	High
10	Acquisition and relocation, elevation, and "demo-rebuild" of flood-prone structures	This will focus on flood-prone structures specifically identified during Hurricane Harvey Flood	12	SIP, NSP	G2, G5, G6	Emergency Management	>$100,000	FMA, PDM, HMGP	60	High
11	Install emergency backup generators at critical facilities	Install emergency backup generators at critical facilities	8	SIP, NSP	G1, G2, G6	Emergency Management	>$100,000	HMGP, City Funds	60	High

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Action No.	Title	Description	Mitigation Action Ranking	Action Type	Applicable Goals	Responsible Department	Estimated Cost	Potential Funding Sources	Timeline in Months	Benefit
12	Use impact fees to help fund public hazard mitigation projects related to land development	Use impact fees to help fund public hazard mitigation projects related to land development	17	LPR	G1, G2, G3, G4, G5	Floodplain Administrator	<$10,000	City Funds	24	Medium
13	Implement warning systems	Coordinate with County and LCRA to implement a County-Wide Flood Warning System of gauges.	9	LPR, EAP	G1	Planning Dept.	>$100,000	Grant Funds, HGAC, and Coordination with County	60	High
14	Establish/implement drought/expansive soil contingency plan	Develop and implement a drought and expansive soils contingency plan that addresses mitigation measures for drought, extreme heat, and expansive soils.	20	LPR	G3, G4, G5	Planning Dept.	<$10,000	City Funds	60	Low
15	Update/implement Drainage Master Plan	Update DMP to identify flood reduction projects, funding sources, and prioritization	14	LPR	G1, G2, G3, G4, G5	Planning Dept.	$10,000 to $100,000	City Funds	60	Medium
16	Improve drainage infrastructure throughout the city (Bridge, culvert, channel, levee, and dam projects)	Implement drainage improvements throughout the City, including culvert improvements, levees, dams, channel widening, storm sewer, and detention facilities.	6	SIP	G1, G2, G6	Planning Dept.	>$100,000	City Funds	60	High
17	Develop plan to improve Pandemic response	Develop a plan based on "lessons learned" from the pandemic. Coordinate with regional partners.	16	LPR	G1, G4	Emergency Management	<$10,000	City Funds	60	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 in Months	Benefit
18	Conduct after-action report and improvement plan meeting in regard to COVID-19 Pandemic	Develop an after-action report based on COVID-19 lessons learned.	18	LPR, EAP	G1, G4	Emergency Management	<$10,000	City Funds	60	Medium
19	Collaborate with local groundwater district to monitor land subsidence	This effort will include coordination and monitoring related to known subsidence issues.	19	LPR	G4	Emergency Management	<$10,000	City Funds	60	Medium
20	Establish a hazardous material response team	Develop a county-wide hazard response team and coordinate a regional response plan.	10	LPR, EAP	G4	Emergency Management	<$10,000	City Funds	24	High

Notes:

COVID-19	Coronavirus Disease 2019	IBC	International Building Code
CRS	Community Rating System	IRC	International Residential Code
DMP	Drainage Master Plan	LCRA	Lower Colorado River Authority
EAP	Education and Awareness Program	LRP	Local Plans and Regulations
ETJ	Extraterritorial Jurisdiction	MUD	Municipal Utility District
FEMA	Federal Emergency Management Agency	NSP	Natural Systems Protection
FIRM	Flood Insurance Rate Map	SIP	Structure and Infrastructure Project
GIS	Geographic Information System		

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 the 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 the 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 Wharton County initiated this planning effort:

Wharton County is 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.

Wharton County and its partners participating in this plan want to be proactive in preparing for the probable impacts from natural hazards.

Wharton County and its communities participated in previous hazard mitigation plans as part of the Texas Colorado River Floodplain Coalition (TCRFC), which included 15 counties (including Wharton) and 63 jurisdictions. In accordance with recent Federal Emergency Management Agency (FEMA) guidance individual hazard mitigation plans must be prepared for each county. In addition, the Texas Division of Emergency Management (TDEM) implemented a "two-county maximum" policy in 2010 on submittals of local plans. Therefore, a plan update was developed in 2011 specifically for Wharton County and its participating communities: the cities of East Bernard, El Campo, and Wharton. This plan was updated in 2016 to comply with FEMA update requirements.

FEMA approval of the previous hazard mitigation plan will expire in 2021. If this plan is not updated, Wharton County would not have a FEMA-approved mitigation plan in place, limiting county 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 Wharton County 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 Wharton County are the ultimate beneficiaries of this hazard mitigation plan update. The plan reduces the risk for those who live in, work in, and visit the county and participating cities. It provides a viable planning framework for all foreseeable natural hazards that may impact the county and participating cities. 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 the 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 Wharton County Hazard Mitigation Plan Update in its entirety.

Chapter 2.
PLAN UPDATE – WHAT HAS CHANGED

2.1 THE PREVIOUS PLAN

Wharton 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. A 2016-2021 update to a previous plan was published in October 2016 entitled *Wharton County Hazard Mitigation Plan Update 2016*. In compliance with FEMA guidelines, this document is the update to the *Wharton County Hazard Mitigation Plan Update 2016.* This plan was updated specifically for Wharton County and the participating communities; City of East Bernard, El Campo, and Wharton.

The 2016 update ranked 13 hazards from high (H) to low (L), or not applicable (N/A) for Wharton County and the participating Cities of East Bernard, El Campo, and Wharton. Table 2-1 list the hazards and their ranking. These 13 hazards were evaluated in the TCRFC plan.

TABLE 2-1.
HAZARD RISK SUMMARY IN THE 2016 WHARTON COUNTY HAZARD MITIGATION PLAN UPDATE

Jurisdiction	Dam/Levee Failure	Drought	Earthquake	Expansive Soils	Extreme Heat	Flood	Hail	Hurricane/Tropical Storm	Lightning	Tornado	Wildfire	Wind	Winter Weather
Wharton County	**N/A**	**M**	**L**	**M**	**M**	**M**	**M**	**H**	**L**	**M**	**M**	**L**	**L**
City of East Bernard	N/A	H	N/A	M	H	M	M	H	L	M	L	L	L
City of El Campo	N/A	H	N/A	M	H	M	M	H	L	M	L	L	L
City of Wharton	N/A	H	N/A	M	H	M	M	H	L	M	L	L	L

The *Wharton County Hazard Mitigation Plan Update 2016* identified goals, objectives, and mitigation actions for these hazards. The overall goal of the 2016-2021 plan was:

To reduce or eliminate the long-term risks to loss of life and property damage in Wharton County from the full range of natural 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 *Wharton County Hazard Mitigation Plan Update 2016* then identified one or more mitigation actions to accomplish each objective. The current status of each of these actions identified in the plan is shown in Table 2-2. Within Table 2-2, an asterisk (*) denotes actions that encompass actions carried forward from the 2011-2016 Plan.

The *Wharton County Hazard Mitigation Plan Update 2016* was integrated into multiple planning mechanisms and projects within Wharton County and the participating communities. The main source of integration into the communities planning mechanisms was conducted through their comprehensive plans. The communities have updated or are in the process of updating their comprehensive plans with applicable material from the *Wharton County Hazard Mitigation Plan Update 2016* to ensure the comprehensive plan identify projects, plans, and policies to help guide the development in the planning areas.

In 2019, Wharton County and the Cities of East Bernard, El Campo, and Wharton, updated the Wharton County Basic Emergency Operation Plan. This plan covers Wharton County and all participating communities. The hazard mitigation plan information was integrated within the emergency operations plan providing base data on high hazards and applicable mitigation actions that affect or will affect emergency operations within the planning area.

The plan also served as a guide for identifying projects within the planning area and the priority in which they should be completed. Multiple projects were started or completed in the area under the guidance of planning officials with the use of the hazard mitigation plan (See Table 2-2).

TABLE 2-2.
WHARTON COUNTY PROJECT IMPLEMENTATION WORKSHEET (2016-2021 PLAN PROJECTS)

Action No.	Title	Project Status				Funding				Comments
		Ongoing	Delayed	Competed	Deleted	Budgeted	Apply for Grant	Grant Received	Target Completion	
WHARTON COUNTY										
1*	Install bridge and culvert drainage improvements throughout the County	X				X	X	X		Incorporated into Mitigation Action 1.
2*	Update and adopt a new Wharton County Flood Insurance Study and FIRM		X							Incorporated into Mitigation Action 2.
3*	Adopt "Higher Standard" Riverine Flood Damage Prevention Ordinances and Standards		X							Incorporated into Mitigation Action 3.
4	Create and Implement Drought and Expansive Soils Plan	X				X				Incorporated into Mitigation Action 13.
5*	Establish Countywide Bench Mark Network				X					No longer deemed applicable.
6*	Provide support to the TCRFC and San Bernard River in flood reduction projects	X								Incorporated into Mitigation Action 11.
7*	Join FEMA's CRS program		X							Incorporated into Mitigation Action 4.
8*	Create a Wharton Disaster Response Team			X		X				
9*	Implement a Wharton County Flood Warning System	X				X	X	X		Incorporated into Mitigation Action 6.
10*	Become an NWS Storm Ready community				X					No longer deemed applicable.
11*	Install emergency back-up generators at critical facilities	X				X	X	X		Incorporated into Mitigation Action 7.
12	Map expansive soils in unincorporated county				X					No longer deemed applicable.
13*	Purchase NOAA All Hazard Radios				X					No longer deemed applicable.
14	Provide training for CFM and CEM				X					No longer deemed applicable.

TABLE 2-2.
WHARTON COUNTY PROJECT IMPLEMENTATION WORKSHEET (2016-2021 PLAN PROJECTS)

Action No.	Title	Project Status: Ongoing	Project Status: Delayed	Project Status: Competed	Project Status: Deleted	Funding: Budgeted	Funding: Apply for Grant	Funding: Grant Received	Funding: Target Completion	Comments
15	Educate homeowners on hazards	X				X				Incorporated into Mitigation Action 8.
CITY OF EAST BERNARD										
1	Create water conservation education materials				X					No longer deemed applicable.
2	Purchase NOAA All Hazard Radios		X				X			Incorporated into Mitigation Action 1.
3	Organize outreach program for vulnerable populations	X				X				Incorporated into Mitigation Action 2.
4	Prepare and adopt a stormwater drainage plan and ordinance	X				X				Incorporated into Mitigation Action 3.
5	Update emergency response plan	X				X				Incorporated into Mitigation Action 4.
6	Educate homeowners on mitigating hazards around their home				X					No longer deemed applicable.
7*	Improve drainage throughout city	X				X	X			Incorporated into Mitigation Action 5.
8*	Drought and Expansive Soils Contingency Plan		X							Incorporated into Mitigation Action 11.
9*	Install emergency generators at critical facilities	X				X	X			Incorporated into Mitigation Action 6.
10	Identify and map areas that are at high risk of expansive soils				X					Incorporated into Mitigation Action 13.
CITY OF EL CAMPO										
1	Drought and expansive soils contingency plan			X		X				
2	Provide education on water conservation techniques	X				X				Incorporated into Mitigation Action 1.
3	Construct regional detention ponds	X				X	X	X		Incorporated into Mitigation Action 2.

TABLE 2-2.
WHARTON COUNTY PROJECT IMPLEMENTATION WORKSHEET (2016-2021 PLAN PROJECTS)

Action No.	Title	Project Status				Funding				Comments
		Ongoing	Delayed	Competed	Deleted	Budgeted	Apply for Grant	Grant Received	Target Completion	
4	Adopt freeboard ordinance	X		X						Incorporated into Mitigation Action 3. Currently, freeboard requirements are incorporated into the city design standards. In the process of formally adopting an ordinance.
5	Adopt IBC and IRC			X						
6	Install Blackboard Connect City-to- Resident Notification System				X					Incorporated into Mitigation Action 9.
7	GIS mapping	X								Incorporated into Mitigation Action 5. In the process of conducting GIS mapping.
8	Outreach to vulnerable populations and cooling centers	X								Incorporated into Mitigation Action 6.
9*	Install larger storm drainage on Pecan Street			X		X				
10*	Install larger storm drainage at Town and Country Drive	X				X	X			Incorporated into Mitigation Action 2.
11*	Implement Master Drainage Plan (7 projects)	X								Incorporated into Mitigation Action 7.
12	Educate homeowners on the hazards	X				X				Incorporated into Mitigation Action 8.
CITY OF WHARTON										
1*	Clean and repair storm drains routinely	X				X	X			Incorporated into Mitigation Action 1.
2*	Increase freeboard requirements for permitting structures in the floodplain	X								Incorporated into Mitigation Action 2.
3*	Implement a comprehensive watershed ordinance for new development	X				X				Incorporated into Mitigation Action 3.
4*	Acquire, reuse and preserve open spaces adjacent to flood-prone areas	X				X		X		Incorporated into Mitigation Action 4.
5*	Zero Discharge Policy			X		X				

TABLE 2-2.
WHARTON COUNTY PROJECT IMPLEMENTATION WORKSHEET (2016-2021 PLAN PROJECTS)

Action No.	Title	Project Status				Funding				Comments
		Ongoing	Delayed	Competed	Deleted	Budgeted	Apply for Grant	Grant Received	Target Completion	
6	Purchase NOAA All Hazard Radios				X					No longer deemed applicable.
7	Educate homeowners on the hazards	X				X				Incorporated into Mitigation Action 5.
8*	Minimize the impact of flooding by installing berms and levees where appropriate	X				X		X		Incorporated into Mitigation Action 6.
9	Design flood-use stream restoration/ channelization projects to ensure adequate drainage/diversion of stormwater	X				X	X	X		Incorporated into Mitigation Action 7.
10*	Establish a reserve fund for emergency and public mitigation measures	X				X				Incorporated into Mitigation Action 8.
11*	Strengthen and harden at-risk critical facilities	X		X		X				Incorporated into Mitigation Action 9. The city has structurally protected water and wastewater facilities and is in the process of collaborating with USACE on the construction of levee improvements to protect the city.
12*	Acquisition and relocation, elevation and "demo-rebuild" of flood-prone structures	X		X		X		X		Incorporated into Mitigation Action 10. The city has completed this task in some areas, but still collaborating with USACE on acquisition and improvements related to the levee.
13*	Install emergency back-up generators at critical facilities	X						X		Incorporated into Mitigation Action 11.
14*	Use impact fees to help fund public hazard mitigation projects related to land development	X								Incorporated into Mitigation Action 12.

Notes:

CEM	Certified Emergency Manager	IBC	International Building Code
CFM	Certified Floodplain Manager	IRC	International Residential Code
CRS	Community Rating System	NOAA	National Oceanic and Atmospheric Administration
FEMA	Federal Emergency Management Agency	NWS	National Weather Service
FIRM	Flood Insurance Rate Map	TCRFC	Texas Colorado River Floodplain Coalition

TABLE 2-2. WHARTON COUNTY PROJECT IMPLEMENTATION WORKSHEET (2016-2021 PLAN PROJECTS)										
		Project Status				Funding				
Action No.	Title	Ongoing	Delayed	Competed	Deleted	Budgeted	Apply for Grant	Grant Received	Target Completion	Comments
GIS	Geographic Information System									

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, Wharton County participated in a mitigation planning process in 2016 as part of the TCRFC and will expire in 2021. 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 current plan update conducted by Scheibe Consulting, LLC focused on Wharton 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 68 mitigation actions:

- 17 countywide actions
- 14 actions specifically for the City of East Bernard
- 17 actions specifically for the City of El Campo
- 20 actions specifically for the City of Wharton

Actions from the previous plan were carried forward into the mitigation actions if they were identified as delayed or in progress. These actions are indicated in 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 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 Hazard Mitigation Plan will expire in 2021. Therefore, the local community initiated steps to begin the next update in 2021. The local communities, consisting of the City of Wharton, City of El Campo, City of East Bernard, and Wharton County all elected to enter into an interlocal agreement and have Wharton County act as the lead entity for this Hazard Mitigation Plan Update. Wharton County then selected Scheibe Consulting, LLC to assist with the development and implementation of the plan update. No grant funding was obtained for this Hazard Mitigation Plan update, and thus all funding for this update came from the local participating communities. Each participating member contributed both monetarily and through in-kind contributions.

3.2 ESTABLISHMENT OF THE PLANNING PARTNERSHIP

Wharton 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
Wharton County	Andy Kirkland	Emergency Management Coordinator
City of East Bernard	Audrey Scearce	Emergency Management Coordinator
City of El Campo	Lori Hollingsworth	Emergency Management Coordinator
City of Wharton	Gwyneth Teves	Community Development Director

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.

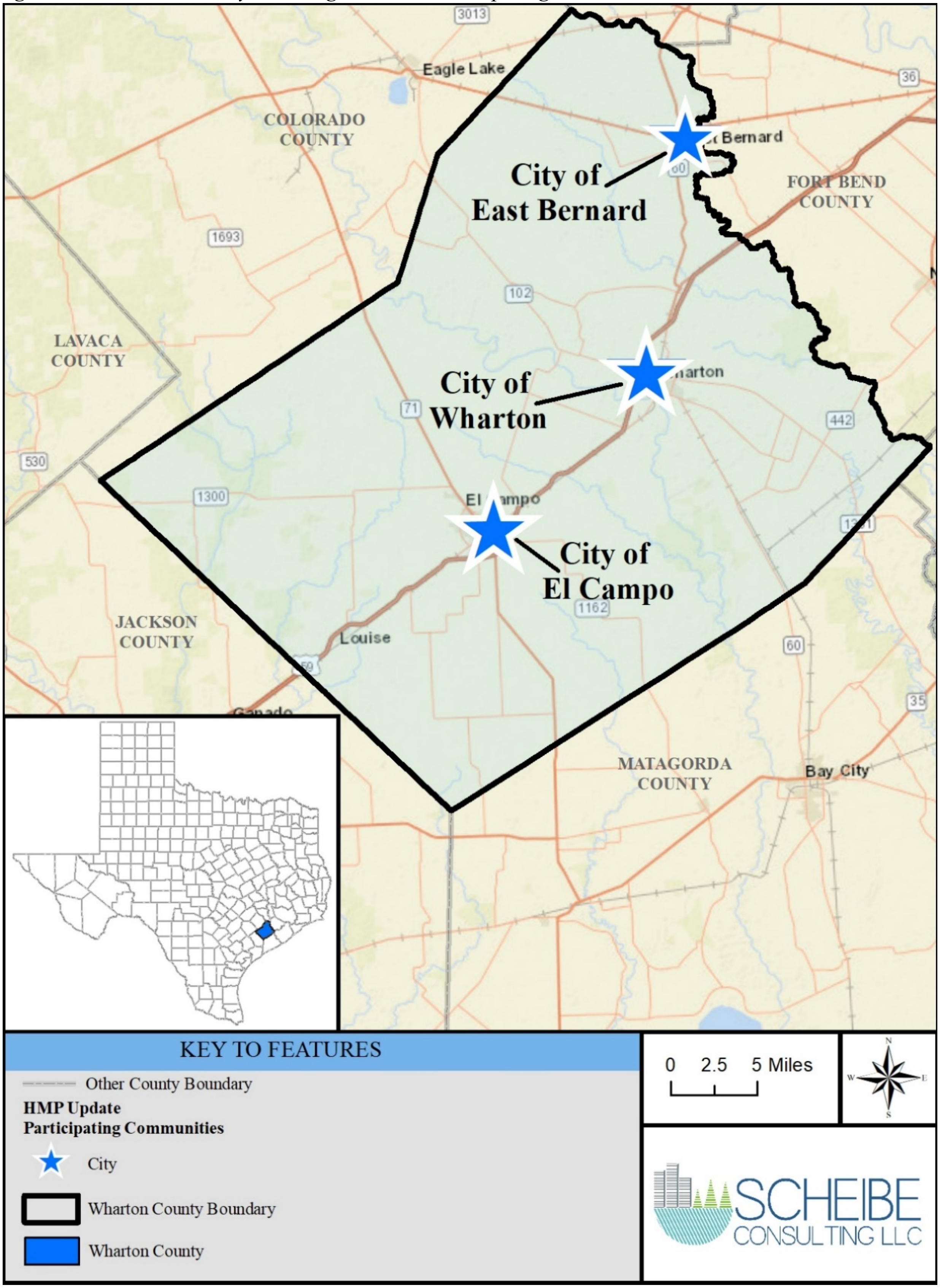
- Each partner will be expected to review the risk assessment and identify hazards and vulnerabilities specific to its jurisdiction. Contract resources will provide jurisdiction-specific mapping and technical consultation to aid in this task, but the determination of risk and vulnerability ranking will 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 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 Wharton County. All partners to this plan have jurisdictional authority within this planning area. Planning partners include the Cities of East Bernard, El Campo, and Wharton (see Figure 3-1).

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



3.4 THE PLANNING COMMITTEE

A small planning committee was formed at the beginning of the hazard mitigation update process. This committee consisted of representatives from each of the planning partners. Planning committee members are denoted by an asterisk (*) in Table 3-2. This committee agreed to meet bi-weekly from March through the completion of the hazard mitigation plan update. The planning committee aided in data collection throughout the process and helped to identify stakeholders in the planning area who were invited to participate in the steering committee. The following stakeholders were identified by the planning committee and invited to take part in the steering committee:

- Colorado County
- Jackson County
- Matagorda County
- Fort Bend County
- Brazoria County
- City of Kendleton
- City of Beasley
- Houston-Galveston Area Council (H-GAC)
- Texas Department of Transportation (TxDOT)
- Lower Colorado River Authority (LCRA)
- Wharton County Precinct 1
- Wharton County Precinct 2
- Wharton County Precinct 3
- Wharton County Precinct 4
- Boling Municipal Utility District (MUD)
- Hungerford MUD
- Isaacson MUD
- Water Control and Improvement District (WCID) 1
- WCID 2
- Coastal Bend Ground Water Conservation District
- Wharton County Emergency Service District (ESD) 1
- Wharton County ESD 2
- Wharton County ESD 3
- Boling Independent School District (ISD)
- East Bernard ISD
- El Campo ISD
- Hallettsville ISD
- Louise ISD
- Wharton ISD
- Wharton County Junior College
- Wharton County Electric Cooperative
- Lost Lagoon

3.5 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 identified stakeholders consisted of neighboring communities, local and regional agencies, businesses, academia, and other private and nonprofit interest. The following stakeholders were identified and invited to take part in the hazard mitigation update process. 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/Entity
Andy Kirkland	Emergency Management Coordinator	Wharton County
Debbie Cenko*	Deputy Emergency Management Coordinator	Wharton County
Krystal Hasselmeier *	Assistant to the Community Development Director	City of Wharton
Gwyneth Teves *	Community Development Director	City of Wharton
Audrey Scearce *	Emergency Management Coordinator	City of East Bernard
Lori Hollingsworth *	Emergency Management Coordinator	City of El Campo
Kevin Thompson*	Director of Public Works	City of El Campo
Steve Johnson	Emergency Management Coordinator	City of Wharton
Joseph Pace	City Manager	City of Wharton
Brandi Jimenez	Assistant to the City Manager	City of Wharton
Stephan Gage	Principal Planner, Transportation	H-GAC
Ryan Simper	Area Engineer	TxDOT
Mario Chapa	Business Continuity Program Manager	LCRA
Rodney Grimmer	Hazard Mitigation Planner	Fort Bend County HS&EM
Frank Garza	Regional Planner	Fort Bend County HS&EM
Richard Zahn	Commissioner Precinct 1	Wharton County
Jessica Moreno	Admin. Assistant Precinct 1	Wharton County
W.D. Bud Graves	Commissioner Precinct 2	Wharton County
Casey Lewis	Admin. Assistant Precinct 4	Wharton County
Fred Ivy	President	Hungerford MUD
Philip Gaudette	Elementary Principal	East Bernard ISD
David Janecek	Junior High Principal	East Bernard ISD
Shelly Schulz	Communication Specialist	Wharton County Electric Cooperative
Kenna Lucas	Owner	Lost Lagoon – El Campo

The Steering Committee agreed to meet three times or as needed throughout the plan's development. Scheibe Consulting, LLC 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 two times from June 2021 through July 2021. Meeting agendas, notes, and attendance logs can be found in Appendix C of this document.

The planning team made a presentation at the first Steering Committee meeting on June 22, 2021, to introduce the mitigation planning process as well as the risk assessment findings. The Steering

Committee, planning partners, and the public were encouraged to participate in the plan update process. Meeting minutes can be found in Appendix C of this document.

3.6 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. Scheibe Consulting served as the primary lead/point of contact for stakeholder and community outreach. The planning team 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 Wharton County HMP Steering Committee. The Steering Committee Members that were invited by the County are identified in section 3.4, and those who participated as stakeholders in the Wharton County mitigation plan are listed in Table 3-2.

  The County utilized personal communication including telephone and email outreach to inform and invite the 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. Attendance and participation were encouraged.

  In addition, Scheibe Consulting also undertook stakeholder/community outreach activities in support of Wharton 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. 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.

- **Agency Notification**
  The Texas Division of Emergency Management (TDEM) was invited to participate in the plan development process from the beginning. TDEM was notified of any issues which arose during the hazard mitigation update process.

- **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 City of Wharton Emergency Management Department Website. The complete draft plan was sent to TDEM for a pre-adoption review to ensure program compliance.

This update process was led by Scheibe Consulting. The process was under the direction of a Texas licensed professional engineer and certified floodplain manager, Eric Scheibe, President of Scheibe Consulting. The Scheibe Consulting team updated the hazard mitigation plan and guided the steering committee throughout the update process.

3.7 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:

- Wharton County
    - Master Subdivision Policy
    - Flood Damage Prevention Order
    - Drainage Fee Ordinance
    - Floodplain Map
    - Basic Emergency Operations Plan
    - Wharton County Office of Emergency Management
    - Wharton County Commissioners' Court
    - Wharton County Economic Development Corporation
- City of East Bernard
    - Comprehensive Plan
    - Code of Ordinances
    - City of East Bernard Emergency Management
- City of El Campo
    - City of El Campo Office of Emergency Management
    - Comprehensive Plan Update 2017
    - Code of Ordinances
    - Office of Municipal Service
    - Emergency Medical Services
    - Code Enforcement
    - Citizen Committees, Boards, and Commissions
- City of Wharton
    - Code of Ordinances
    - Planning Commission
    - Economic Development Corporation
    - Floodplain Management
    - Volunteer Fire Department
    - Code Enforcement

- City of Wharton Office of Emergency Management

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 help 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 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 to ensure all information was accurate and used this to help identify mitigation actions.

3.8 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.

3.8.1 Stakeholders and the Steering Committee

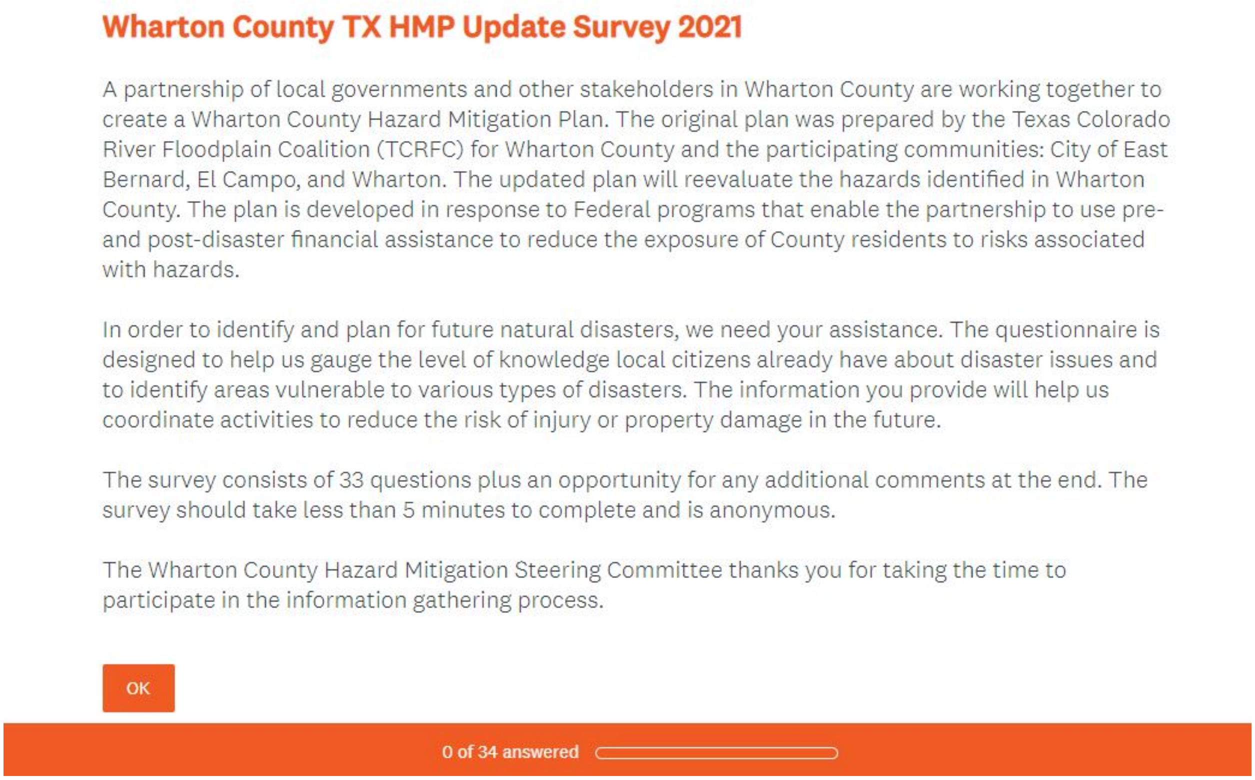
Stakeholders are the individuals, agencies, and jurisdictions that have a vested interest in the recommendations of the hazard mitigation plan, including planning partners. The effort to include stakeholders in this process included stakeholder participation on the Steering Committee. Stakeholders were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

3.8.2 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 Wharton County residents and businesses. This online questionnaire was designed to help identify areas vulnerable to one or more natural hazards. The answers to these 33 questions as well as any comments submitted helped guide the Steering Committee in prioritizing hazards of impact and in selecting goals, objectives, and mitigation strategies. A total of 89 questionnaires were completed during the course of this planning process with the

English translation receiving 87 responses and the Spanish translation receiving 1. A summary of the survey responses can be found in Appendix C.

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



Wharton County TX HMP Update Survey 2021

A partnership of local governments and other stakeholders in Wharton County are working together to create a Wharton County Hazard Mitigation Plan. The original plan was prepared by the Texas Colorado River Floodplain Coalition (TCRFC) for Wharton County and the participating communities: City of East Bernard, El Campo, and Wharton. The updated plan will reevaluate the hazards identified in Wharton 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. The questionnaire is designed to help us gauge 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 33 questions plus an opportunity for any additional comments at the end. The survey should take less than 5 minutes to complete and is anonymous.

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

OK

0 of 34 answered

3.8.3 Meetings

Two Steering Committee meetings were held during the planning process as well as bi-weekly meetings with the planning committee. Steering Committee Meetings were held in the City of Wharton on June 22, 2021, and July 26, 2021.

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.

Wharton County and participating communities solicited public comment on the draft plan prior to submittal. Wharton County, the City of East Bernard, the City of El Campo, and the City of Wharton posted the draft plan and comment submittal form online via their social media outlets and at their local jurisdictional building in September 2021. No comments that resulted in changes to the plan were received from the public electronically or in person.

3.8.4 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. Scheibe Consulting coordinated public outreach with the committee members to engage the public and solicit survey participation and comments regarding the plan draft.

3.8.5 Internet

The participating communities posted information regarding the update process, a link to the community survey, and an informational brochure on their community websites as well as on social media outlets such as Facebook. The community was encouraged to take part in the hazard mitigation process through multiple posts and was encouraged to reach out to Scheibe Consulting or planning partners with any concerns or questions throughout the planning process.

The draft plan was posted online for review by Wharton County and participating communities. The draft plan was posted online in September 2021 by all planning partners as described in Section 3.8.3.

3.9 PLAN DEVELOPMENT, CHRONOLOGY, AND MILESTONES

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

TABLE 3-3. PLAN DEVELOPMENT MILESTONES			
Date	Event	Description	Attendance
2021			
2/22	Contract signed	Notice to proceed given to Scheibe Consulting, LLC	N/A
3/05	Planning Committee	First Planning Committee meeting	N/A
05/31	Public Outreach	Community Survey/Community Brochure distributed via multiple outlets	N/A
6/22	Steering Committee/ Stakeholder Meeting #1	Presentation on plan process given, review hazard identification and risk assessment, community survey, intro to mitigation strategies	Wharton County; Cities of East Bernard, El Campo, and Wharton
7/26	Steering Committee Meeting #2	Addition of Land Subsidence, Survey Results, Identifying Mitigation Actions	Wharton County; Cities of East Bernard, El Campo, and Wharton
8/27	Draft Plan	Internal review draft provided to Steering Committee	N/A
Ongoing	Public Outreach	News articles and website posting	N/A
09/07	Public Comment Period	The initial public comment period for the draft plan opens. Draft plan posted on plan website and resources to review the Draft at the courthouse and at East Bernard City Hall, El Campo City Hall, and Wharton City Hall with press release notifying the public of plan availability	N/A
09/24	Plan Review	Final draft plan submitted to Texas Division of Emergency Management for review	N/A
XX/XX	Public Outreach	Final public meeting on draft plan	N/A
XX/XX	Plan Approval Pending Adoption	Plan approval pending adoption by FEMA	N/A
XX/XX	Adoption	Adoption window of final plan opens	N/A
XX/XX	Plan Approval	Final plan approved by FEMA	N/A
FEMA	Federal Emergency Management Agency		
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 reviewed the previous hazard mitigation plan guiding principle, goals, and objectives as part of the update process. Based on data from the preliminary risk assessment and the results of the public involvement strategy the guiding principle, goals, and objectives were deemed applicable in the current update by all planning partners and were brought forward as part of the update. These components are described in further detail below.

4.1 GUIDING PRINCIPLE

A guiding principle focuses on 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 Wharton County Hazard Mitigation Plan Update is as follows:

To reduce or eliminate the long-term risks to loss of life and property damage in Wharton County 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 the requirements of the DMA (44 CFR, Section 201.6(c)(2)).

5.1 IDENTIFIED HAZARDS OF CONCERNS

For this plan, the Steering Committee considered the full range of hazards that could impact the planning area and then listed hazards that present the greatest concern. The process incorporated a 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 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 TCRFC plan and the hazard ranking. Based on the review, this plan addresses the following hazards of concern:

- Dam/Levee Failure
- Drought
- Expansive Soils
- Extreme Heat
- Earthquake
- Flood
- Hazardous Materials
- Hail
- Hurricane and Tropical Storm
- Land Subsidence
- Lightning
- Pandemic
- 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, lightning, hail, and wind. Coastal erosion was profiled in the *State of Texas Hazard Mitigation Plan*; however, coastal erosion was not profiled in this plan because of Wharton County's inland location.

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 streamflow levels around the world.
- The risk of drought and the frequency, intensity, and duration of heatwaves 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-borne 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 20 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** - The 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 earthquake, dam/levee failure, flood, and hurricane hazards. Outputs similar to those from HAZUS-MH were generated for other hazards, using maps generated by the HAZUS-MH program as well as a variety of other government and private sources.

5.4 RISK ASSESSMENT TOOLS

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

Overview

In 1997, FEMA developed the standardized HAZUS-MH model to estimate losses caused by earthquakes and identify areas that face the highest risk and potential for loss. HAZUS-MH 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-MH and GIS-based analysis methodology. The default HAZUS-MH inventory database for Wharton County was updated with 2010 U.S. Census data and 2018 RS Means Square Foot Costs. This enabled a HAZUS-MH 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-MH. Therefore, dam failure inundation maps were not used for performing HAZUS-MH risk analysis.
- **Earthquake** – 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. Only a minimum Level 1 HAZUS-MH analysis was profiled using the 500-Year Probability Event scenario.
- **Flood** - A Level 2 flood analysis was performed using HAZUS-MH.
- **Hurricane** -. The probabilistic option in the HAZUS-MH hurricane module was used for the analysis of this hazard.

5.4.2 Other Hazards of Concern

For hazards of concern that are not directly modeled in HAZUS-MH, 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-MH inventory data updated with 2010 U.S. Census data and 2018 RS Means Square Foot Costs and augmented with state and federal data sets. Additional data sources for specific hazards were also used and cited within their respective sections.

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 the relative risk for planning purposes and not engineering. Over the long term, Wharton County and its planning partners will collect additional data to assist in estimating potential losses associated with other hazards.

Chapter 6.
WHARTON COUNTY PROFILE

Wharton County covers 1,094 square miles, of which 10 square miles is water and the rest is land. It is located in southeast Central Texas (Figure 6-1). The San Bernard River forms the northeastern border and the Colorado River bisects the county from northwest to southeast. The creeks in the county are Mustang Creek, West Bernard Creek, Blue Creek, Jones Creek, Peach Creek, and Caney Creek. The City of El Campo is the largest city and the City of Wharton is the county seat. As of the 2010 U.S. Census, Wharton County had a population of 41,280. The county has one hospital, El Campo Memorial Hospital in the City of El Campo. The main land uses in Wharton County are cattle ranching, and cotton and rice production. Wharton County is only 35 miles from the Gulf of Mexico and minutes away from Houston.

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

6.1 HISTORICAL OVERVIEW

Wharton County, named for brothers William and John Wharton, was established in 1846. It was created from parts of Matagorda, Jackson, and Colorado Counties. The majority of this section was summarized from the Handbook of Texas Online (Hudgins 2010).

The Anglo-American colonization began when 31 of Stephen F. Austin's "Old Three Hundred" families received titles to land in present Wharton County. They located along the Colorado and San Bernard Rivers for access to building materials and stream transportation, but most built their homes along Peach and Caney Creeks, as the Colorado River was prone to flooding. The settlers were mostly from southern states and their homesteads were copies of those they had left. The later settlements were located on the open prairies in the county's western areas, where European immigrants operated small family farms. Many individuals from the future Wharton County participated in the Texas Revolution.

Dispersed settlement in the county continued during the Republic of Texas period from 1836 to 1846. Aside from occasional farm settlements, the area was a near wilderness. Wharton County was established after Texas statehood and the Mexican War in 1846. The act that formed Wharton County established the county seat to be named Wharton, located on the northeast bank of the Colorado River.

The first county courthouse was built in 1848 but was so poorly constructed that it was replaced in 1852. Wharton County resembled parts of the Deep South; one plantation was over 4,500 acres and the county had 16,784 acres of land under cultivation. Prior to the Civil War, the largest plantation and sugar mill in Texas were located in Wharton County. Completion of the Buffalo Bayou, Brazos, and Colorado Railway extensions across the northwest corner of the county by 1860 improved commodity prices, though roads to the railroad line remained poor. Residents joined the Confederate War effort as part of Terry's Texas Rangers, the Home Guards, or the Wharton Rifles. No fighting occurred in Wharton County, but the Civil War destroyed the county's plantation economy. Plantations were converted into cattle ranges and many residents left for Mexico. The resulting commercial and agricultural depression was heightened by a national depression in 1873.

Cattle raising replaced the plantation system as Wharton County's major industry after the Civil War. Abel Head Pierce acquired vast acreage on the west side of the Colorado River, with a cattle empire that stretched over three counties, encompassing 500,000 acres, of which 30,000 were in Wharton County. After his death in 1900, his nephew, A. P. Borden, facilitated the first major importation of Brahmans to the United States (specifically Wharton County) in 1906. Wharton County became the second largest cattle-producing area in the state. Japanese families came to the area and began rice farming on land just opposite the Town of Wharton on the west bank of the Colorado River. Irrigation from three canal systems built from the Colorado River around 1900 helped farmers diversify and turn to rice as a dependable cash crop. By 1930, Wharton County was a leader in Texas for rice production. During World War I, Wharton County contributed men to the armed forces and organized home guards.

One of the world's largest sulfur deposits, the Boling Dome, was discovered in 1923. Drilling for oil began in 1904 southwest of the Town of El Campo, but the first productive oil well was drilled east of the Colorado River in the Boling Field in 1925. Between 1925 and 1973 over 230 million barrels of crude oil were produced in the county. Several natural gas transmission plants were built around 1944 boosting pressure and sending natural gas north from the area fields.

Farm tenancy in the county peaked in 1930 when a majority of the farms were operated by tenant families. During the Great Depression in the 1930s, public works projects upgraded county and federal facilities. During World War II, federal funds were used to establish community centers for servicemen at Wharton and El Campo; the 47th Battalion of the Texas State Guard had its headquarters in Wharton County.

From 1960 to 1970 Wharton County's population declined, but between 1970 and 1982 it increased in the urban areas. In 1970, the county was the leading Texas rice producer and third among Texas counties in beef cattle production. In the 1980s, 94% of the county land was in farms and ranches, and 64% of farmland was under cultivation. County-wide ranching continued, and the county was second in the state in sorghum production. Scientifically managed farms and ranches replaced the county's earlier plantation system.

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 25 events between 1990 and March of 2021 for which federal disaster declarations were issued. These events are listed in Table 6-1.

A 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 WHARTON COUNTY		
Disaster Declaration	Description	Incident Date
DR-4586	Severe Winter Storms	2/11/21 – 2/21/21
EM-3554	Severe Winter Storm	2/11/21 – 2/21/21
EM-3540	Tropical Storms Marco and Laura	8/23/20 – 8/27/20
EM-3530	Hurricane Hanna	7/25/20 – 7/31/20
DR-4485	COVID-19 Pandemic	1/20/20 – Ongoing
EM-3458	COVID-19	1/20/20 - Ongoing
DR-4332	Hurricane Harvey	8/23/2017 - 9/15/2017
DR-4269	Severe Storms and Flooding	4/17/2016 - 4/30/2016
DR-4223	Severe Storms, Straight-line Winds, Tornadoes, and Flooding	5/4/2015 - 6/22/2015
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-1434	Tropical Storm Fay	9/6/2002 - 9/30/2002
EM-3142	Extreme Fire Hazards	8/1/1999 - 12/10/1999
DR-1257	Flooding	10/17/1998 - 11/15/1998
DR-1239	Tropical Storm Charley	8/22/1998 - 8/31/1998
DR-1041	Severe Thunderstorms and Flooding	10/14/1994 - 11/8/1994
EM-3113	Extreme Fire Hazard	8/30/1993 - 11/15/1993
DR-930	Severe Thunderstorms	12/20/1991 - 1/14/1992
DR-863	Severe Storms, Tornadoes, and Flooding	4/15/1990 - 5/29/1990

Notes:
Federal disaster declarations are coded as follows: DR = Major Disaster Declaration; EM = Emergency Declaration
From OpenFEMA Dataset

6.3 CLIMATE

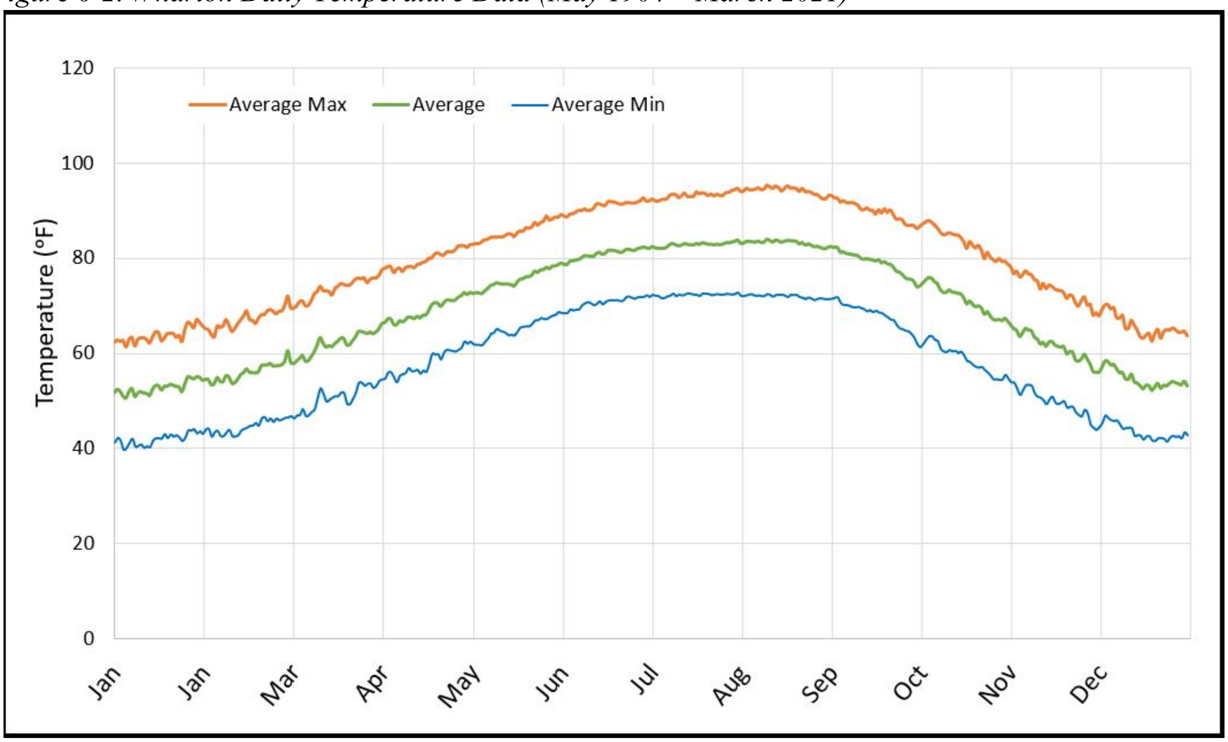
Wharton County is hot and humid in the summer and cool in winter. Average temperatures range from 92.8°F in the summer to 43.3°F in the winter. NOAA weather station climate data consists of information collected from May 1904 to September 2011 by Pierce 1 E (USC00417020) weather station augmented with data from October 2011 to March 2021 from El Campo (USC00412786) weather station. Table 6-2 contains temperature summaries for the stations. Figure 6-2 graphs the daily temperature averages and extremes from May 1, 1904, through March 31, 2021. Figure 6-3 and Figure 6-4 show the geographic distribution of annual average minimum and annual average maximum temperatures in Wharton County compared to the State of Texas from 1981 to 2010.

TABLE 6-2.
WHARTON COUNTY TEMPERATURE SUMMARIES

Winter[a] Average Minimum Temperature	43.3°F
Winter[a] Mean Temperature	54.5°F
Summer[a] Average Maximum Temperature	92.8°F
Summer[a] Mean Temperature	82.2°F
Maximum Temperature (and Date)	112°F (September 5, 2000)
Minimum Temperature (and Date)	4°F (January 31, 1949)
Average Annual Number of Days >90°F[a]	108.3
Average Annual Number of Days <32°F[a]	18.9

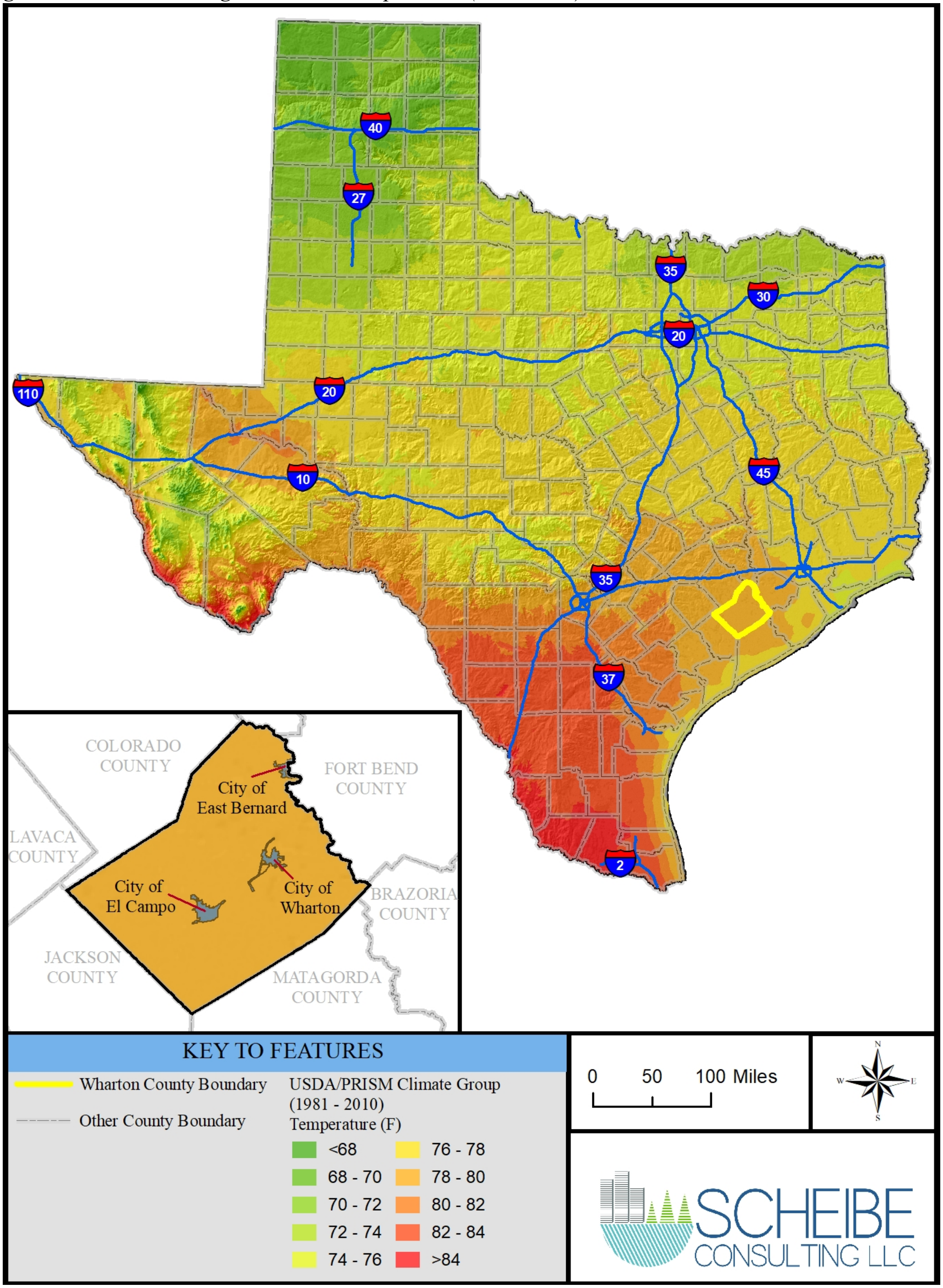
Notes:
Winter: December, January, February; Summer: June, July, August
From NOAA Weather Station Climate Data (May 1904 – March 2021)

Figure 6-2. Wharton Daily Temperature Data (May 1904 – March 2021)



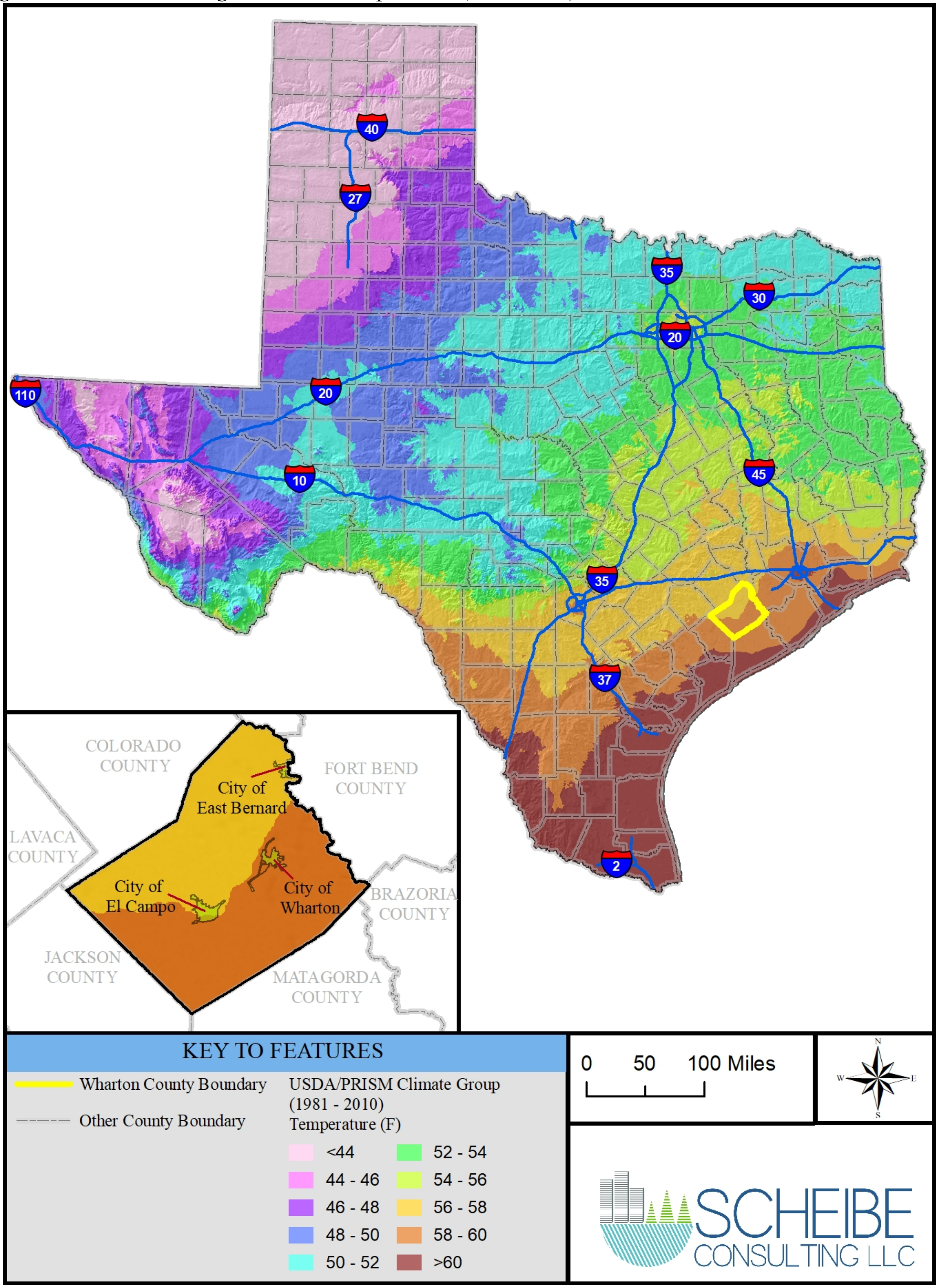
Note: From NOAA Weather Station Climate Data (May 1904 – March 2021)

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



Notes: From USDA/PRISM CLIMATE GROUP

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

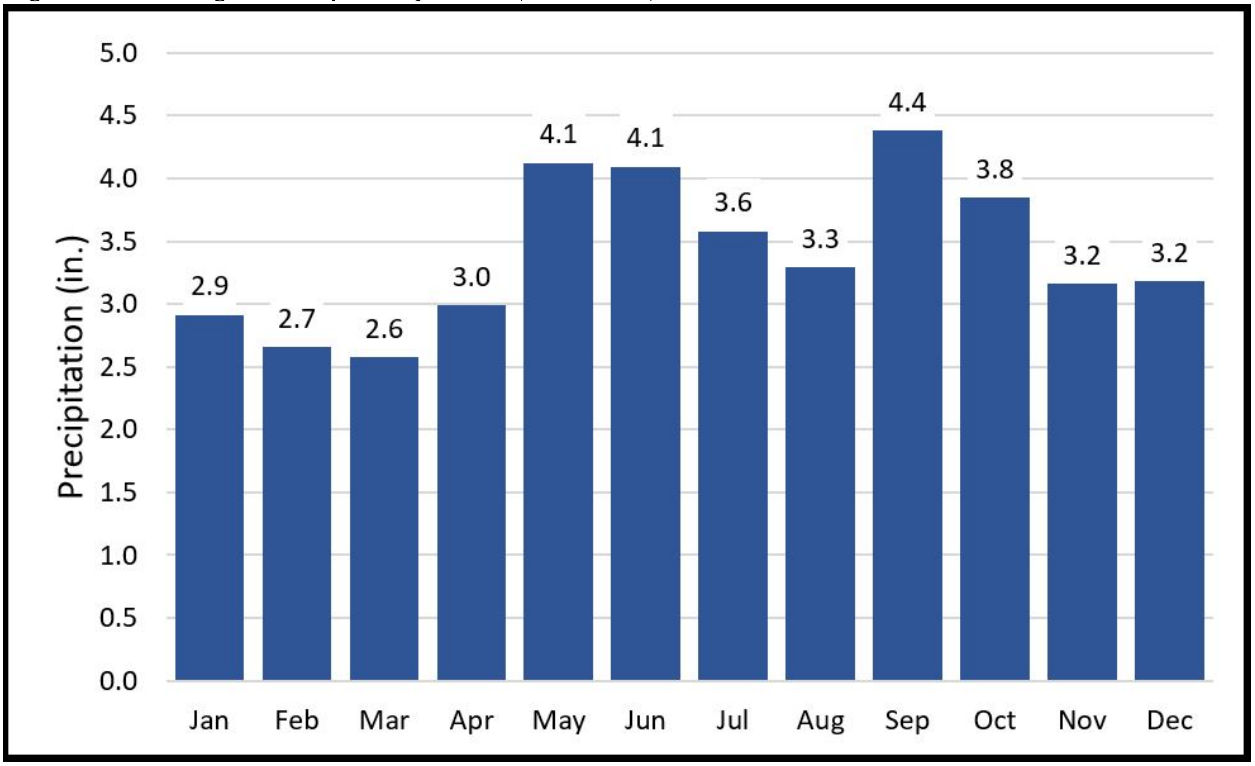


Note: From USDA/PRISM CLIMATE GROUP

Rainfall is uniformly distributed throughout the year, reaching a slight peak in May and September. Snowfalls are infrequent. Precipitation is highest in September. The average annual precipitation is 40.48 inches based on NOAA weather station data. Severe thunderstorms occur mostly in the spring. Data from the National Lightning Detection Network ranked Texas first in the nation (excluding Alaska and Hawaii) with respect to the number of cloud-to-ground lightning flashes in 2020.

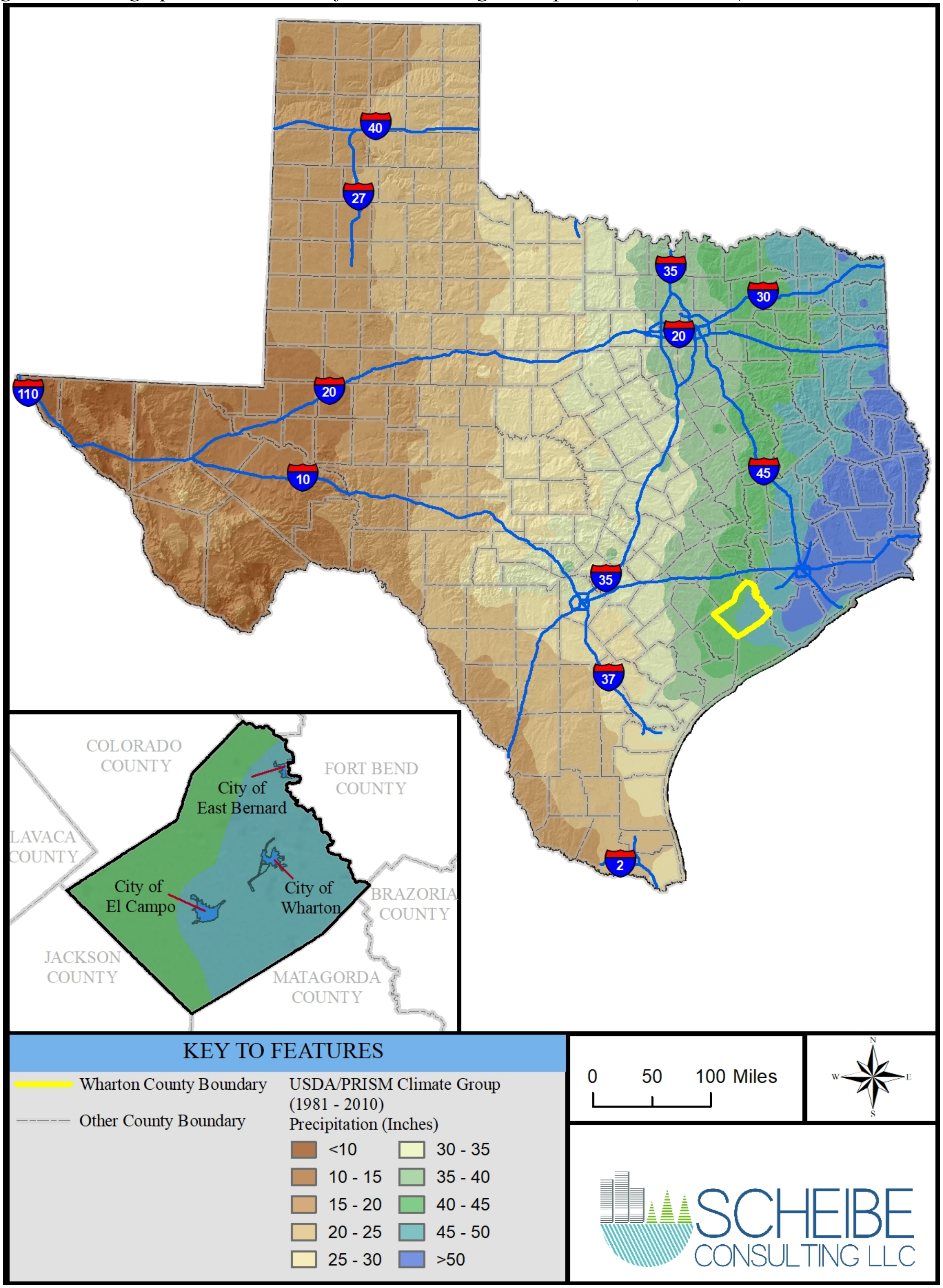
Figure 6-5 shows the average monthly precipitation in Wharton County. Figure 6-6 shows the geographic distribution of annual average precipitation in Wharton County compared to the State of Texas.

Figure 6-5. Average Monthly Precipitation (1904-2021)



Note: From NOAA Weather Station

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



Note: From USDA/PRISM CLIMATE GROUP

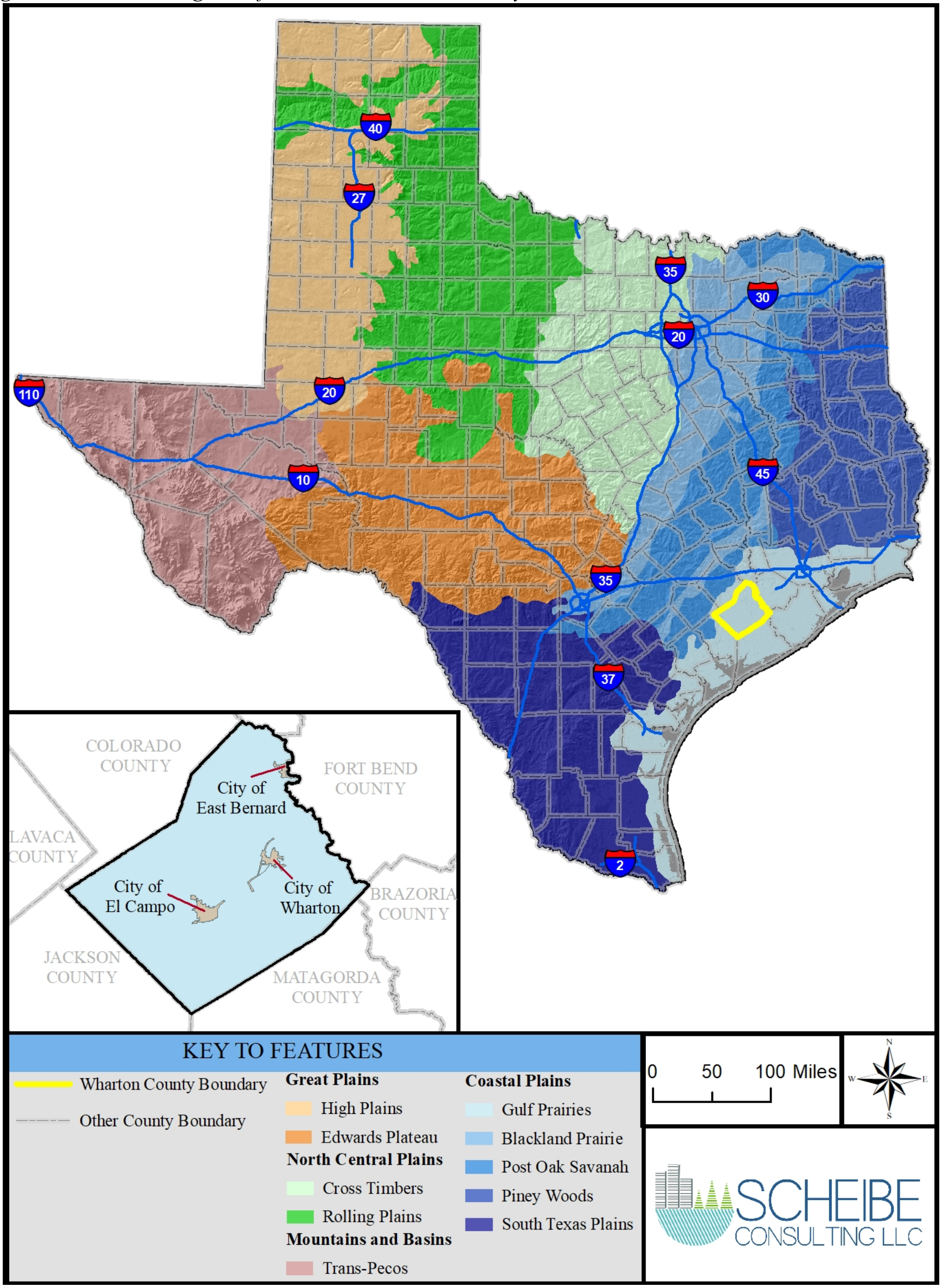
6.4 GEOLOGY AND SOILS

Texas is broadly divided into four regions by physical geography features such as landforms, climate, and vegetation. Wharton County is in southeast Central Texas. It lies in the Gulf Prairies Land Resource Area of the Coastal Plains Natural Region. Figure 6-7 shows the Texas natural regions with Wharton County highlighted.

The major natural drainage ways in the county are the San Bernard River and the Colorado River, which carry water from the creeks. Most of the county is nearly level to gently sloping. The western part of the county has slopes of a five-foot fall in one mile, and the eastern part of the county has slopes of a two-foot fall in one mile. Thus, runoff moves very slowly off the soil and most runoff is carried in constructed ditches to the rivers.

The predominant soil types in Wharton County are alluvial alluvium, coastal clay, loam, and sand. Natural resources of the county include salt domes, sand and gravel, oil, gas, and sulfur; all have been tapped for commercial and industrial use (Hudgins 2010).

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



Note: From Texas Parks & Wildlife

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:

- Elderly care centers (nursing homes)
- Congregate care serving 12 or more individuals (daycare 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)

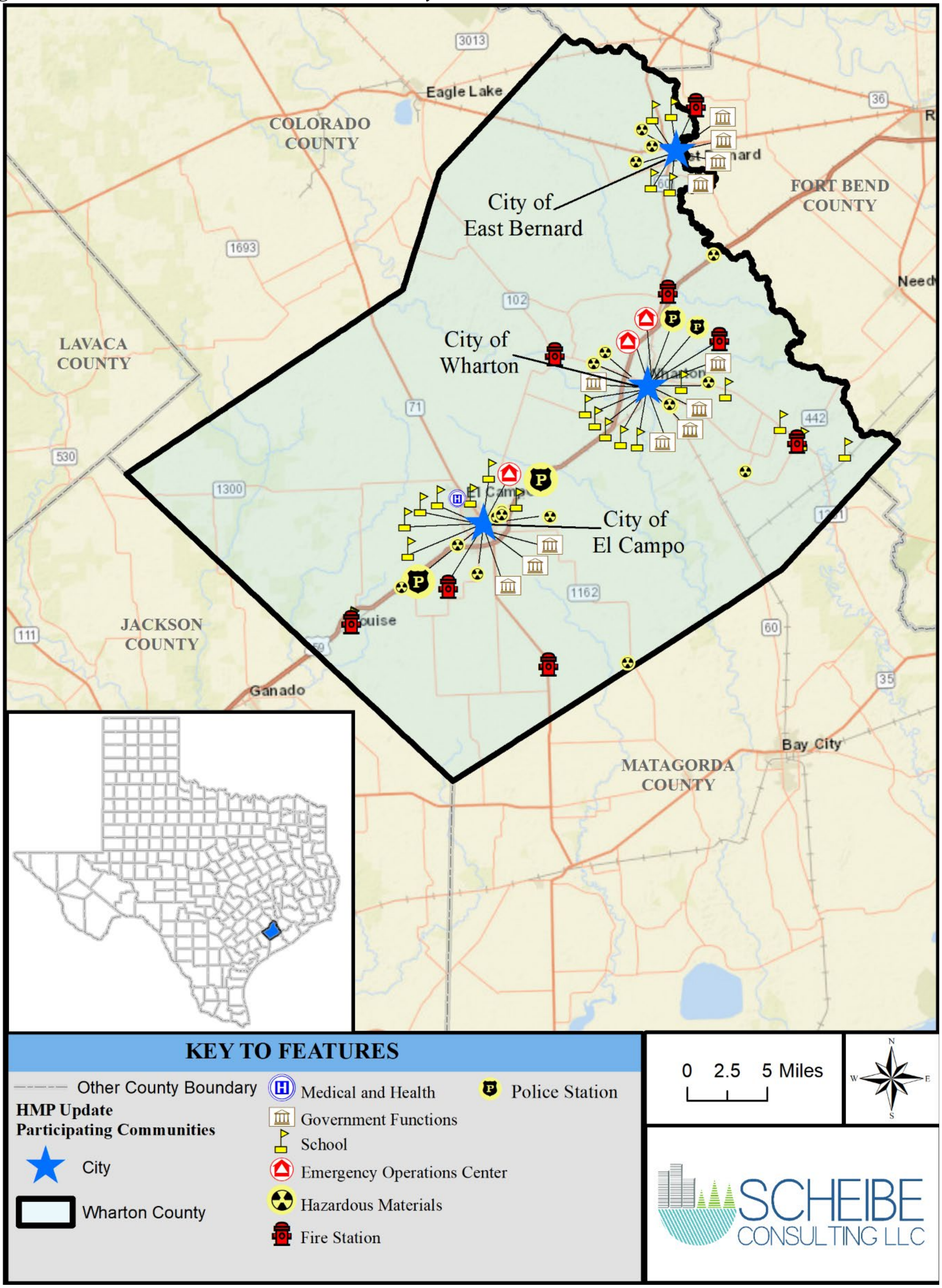
Table 6-3 and Table 6-4 summarize the critical facilities and infrastructure in each municipality and unincorporated county areas. This information was obtained from HAZUS-MH and GIS.

TABLE 6-3. CRITICAL FACILITIES IN THE PLANNING AREA					
Facility Type	City of East Bernard	City of El Campo	City of Wharton	Unincorporated or Other	**Wharton County Total**
Fire Stations	1	1	1	5	**8**
Police Stations	0	1	2	1	**4**
Medical and Health	0	1	0	0	**1**
Emergency Operations Center	0	1	2	0	**3**
School	4	7	4	9	**24**
Hazardous Materials	3	6	5	4	**18**
Government Functions	4	3	5	0	**12**
Total	**12**	**20**	**19**	**19**	**70**

TABLE 6-4. CRITICAL INFRASTRUCTURE IN THE PLANNING AREA					
Facility Type	City of East Bernard	City of El Campo	City of Wharton	Unincorporated or Other	**Wharton County Total**
Communication	0	0	0	3	**3**
Power Facility	0	0	0	3	**3**
Potable Water/ Wastewater Facility	3	5	0	5	**13**
Dam Location	0	0	0	11	**11**
Airport Facility	0	0	1	0	**1**
Airport Runway	0	0	1	0	**1**
Other Transportation	0	1	1	0	**2**
Bridge	1	32	34	290	**357**
Total	**5**	**36**	**37**	**316**	**398**

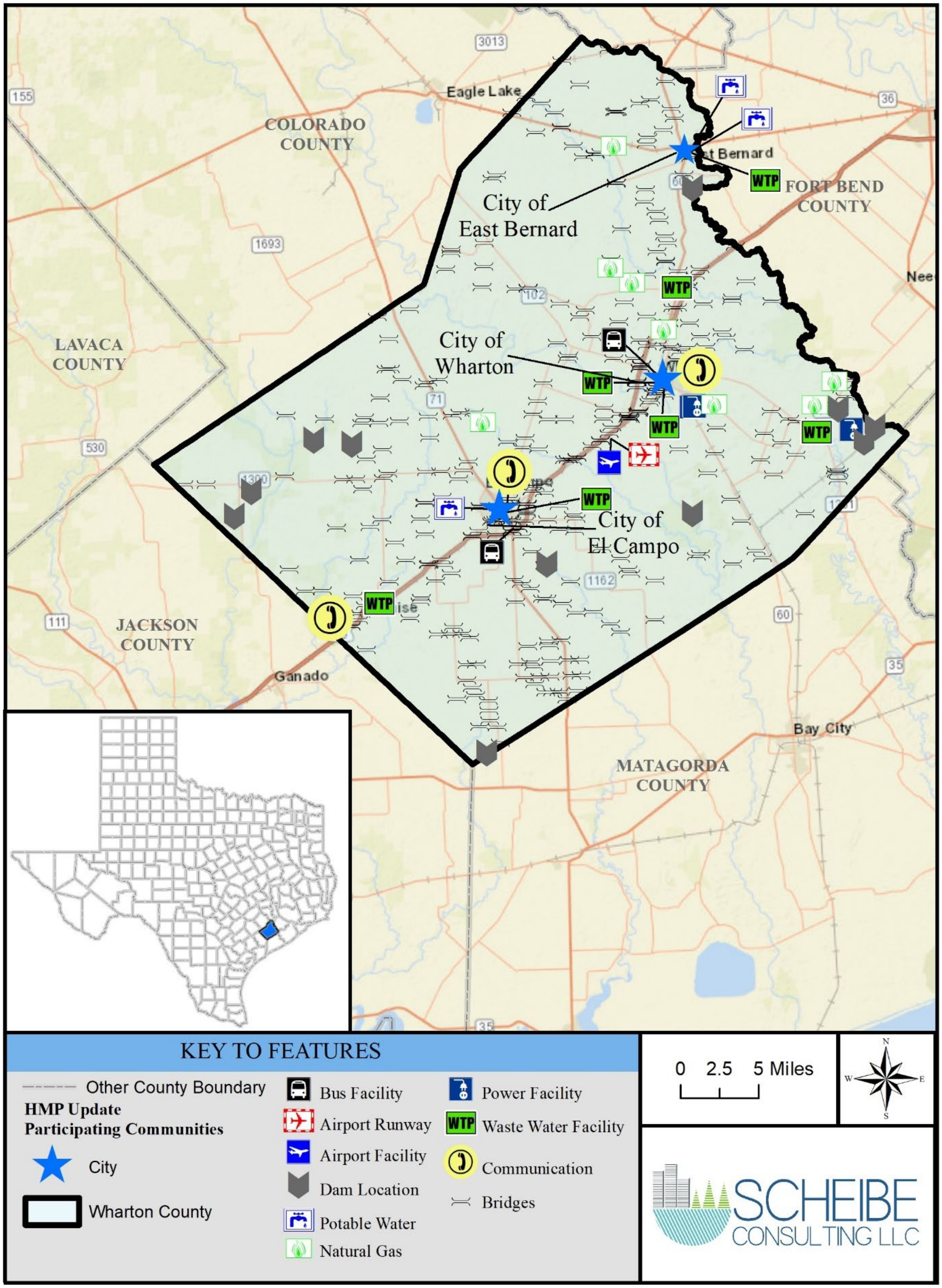
Figures 6-8 through Figure 6-15 show the location of critical facilities and infrastructure in the county and participating cities. Due to the sensitivity of this information, a detailed list of facilities is not provided. The list is on file with each planning partner. Critical facilities and infrastructure were analyzed in HAZUS-MH 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 Wharton County



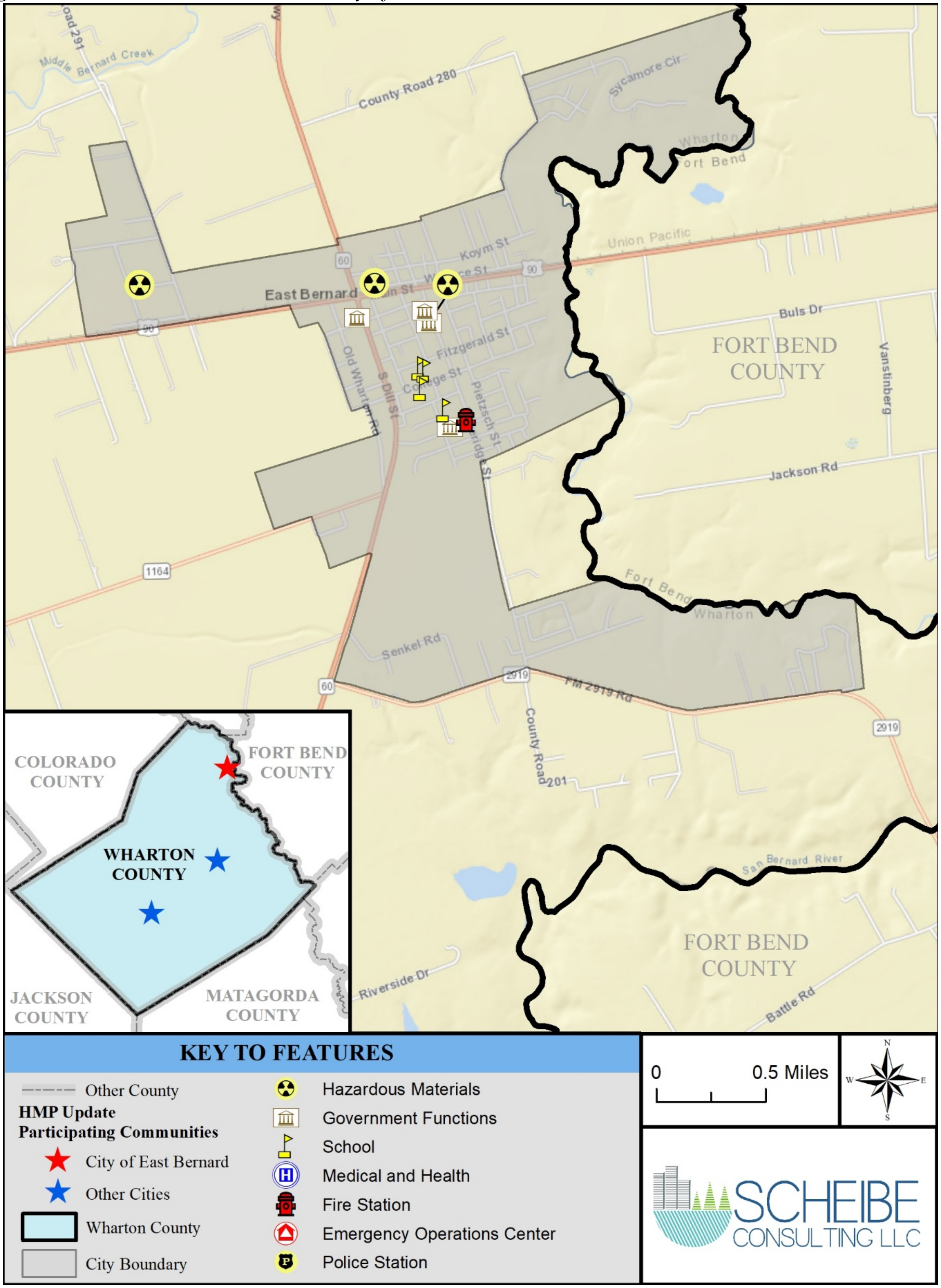
Note: From HAZUS-MH

Figure 6-9. Critical Infrastructure in Wharton County



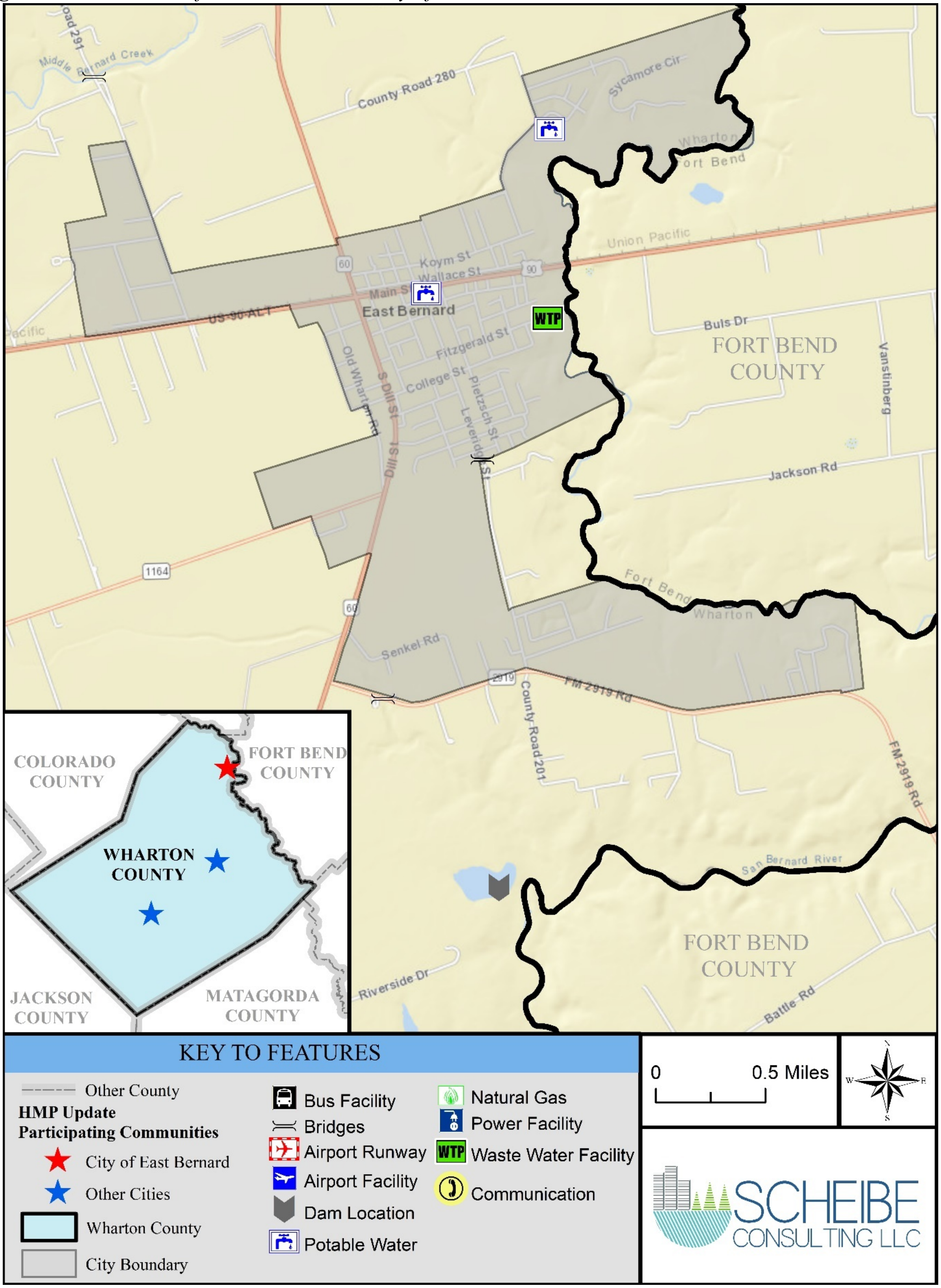
Note: From HAZUS-MH and GIS

Figure 6-10. Critical Facilities in the City of East Bernard



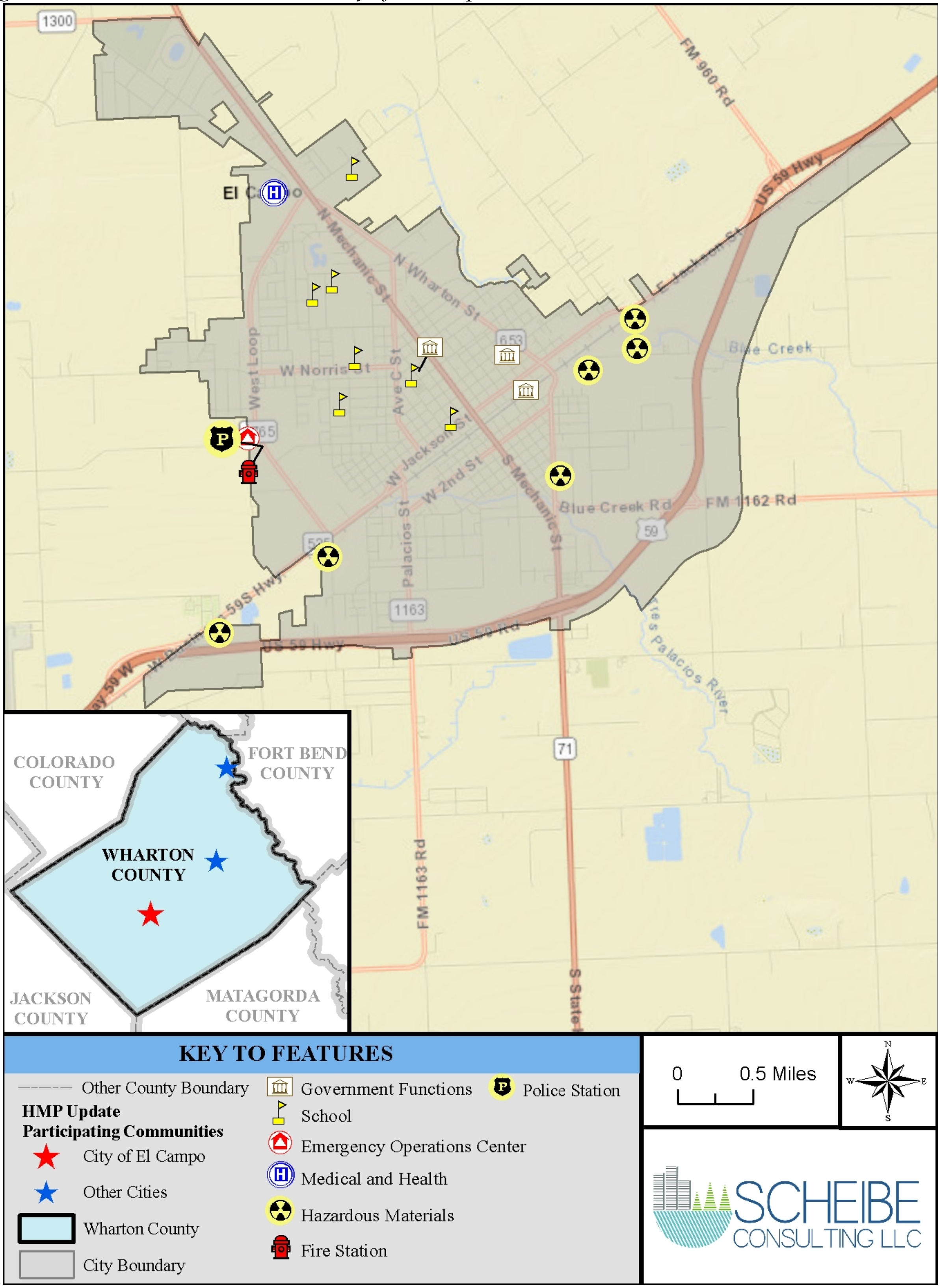
Note: From HAZUS-MH and GIS

Figure 6-11. Critical Infrastructure in the City of East Bernard



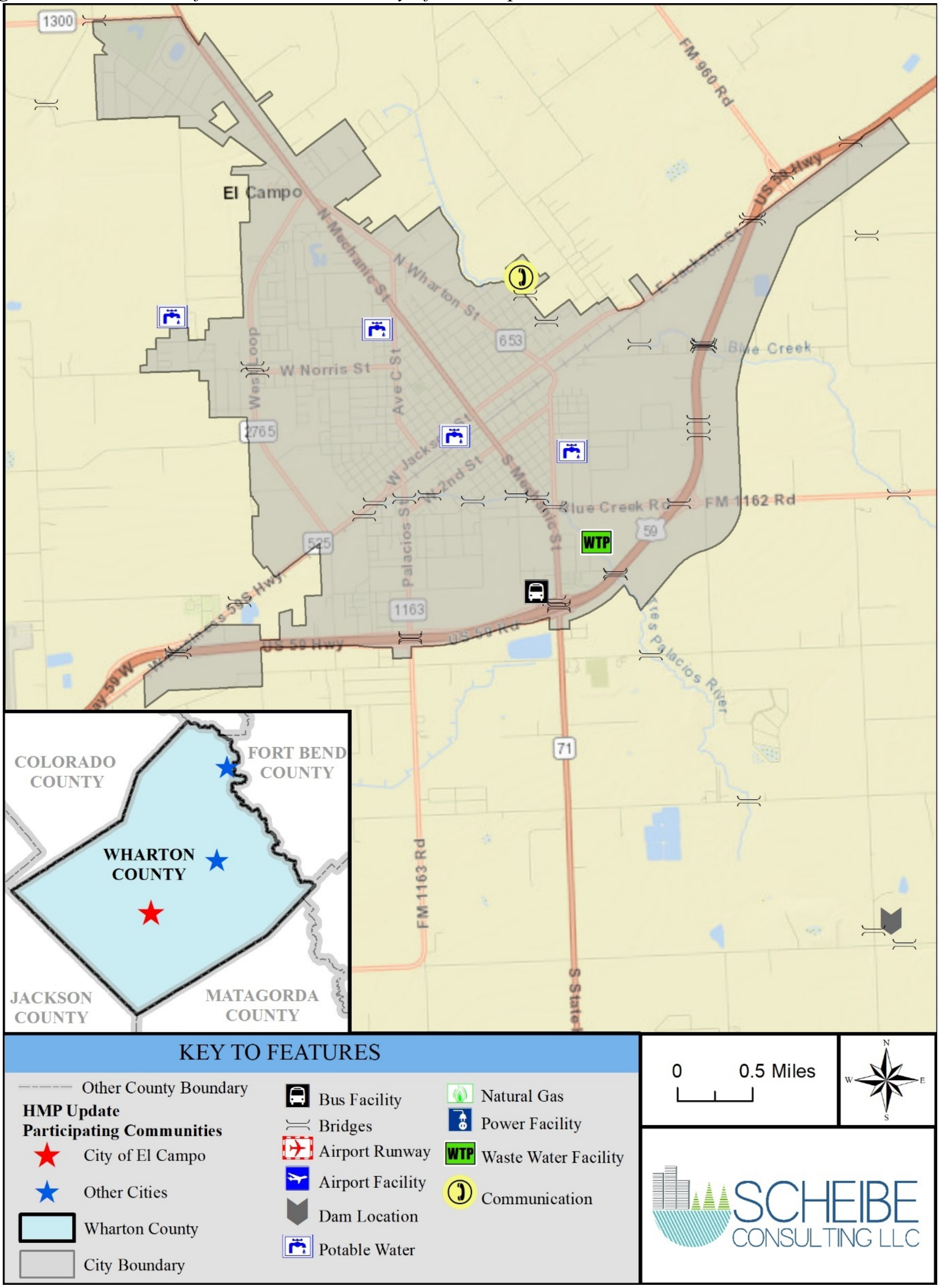
Note: From HAZUS-MH and GIS

Figure 6-12. Critical Facilities in the City of El Campo



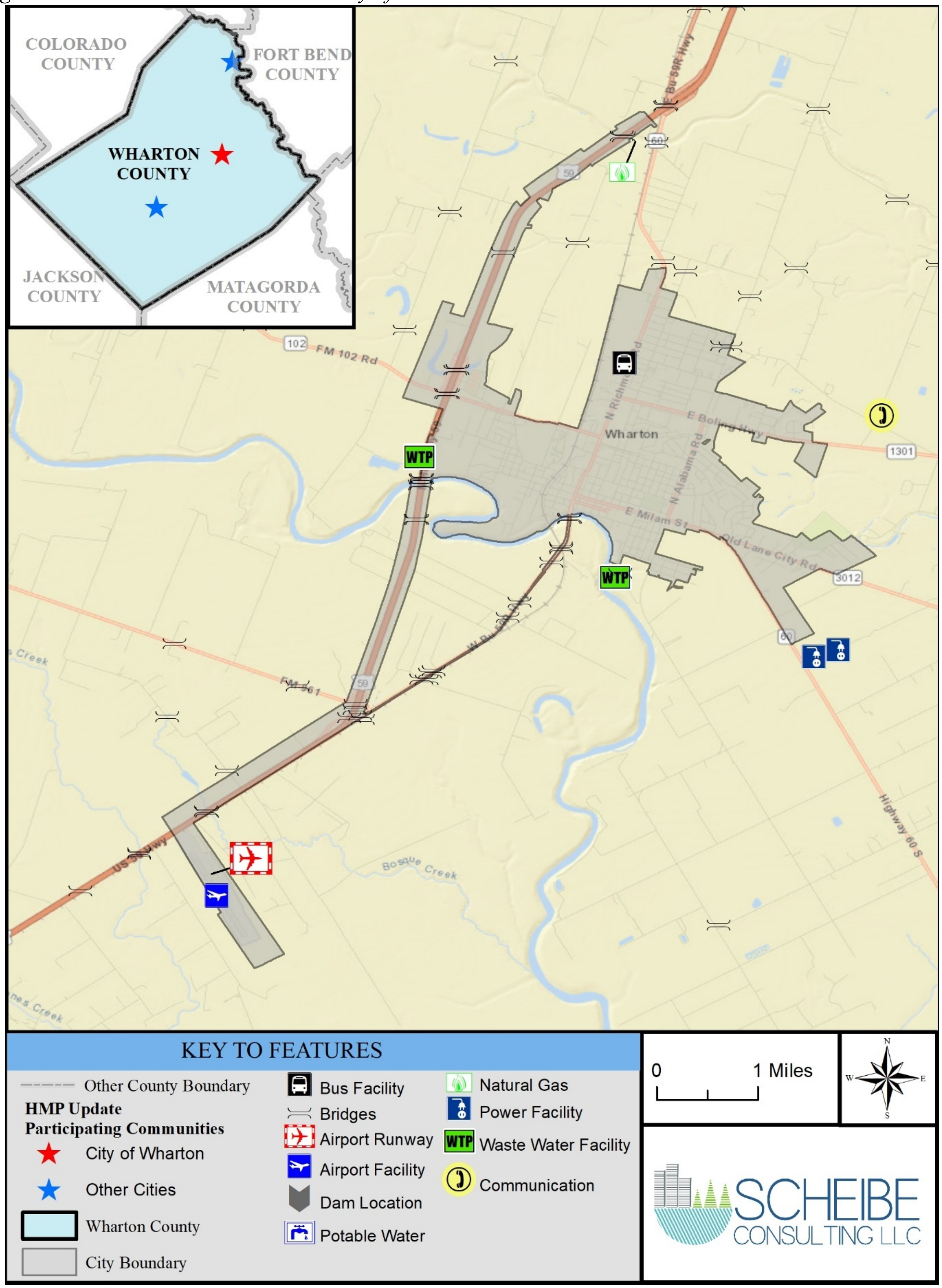
Note: From HAZUS-MH and GIS

Figure 6-13. Critical Infrastructure in the City of El Campo



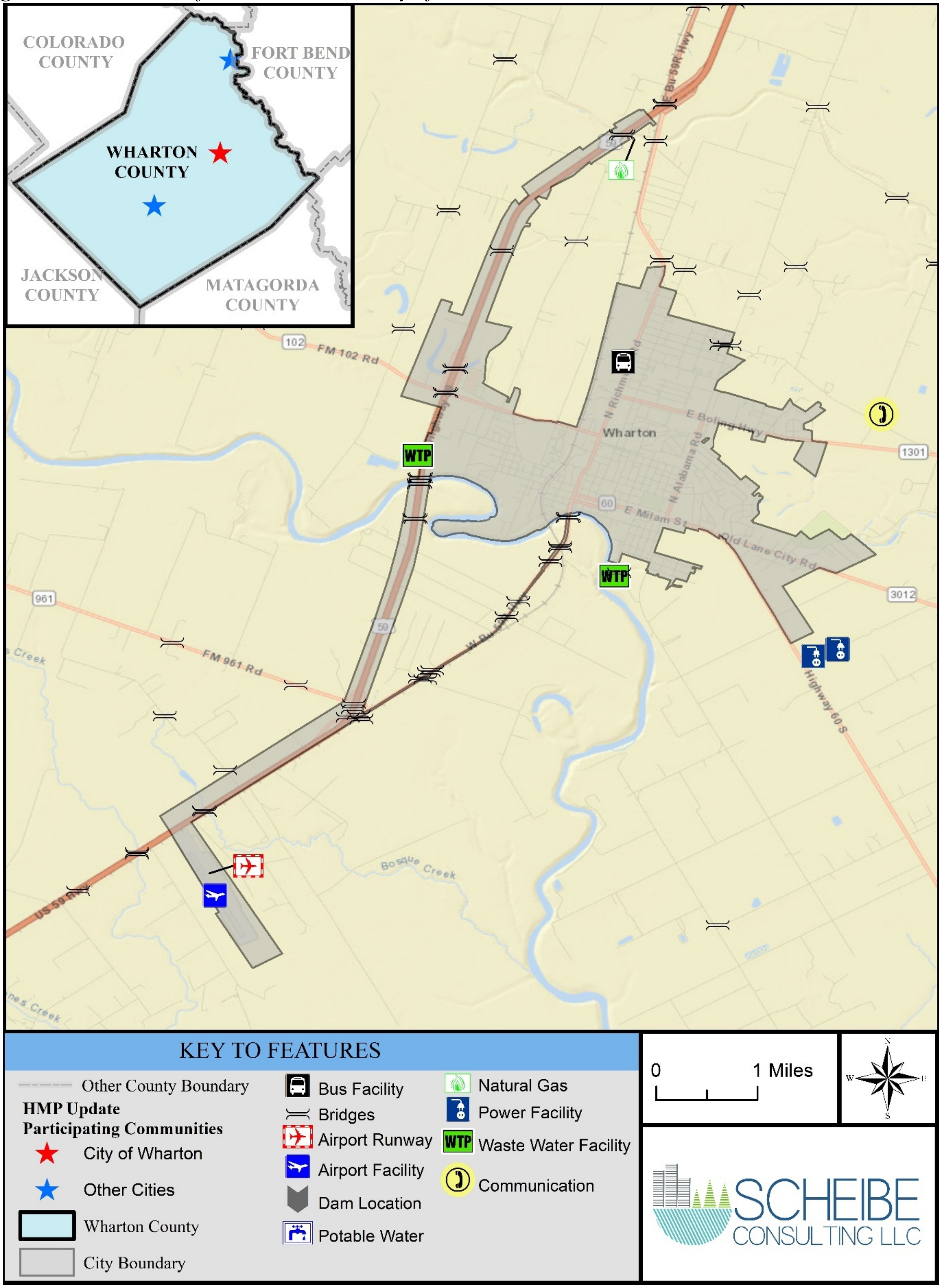
Note: From HAZUS-MH and GIS

Figure 6-14. Critical Facilities in the City of Wharton



Note: From HAZUS-MH and GIS

Figure 6-15. Critical Infrastructure in the City of Wharton



Note: From HAZUS-MH and GIS

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 participating cities in extending focused public outreach and education to these most vulnerable citizens. Select U.S. Census demographic and social characteristics estimates for 2015 through 2019 in Wharton County are shown in Table 6-5.

TABLE 6-5.
WHARTON COUNTY DEMOGRAPHIC AND SOCIAL CHARACTERISTICS (2015-2019)

	Wharton County	City of East Bernard	City of El Campo	City of Wharton
Gender/Age (% of Total Population)				
Male	49.1	47.5	47.3	49.6
Female	50.9	52.5	52.7	50.4
Under 5 years	6.8	6.4	8.0	7.0
65 years and over	16.6	16.0	15.7	18.5
Race/Ethnicity (% of Total Population)				
White	80.6	93.6	83.9	63.9
American Indian/Alaska Native	0.1	0.0	0.2	0.0
Asian	0.3	0.0	0.0	0.7
Black or African American	14.3	1.4	9.2	30.0
More Than One Race	1.0	0.0	1.4	1.6
Hispanic or Latino (of any race)[1]	41.4	30.1	56.0	37.1
Education (% of Total Population)				
High School Graduate or Higher (25 years and over)	78.3	89.5	73.3	72.7

Notes:
1The 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.
From U.S. Census Bureau

6.6.1 Population

The U.S. Census Bureau estimated a population of 41,556 for Wharton County as of July 2019. Table 6-6 shows planning area population data from 1990 through 2019. The total Wharton County population increased 3.1% from 1990 to 2000, 0.2% from 2000 to 2010, and 0.7% from 2010 to 2019; thus, the population has continued to grow since 1990 at a varying rate. The Cities of El Campo and Wharton are the county's principal population centers.

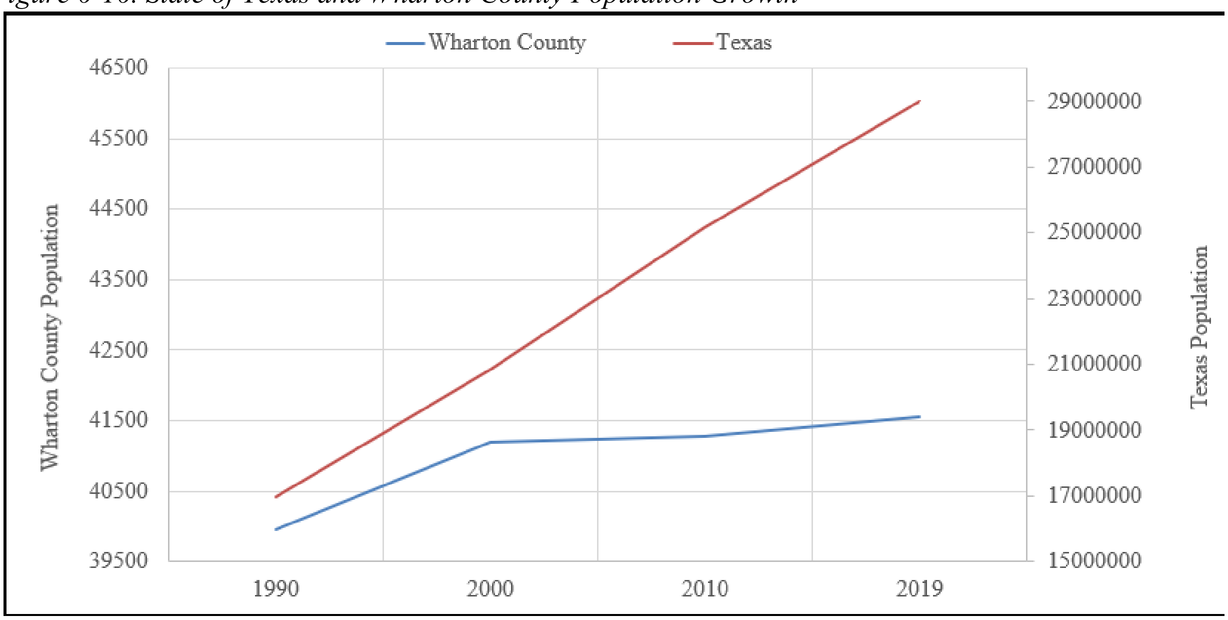
TABLE 6-6.
WHARTON COUNTY POPULATION

	Total Population			
	1990	2000	2010	2019
City of East Bernard	-	2,306	2,272	2,342
City of El Campo	10,932	11,569	11,602	11,539
City of Wharton	9,140	9,529	8,832	8,637
Unincorporated Areas[a]	19,883	17,787	18,574	19,038
Wharton County Total	**39,955**	**41,191**	**41,280**	**41,556**

Notes:
a. Includes non-participating communities
From U.S. Census Bureau

Figure 6-16 shows 10-year population changes in Wharton County and the State of Texas from 1990 to 2010 and the 9-year change from 2010 to 2019. Between 1990 and 2019, the State of Texas' population grew by 70.7% (about 2.4% per year) while Wharton County's population increased by 4% (0.14% per year).

Figure 6-16. State of Texas and Wharton County Population Growth



Note: From U.S. Census Bureau

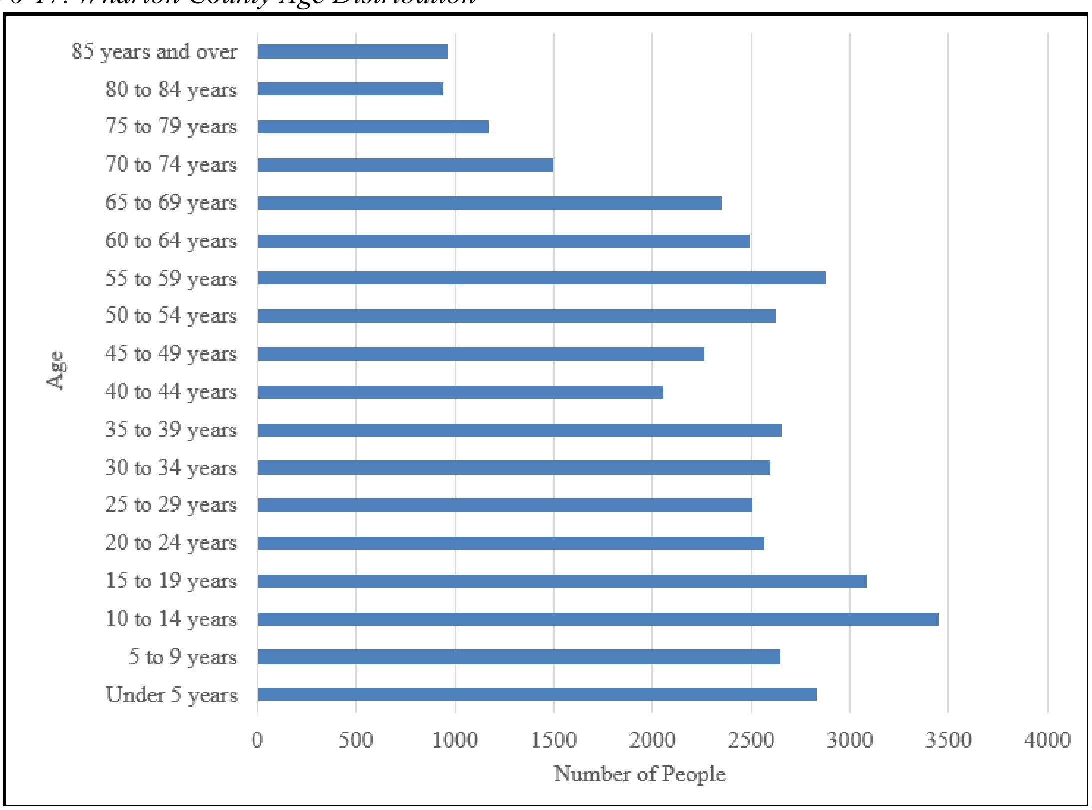
6.6.2 Age Distribution

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 6-17. Based on U.S. Census data estimates, in 2019 16.6% 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. U.S. Census estimates for 2019 indicate that 21.3% of Wharton County families have children under 18 and are below the poverty line.

Figure 6-17. Wharton County Age Distribution



Note: From U.S. Census Bureau

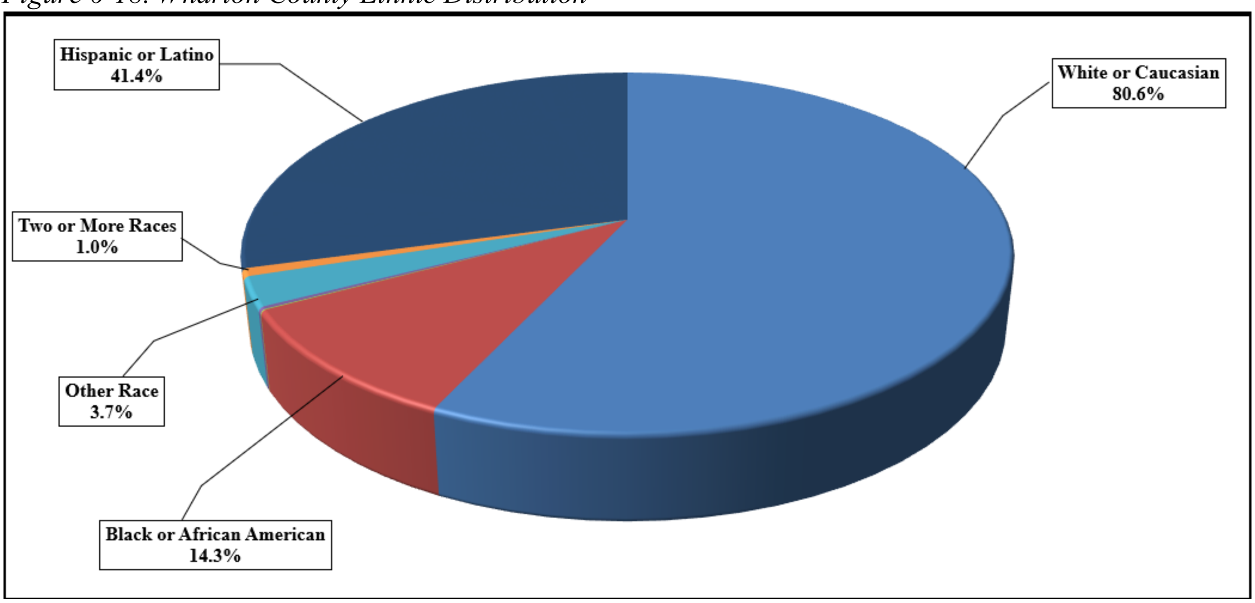
6.6.3 Disabled Populations

In 2019 the U.S. Census Bureau estimates that 40.3 million non-institutionalized Americans with disabilities live in the U.S, approximately 12.6%. People with disabilities are more likely to have difficulty responding to hazard events 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. Emergency managers need to distinguish between functional and medical needs in order to plan for incidents that require evacuation and sheltering. Knowing the percentage of the 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 2019 U.S. Census Bureau estimates, 14.6% of the population in the planning area lives with some form of disability.

6.6.4 Ethnic Populations

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 2019 U.S. Census estimates, the ethnic composition of Wharton County is predominantly white, at about 80.6%. The largest minority population is Hispanic or Latino at 41.4%. Figure 6-18 shows the population distribution by race and ethnicity in Wharton County. The values shown in Figure 6-18 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 6-18. Wharton County Ethnic Distribution



Note: From U.S. Census Bureau

Wharton County has a 9.9% foreign-born population. Other than English, the most commonly spoken language in Wharton County is Spanish. An estimated 9.4% of the residents speak English "less than very well."

6.7 ECONOMY

Select 2019 economic characteristics estimated for Wharton County by the U.S. Census Bureau are shown in Table 6-7.

TABLE 6-7.
WHARTON COUNTY ECONOMIC CHARACTERISTICS

	Wharton County	City of East Bernard	City of El Campo	City of Wharton
Families Below Poverty Level	14.3%	7.2%	16.9%	17.8%
Individuals Below Poverty Level	17.6%	11.3%	20.8%	20.1%
Median Home Value (Owner Occupied)	$128,100	$165,900	$146,000	$92,700
Median Household Income	$48,310	$62,200	$49,182	$39,079
Per Capita Income	$25,298	$28,965	$27,783	$19,369
Population >16 Years Old in Labor Force	59.7%	62.1%	62.0%	50.3%
Population Employed	56.7%	60.7%	59.9%	49.5%

Note: From U.S. Census Bureau

6.7.1 Income

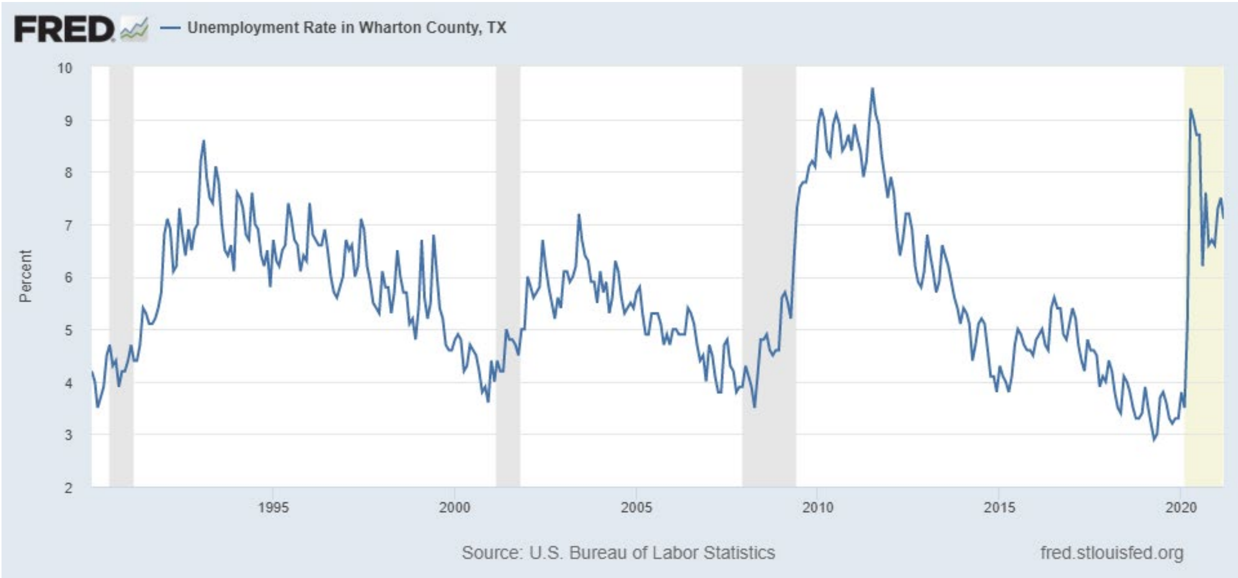
In the United States, individual households are expected to use private resources to some extent to prepare for, respond to, and recover from disasters. This means that households living in poverty are automatically disadvantaged when confronting hazards. Additionally, the poor typically occupy more 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 reside 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 2019 was $25,298 and the median household income was $48,310. It is estimated that 14.4% of households receive an income between $100,000 and $149,999 per year and 7.6% are above $150,000 annually. Families with incomes below the poverty level in 2019 made up 14.3% of all families and 17.6 % of the total population in Wharton County.

6.7.2 Employment Trends

According to the U.S. Bureau of Labor Statistics in March of 2021, Wharton County’s unemployment rate was 7.1%, compared to a statewide rate of 6.9%. Figure 6-19 shows Wharton County’s unemployment trends from 1990 through, March 2021. Wharton County’s unemployment rate was lowest in 2019 at 3.4% and peaked in 2011 at 9.6%.

Figure 6-19. Wharton County Unemployment Rate (1990-2021)



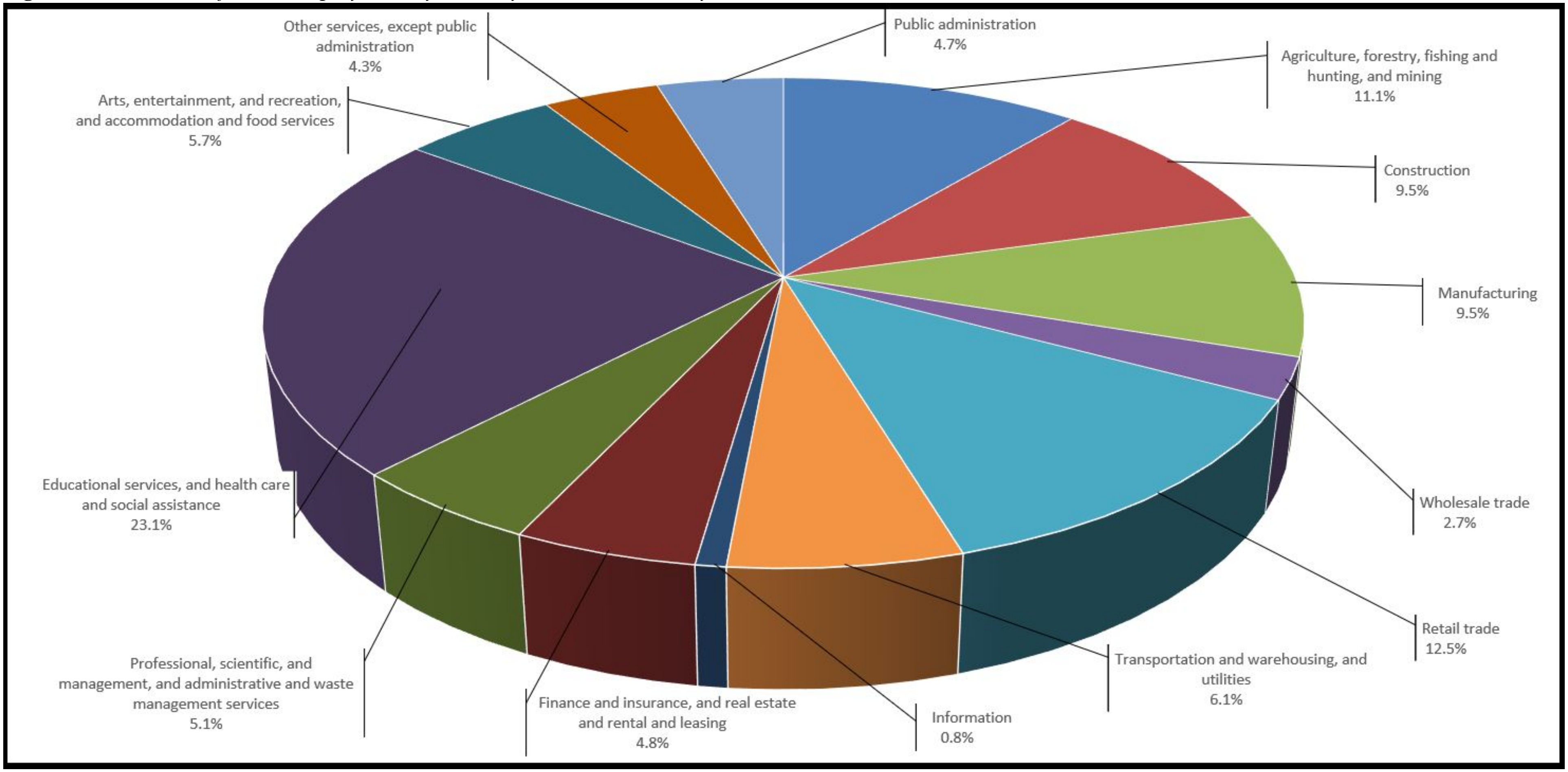
Notes: Shaded areas indicate U.S. recessions, From U.S. Bureau of Labor Statistics

According to the 2019 U.S. Census Bureau estimates, 59.7 of Wharton County's population 16 years and older are in the labor force, including 65.7% of women and 81.8% of men.

6.7.3 Occupations and Industries

According to 2019 U.S. Census data estimates, the planning area's economy is strongly based in the education services, health care and social assistance industries (23.1% of total employment), followed by retail trade (12.5%), and then agriculture, forestry, fishing and hunting, and mining industry group (11.1%). Figure 6-20 shows the distribution of industry types in Wharton County, based on the share of total employment.

Figure 6-20. Percent of Total Employment by Industry in Wharton County



Note: From U.S. Census Bureau

6.8 FUTURE TRENDS IN DEVELOPMENT

The municipal planning partners have adopted plans that govern land-use decisions and policymaking 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, Wharton County and the cities of East Bernard, El Campo, and Wharton 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 Wharton County

Wharton County consists primarily of agricultural land. Developed land accounts for only 5.1 % of the county. Table 6-8 lists the present land use in Wharton County.

**TABLE 6-8.
PRESENT LAND USE IN PLANNING AREA**

Present Use Classification	Area (acres)	% of Total Land Area
Agriculture	570,198	81.4
Developed, Open Space	26,949	3.8
Developed, High Intensity	648	0.1
Developed, Medium Intensity	2,029	0.3
Developed, Low Intensity	6,060	0.9
Forest Land	51,226	7.3
Grassland/Prairie	10,383	1.5
Water/Wetland	32,897	4.7
Total	**700,390**	**100**

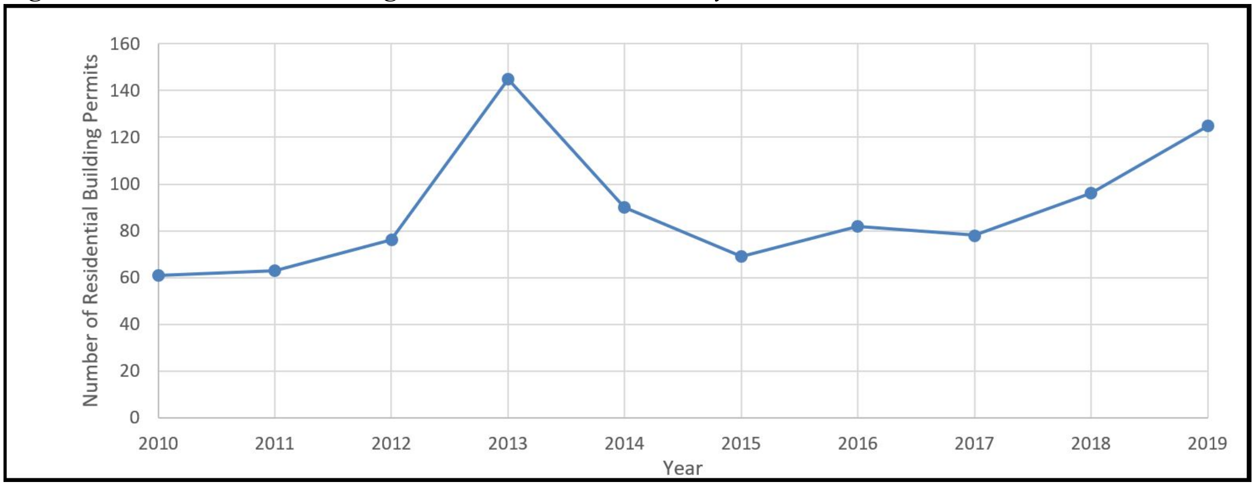
Note: From U.S. Geological Survey: National Land Cover Database

As described in Chapter 6.6.1, the population of Wharton County increased by 4% from 1990 to 2019. Most of the population in the county lives in unincorporated areas, while the cities of El Campo and Wharton are also large population centers.

Housing units in Wharton County are mainly single-family detached homes; however, there are approximately 2,299 mobile homes in the county.

The number of residential building permits reported in Wharton County over the past 10 years represents an upward trend, spiking in 2013 (145 permits). Wharton County would be impacted by an increase in vulnerability since additional residential building permits have been issued since 2010. Records on Wharton County building permits include all permits issued within the county. Figure 6-21 shows the reported residential building permits in Wharton County between 2010 and 2019.

Figure 6-21. Residential Building Permits in Wharton County

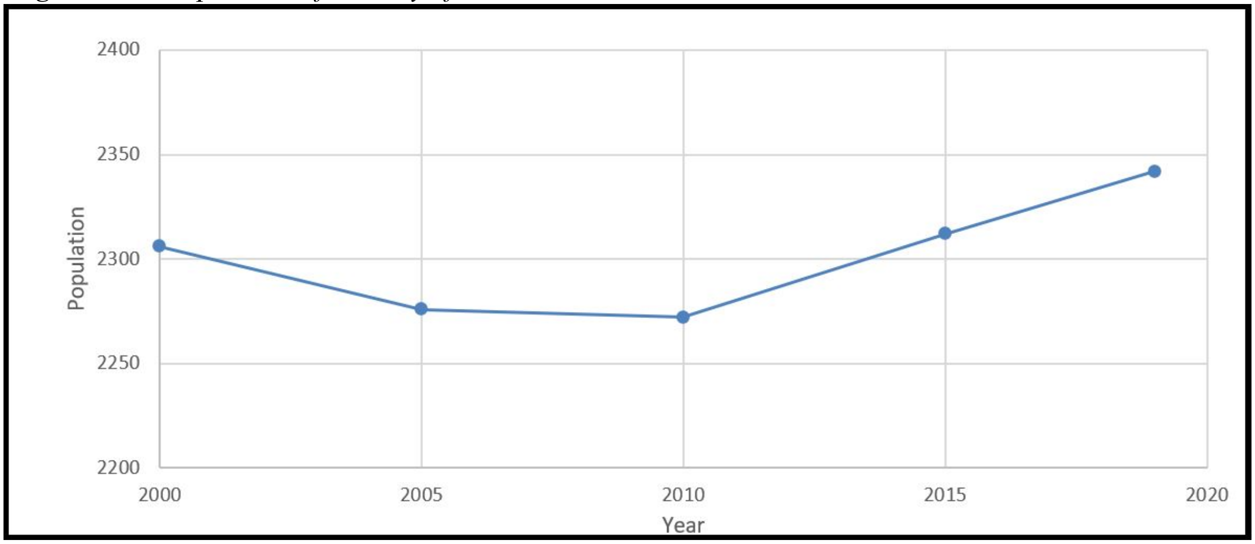


Note: From Texas Real Estate Research Center at Texas A&M University

6.8.2 City of East Bernard

According to 2019 U.S. Census data, the population of the City of East Bernard increased approximately 1.5% from 2000 to 2019, as shown in Figure 6-22. Building permits for the City of East Bernard are managed by Wharton County – see section 6.8.1 for historical building permit trends in Wharton County. According to the U.S. Census Bureau estimates for 2015-2019, 997 homes in the City of East Bernard are single-family housing units and 65 are mobile homes.

Figure 6-22. Population of the City of East Bernard

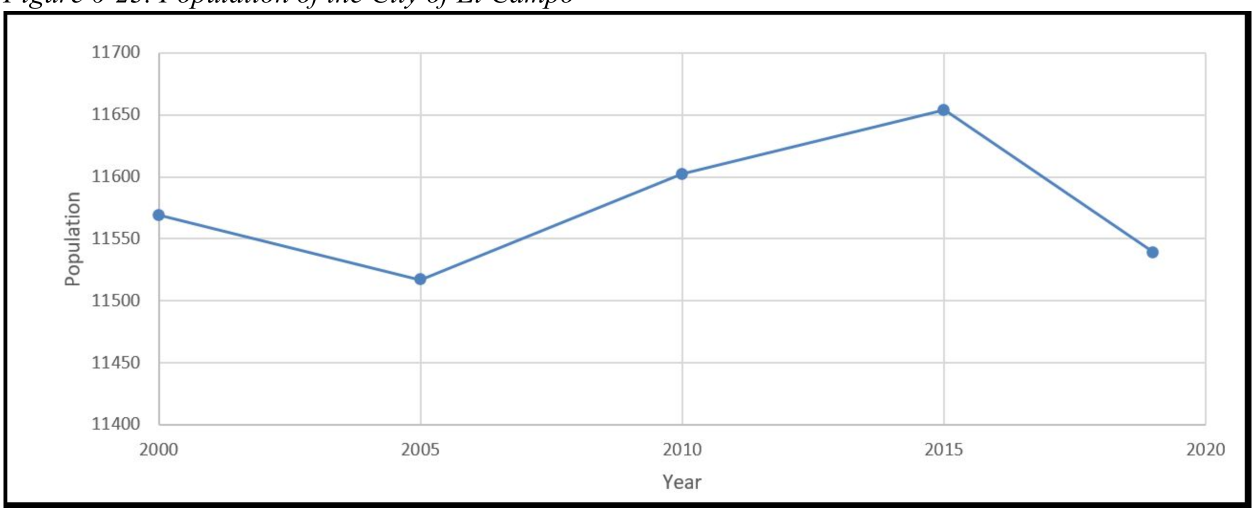


Note: From U.S. Census Bureau

6.8.3 City of El Campo

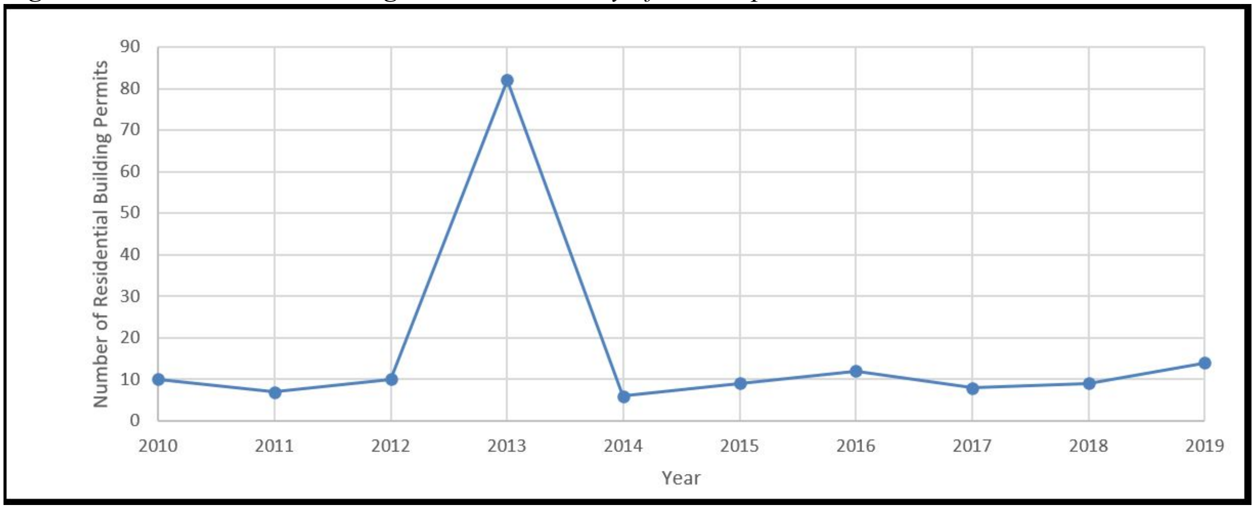
According to 2019 U.S. Census estimates, the population of the City of El Campo decreased approximately 0.25% from 2000 to 2019, as shown in Figure 6-23. The number of residential building permits reported in the City of El Campo fluctuated between 2010 and 2019, hitting a high of 82 permits in 2013, as shown in Figure 6-24. New residential building permits issued since 2010 will result in an increased vulnerability within the City of El Campo. According to the 2019 American Community Survey 5-year estimates, 4,615 homes in the City of El Campo are single-family homes and 281 are mobile homes.

Figure 6-23. Population of the City of El Campo



Note: From U.S. Census Bureau

Figure 6-24. Residential Building Permits in the City of El Campo

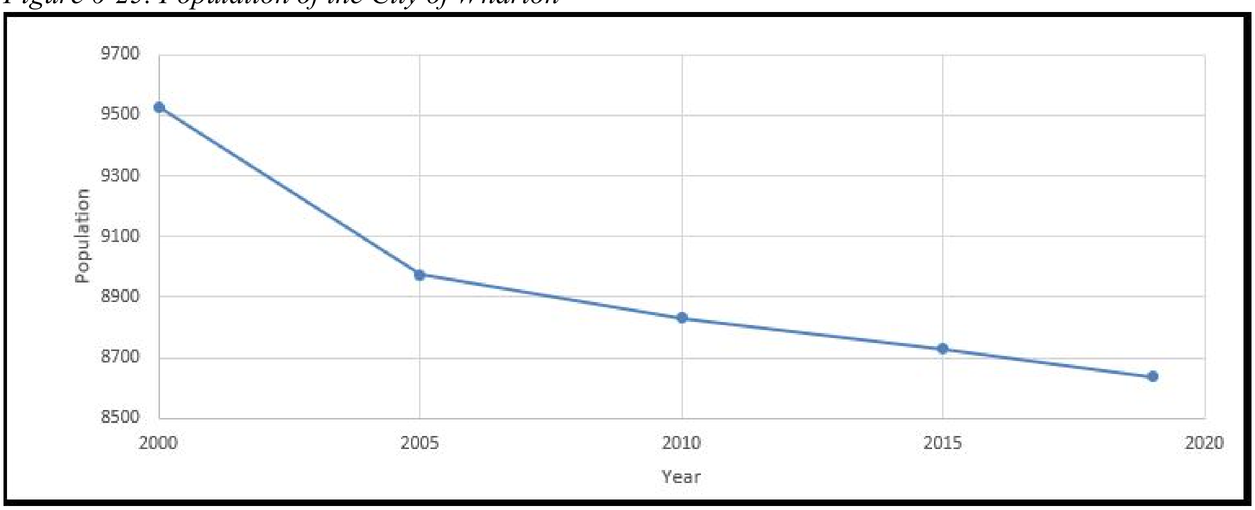


Note: From City-Data.Com: El Campo

6.8.4 City of Wharton

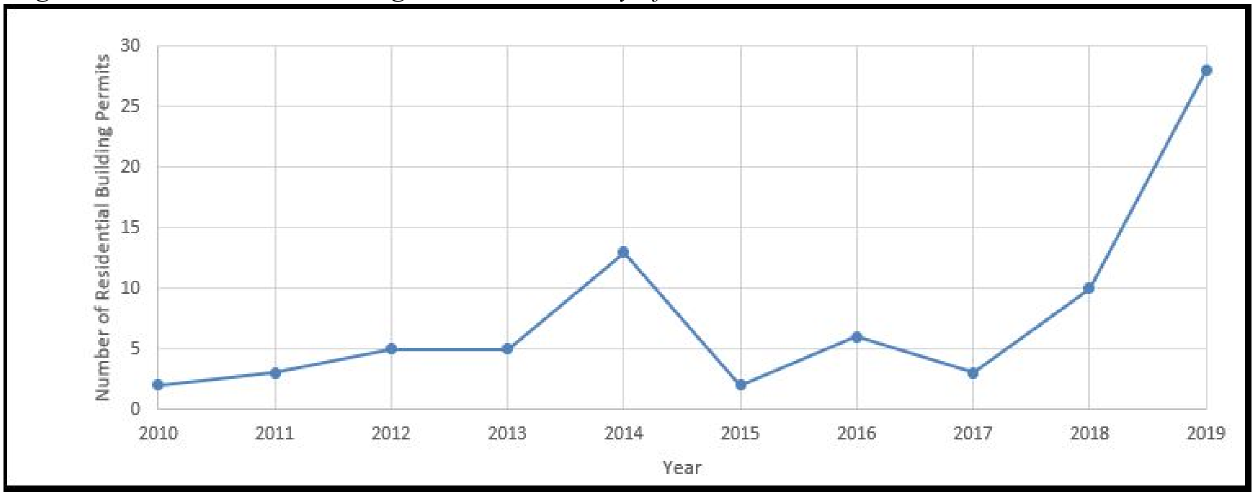
According to 2019 U.S. Census estimates, the population of the City of Wharton decreased approximately 9.4% from 2000 to 2019, as shown in Figure 6-25. The number of residential building permits reported in the City of Wharton trended positively over the last 10 years, spiking in 2019 (28 permits) and began to increase from a low in 2015 as shown in Figure 6-26. The City of Wharton will be impacted and vulnerability will be increased as a result of the residential building permits issued since 2010. According to the 2019 U.S. Census estimates, 3,968 homes in the City of Wharton are single-family homes and 353 are mobile homes.

Figure 6-25. Population of the City of Wharton



Note: From U.S. Census Bureau

Figure 6-26. Residential Building Permits in the City of Wharton



Note: From City-Data.Com: Wharton

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 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 grand 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 comments 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."

The 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. The 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. Wharton County and the Cities of East Bernard, El Campo, and Wharton participate in the NFIP and have adopted regulations that meet the NFIP requirements. At the time of the preparation of this plan, Wharton County and the Cities of East Bernard, El Campo, and Wharton 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 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 State 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 the 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. It's 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 State Health Services 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."

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 Wharton County

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

- County Judge
- Commissioners' Court
- County Attorney
- County Clerk
- County Treasurer
- County Tax Assessor/Collector
- Constable
- Sheriff
- Drainage
- Justice of the Peace
- County Auditor
- Indigent Healthcare
- Elections
- Information Technology
- Child Support
- Permits/Inspections
- 911 Addressing
- Veterans Services

Wharton County has multiple plans and functions in place that guide growth and development within the county. The county also has an Economic Development Corporation. Excerpts from applicable policies, regulations, and plans, and program descriptions follow to provide more detail on existing mitigation capabilities.

Wharton County Master Subdivision Policy, 2005 (as amended)

The Wharton County Master Subdivision Policy established rules, regulations, and standards governing the subdivision of land within the unincorporated areas of Wharton County. The Commissioners' Court has the authority to renew, approve, issue variances, or disapprove of any plat submitted under this policy.

The county currently has regulations that limit lot sizes down to one acre with some limitations. It also established standards and specifications for the construction of roads and drainage, utilities, private sewage facilities, and development within the floodplain. 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 Wharton County.

Wharton County's Flood Damage Prevention Order

The Flood Damage Prevention Order established the Wharton County Permit and Inspection Department as the governing body 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 floodwaters; (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 floodwaters or which may increase flood hazards to other lands.

The order appoints the Director of the Wharton County Permit & Inspection Department the Floodplain Administrator. The duties and responsibilities of the Floodplain Administrator are outlined in section B of the document.

Drainage Fee Ordinance, 2011(as amended)

The drainage fee ordinance requires a review of Engineering Plans for compliance with Federal, State, and County Ordinances to reduce flood risk and damages. Drainage reviews shall be performed on the following: single-family residential developments, commercial/industrial developments, roadway creek crossing projects, conditional letter of map revision review, linear pipeline projects, public improvements construction phase inspections, reviews and close-out, and subdivision plats without public improvements. The fee will be added to that of the Wharton County Development Permit fee and the Wharton County Commissioners Court has the right to grant a variance to the ordinance as it deems appropriate.

Wharton County Floodplain Map

The current floodplain maps from FEMA are dated 12/21/2017.

Wharton County Basic Emergency Operations Plan, 2019

The Wharton County Basic Emergency Operations Plan (EOP) covers the entire county including the Cities of East Bernard, El Campo, Wharton. The EOP is jointly signed by all participants. The EOP outlines the joint approach to emergency operations. It provides general guidance for emergency management activities and an overview of methods of mitigation, preparedness, response, and recovery. The plan describes participating emergency response organizations and assigns responsibilities for various emergency tasks. The plan is intended to provide a framework for more specific functional annexes that describe in more detail who does what, when, and how. The plan applies to all local officials, departments, and agencies within the communities of Wharton County, and the Cities of Wharton, El Campo, and East Bernard. The primary audience for the document includes the chief elected official and other elected officials of each jurisdiction, the emergency management staff members, department and agency heads and their senior staff members, leaders of local volunteer organizations that support emergency operations, and others who may participate in mitigation, preparedness, response, and recovery efforts. A hazard assessment is also included.

Wharton County Office of Emergency Management

The Wharton County Office of Emergency Management coordinates with all county fire and EMS services to prepare and plan for emergencies in Wharton County. In addition, communication is maintained with state and federal agencies for coordination in the event of large disasters, natural or manmade.

Wharton County Commissioners' Court

The Wharton County Commissioners' Court consist of the County Judge and four Commissioners. The court is responsible for approving the platting and enforcing the subdivision rules.

Wharton County Economic Development Corporation

The Wharton County Economic Development Corporation (WEDC), a nonprofit industrial development corporation, was formed in March 1998 with the passage of the one-half-cent sales tax increase. WEDC functions under the City of Wharton, Texas, pursuant to Article 5190.6, Section 4B of the Development Corporation Act of 1979, as amended. Expenditures of the tax revenues are intended for the development of commercial, industrial, and manufacturing enterprises and to promote and encourage employment and public welfare. The purpose for the corporation and constituents include:

- Develop a positive climate for business and industrial growth and investment.
- Assist in the creation of jobs.
- Increase the tax base of the various taxing entities.
- Diversify the local economy to make it more impervious to state and national economic recession.
- Make plans and take necessary actions to ensure that essential infrastructure is in place to allow for proper development.
- Take necessary actions to stop negative developments from occurring that would denigrate the quality of life in the city or impede future development.
- Act as a catalyst for solutions to problems that cross geopolitical boundaries.

6.9.4 City of East Bernard

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

- Municipal Court

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

City of East Bernard Comprehensive Plan, 2005

The City of East Bernard Comprehensive Plan was created in 2005 in conjunction with the LCRA. The comprehensive plan lays out recommendations for the City of East Bernard and attempts to balance long-term, expensive projects, such as developing a recreation center, with smaller, faster projects, such as a Yard of the Month program. The purpose of the smaller projects is to have some early, quick successes that will build additional community support for the more challenging projects. Because the City of East Bernard is a new city with very limited resources, the plan draws upon many other community organizations, notably the Chamber of Commerce, for implementation. The plan has the following chapters, each of which serves a role in the overall comprehensive plan.

- Baseline Analysis
- Land Use
- Growth Management
- Community Development
- Economic Development
- Housing

- Implementation Guide
- Resources

City of East Bernard Code of Ordinances

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

General Ordinance

- Establishment of the East Bernard Emergency Management Coordinator
- Identification of the powers, duties, and responsibilities of the Emergency Management Director
- Development of an emergency management plan to establish and designate divisions and functions; assign responsibilities, tasks, duties, and powers; and designate officers and employees to carry out the provisions of this division

Building Ordinance

- Building permit requirements (June 15, 2009)
- Adoption of the International Building Code, 2015 edition (March 19, 2018)

Flood Damage Prevention Ordinance (June 23, 2004)

- Methods of reducing flood losses
- The basis for establishing the areas of special flood hazard and permitting requirements
- Designation, duties, and responsibilities of the floodplain administrator
- Permit and variance procedures for a floodplain development permit
- Provisions for flood hazard reduction
- Construction standards for new construction and substantial improvements to minimize flood damage
- Review of proposed subdivisions and land use areas to minimize flood
- Penalties for noncompliance

Subdivision Regulations

- This chapter includes the purpose of the subdivision regulations and establishes established rules, regulations, and standards governing the subdivision of land within the city. It established standards and specifications for the construction of roads and drainage, private sewage facilities, and development within the floodplain (November 18, 2019)

City of East Bernard Emergency Management

The City of East Bernard Emergency Management coordinates with local fire and EMS services to prepare and plan for emergencies in the City of East Bernard. In addition, communication is maintained with county, state and federal agencies for coordination in the event of large disasters, natural or manmade.

6.9.5 City of El Campo

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

- City Administration
- Finance
- Municipal Court
- Human Resources
- Inspections & Planning
- Public Works
- Parks and Recreation
- Utilities
- Public Safety

The City of El Campo has multiple plans and functions in place that guide growth and development within the community. The city also has the following citizen committees, boards and commissions: Board of Adjustment; Planning and Zoning; Northside Board; Building Standard Commission; Housing Authority Board; Charter Review Commission; Parks Recreation and Community Services Board; City Development Corporation; City Development Corporation; Keep El Campo Beautiful. Excerpts from applicable policies, regulations, and plans, and program descriptions follow to provide more detail on existing mitigation capabilities.

El Campo Office of Emergency Management

The City of El Campo Office of Emergency Management coordinates with local fire and EMS services to prepare and plan for emergencies in the City of El Campo. In addition, communication is maintained with county, state and federal agencies for coordination in the event of large disasters, natural or manmade.

El Campo Comprehensive Plan Update 2017

The City of El Campo 2020 Plan, was originally developed in 1999 and has been updated to the *El Campo Comprehensive Plan Update 2017*. An update was conducted to ensure the plan remains responsive to the needs and vision of the community. The 2017 Update includes three phases: (1) Community Vision, Community Profile, and Land Use Updates; (2) Utility Infrastructure & Transportation; (3) Parks and Recreation, Housing Strategies, and Implementation Plan. The city and various commissions use the plan to help the city budget, prepare for, and manage growth. The plan is cover housing, land use, and other aspects pertinent to the proper growth of a city.

City of El Campo Code of Ordinances

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

Chapter 1 – General Provisions

- Creation of the Parks, Recreation, and Community Services Board to advise the city council on activities and policies concerning parks, recreation, El Campo Civic Center, and the City of El Campo Aquatic Center. (1988 Code, Ch. 8, sec. 11.01; 2010 Code, sec. 2-106; Ordinance 2018-15 adopted 6/11/18 Ch. 1, sec. 3-31)
- Standard of care for emergency action (1988 Code, Ch. 1, sec. 2.00; Ordinance 1986-12, adopted 5/27/86; 2010 Code, sec. 2-134; Ch. 1, sec. 2-1)
- Establishment of the El Campo Emergency Management Organization (1988 Code, ch. 1, sec. 8.01; Ordinance 1988-09, sec. 1, adopted 7/26/88; 2010 Code, sec. 14-1; Ch. 1, sec. 4-1)

- Identification of the powers, duties, and responsibilities of the Emergency Management Director (1988 Code, ch. 1, sec. 8.02; Ordinance 1988-09, sec. 2, adopted 7/26/88; 2010 Code, sec. 14-2; Ch. 1, sec. 4-2)
- Development of an emergency management plan to establish and designate divisions and functions; assign responsibilities, tasks, duties, and powers; and designate officers and employees to carry out the provisions of this division (State law reference–Local and inter-jurisdictional emergency management plans, V.T.C.A., Government Code, sec. 418.106)

Chapter 3 – Building Regulations

- Adoption of the International Building Code, 2015 edition (1988 Code, Ch. 3, sec. 2.01; Ordinance 1996-12, adopted 6/11/96; Ordinance 2006-06, sec. 1(2.01), adopted 3/28/06; Ordinance 2013-11, sec. 1, adopted 7/8/13; 2010 Code, sec. 10-40; Ordinance 2017-15A, sec. 1(A), adopted 12/11/17; Ch. 3, sec. 2-31)
- Building permit requirements (Ordinance 2006-06, sec. 1(2.02), adopted 3/28/06; 2010 Code, sec. 10-41; Ch. 3, sec. 2-32)
- Description of enforcement, authorization, and purpose of the Floodplain administrator (Ordinance 2006-02, exh. A, sec. 8.13, adopted 3/14/06; 2010 Code, sec. 10-353; Ch. 3 sec, 4-13)
- Methods of reducing flood losses (Ordinance 2006-02, exh. A, sec. 8.04, adopted 3/14/06; 2010 Code, sec. 10-345; Ch. 3, sec 4-5)
- Standards for flood hazard reduction (Ordinance 2006-02, exh. A, sec. 8.16, adopted 3/14/06; 2010 Code, sec. 10-356; Ch. 3, sec. 4-16)
- Standards for areas of shallow flooding (AO/AH zones) and floodways (Ordinance 2006-02, exh. A, sec. 8.19, adopted 3/14/06; 2010 Code, sec. 10-359; Ch 3, sec. 4-19)
- Permit and variance procedures for a floodplain development permit (Ordinance 2006-02, exh. A, sec. 8.14, adopted 3/14/06; 2010 Code, sec. 10-354; Ch. 3, sec.4-14)
- Construction standards for new construction and substantial improvements to minimize flood damage (Ordinance 2006-02, exh. A, sec. 8.14, adopted 3/14/06; 2010 Code, sec. 10-354; Ch. 3, sec. 4-14-b-4)

Chapter 5 – Fire Prevention and Protection

- Adoption of International Fire Code, 2015 edition, and appendicies B, C, D, E, and H (1988 Code, ch. 5, sec. 9.01; Ordinance 1996-09, adopted 6/11/96; Ordinance 2006-08, sec. 1(9.01), adopted 4/25/06; 2010 Code, sec. 18-53; Ordinance 2017-19, sec. 1 (18-23), adopted 11/13/17; Ordinance 2019-06 adopted 2/25/19; Ordinance 2019-09 adopted 4/22/19)
- Regulations on the use, possession, and sale of fireworks (1988 Code, ch. 5, sec. 9.02; Ordinance 1996-09, adopted 6/11/96; Ordinance 2006-08, sec. 1(9.02), adopted 4/25/06; 2010 Code, sec. 18-54; Ordinance 2017-19, sec. 1 (18-24), adopted 11/13/17; Ordinance 2019-06 adopted 2/25/19; Ordinance 2019-09 adopted 4/22/19; Ordinance 2020-01 adopted 1/13/20; Ch 5, Sec 2-2-5601.1)
- (1988 Code, ch. 5, sec. 9.02; Ordinance 1996-09, adopted 6/11/96; Ordinance 2006-08, sec. 1(9.02), adopted 4/25/06; 2010 Code, sec. 18-54; Ordinance 2017-19, sec. 1 (18-24), adopted 11/13/17; Ordinance 2019-06 adopted 2/25/19; Ordinance 2019-09 adopted 4/22/19; Ordinance 2020-01 adopted 1/13/20; Ch 5, Sec 2-2-202)

Chapter 9 – Personnel

- Designation of the Building Official, roles, responsibilities, and authorities (1988 Code, Ch. 8, sec. 5.00; Ordinance adopted 6/16/69, secs. 2–5; 2010 Code, sec. 2-22; Ordinance adopting 2018 Code; Ch. 9, sec. 2-2)
- Chapter 10 – Unified Development Code
- Subdivision regulations – purpose and intent (Ordinance 2014-08, sec. I (exh. A), adopted 9/8/14; 2010 Code, sec. 38-1; Ordinance 2019-02 adopted 3/25/19; Ordinance 2019-12 adopted 4/22/19; Ch 10, Sec. 12-1)
- Establishes construction requirements for subdivisions (Ordinance 2014-08, sec. I (exh. A), adopted 9/8/14; 2010 Code, sec. 38-22; Ordinance 2019-02 adopted 3/25/19; Ordinance 2019-12 adopted 4/22/19; Ch. 10, sec. 12-22)
- Establishment of zoning districts (Ordinance 2000-09, exh. A, sec. 4.A, adopted 8/8/00; Ordinance 2004-09, exh. A, adopted 5/25/04; 2010 Code, sec. 50-87; Ordinance 2019-12 adopted 4/22/19)
- Infrastructure standards and plan requirements (Ordinance 2012-02, sec. 3, adopted 4/23/12; 2010 Code, sec. 46-88; Ordinance 2019-12 adopted 4/22/19)

City of El Campo Office of Municipal Services

Based on the close proximity to the Gulf of Mexico, the City of El Campo has conducted extensive hurricane response planning. Standard operating procedures have been developed with roles, responsibilities, checklists, and staffing assignments pre- and post-landfall. Topic areas include streets and bridges, debris clearance, high water, parks, utilities, water plant, equipment maintenance, damage assessment, and incident command.

City of El Campo Emergency Medical Services

The City of El Campo EMS Department consists of 17 full-time medics. The department also has 25 part-time medics. The City of El Campo EMS operates at the Mobile Intensive Care Level. The EMS department has five in-service Type I ambulances and one Type II ambulance.

City of El Campo Code Enforcement

The City of El Campo maintains a Building Official to ensure city ordinances are being upheld. The duty of the Building Official is to enforce all laws relating to the construction, alteration, removal, and demolition of buildings and structures.

City of El Campo Citizen Committees, Boards and Commissions

The following citizen committees, boards and commissions assist in the governance of the City of El Campo.

- **Board of Adjustment:** Hears and decides appeals for interpretations, special exceptions, and variances to the terms of the zoning ordinance, as well as permits.
- **Planning and Zoning:** Recommends changes in development codes and zoning ordinances to City Council. Makes studies and recommendations with regards to proposed annexations. Has final authority over all plats submitted to the City.

- **Northside Board:** Guides and provides feedback and assistance to the Northside Education Center concerning maintenance and operations of the Center.
- **Building Standards Commission:** The Building Standards Commission will advise the City Council on policies and matters concerning plumbing, electrical, mechanical, and building codes and permitting of the City of El Campo.
- **Housing Authority Board:** Guides the Housing Authority by setting policy and providing leadership and oversight that enables the Housing Authority to reach its goals and advance its mission of providing quality, affordable housing options.
- **Charter Review Commission:** Advises council on any additions, edits, or revisions to the city's charter.
- **Parks, Recreation, and Community Services Board:** The Parks, Recreation and Community Services Board will advise the City Council on activities and policies concerning parks, recreation, the El Campo Civic Center, and the City of El Campo Aquatic Center.
- **City Development Corporation:** Aids in the economic development of the city. Provides guidance and feedback to the council regarding the use of 4A sales tax.
- **Keep El Campo Beautiful:** The Keep El Campo Beautiful Board is an advisory board to staff and City Council with the goals and purposes of the Keep El Campo Beautiful program and shall participate with Keep Texas Beautiful, Inc. "To promote public interest in creating a cleaner, more beautiful El Campo through volunteerism and education."

6.9.6 City of Wharton

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

- City Secretary
- Finance Department
- Police Department
- Fire Department
- Code Enforcement
- Municipal Court
- Public Works Department
- Facilities Maintenance
- Community Services
- Emergency Medical Services
- Civic Center
- Airport

The City of Wharton has multiple plans and functions in place that guide growth and development within the community. The city also has the following boards and commissions: Airport Board, Beautification City Commission, Building Standards Commission, Electrical Board, Housing Finance Corporation, Mayor's Committee on People with Disabilities, Planning Commission, Plumbing and Mechanical Board, Wharton Economic Development Corporation. Excerpts from applicable policies, regulations, and plans, and program descriptions follow to provide more detail on existing mitigation capabilities.

City of Wharton Code of Ordinances

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

Article XII. – Planning and Zoning
Provisions under this chapter include:

- Establishing a Planning Commission, powers, and duties (Ord. No. 78-3, § 7, 2-13-78)
- Requirements for a master plan for the growth, development, and beautification of the city (Ord. No. 78-3, § 7, 2-13-78)

Chapter 6 – Aircraft and Airports
Provisions under this chapter include:

- Establishment of airport zoning regulations (Code 1978, § 3-36)
- Establishment of the board of adjustment and their powers, policies, and procedures (Code 1978, § 3-38)

Chapter 18 – Buildings and Construction
Provisions under this chapter include:

- Establishment of fire zone limits (Code 1978, § 6-6)
- Establishment of a Building Official qualification and duties (Code 1978, § 6-1 & Code 1978, § 6-2)
- Criteria for issuance of building permit (Ord. No. 1997-01, 1-13-97; Ord. No. 2004-13, 8-9-04; Ord. No. 2014-13, 12-18-2014; Ord. No. 2017-10, 8-28-17)
- Adoption of the International Building Code, 2018 edition (Ord. No. 2000-18, § I, 9-11-00; Ord. No. 2002-11, § I, 5-28-02; Ord. No. 2006-21, 10-23-06; Ord. No. 2012-11, 9-10-12; Ord. No. 2019-19, 8-26-19)
- Establishment of the Building Standards Commission, powers, and duties (Ord. No. 2017-05, 2-13-17)
- Description of enforcement, authorization, and purpose of the Standard for Floodplain Management (Ord. No. 2006-06, 3-13-06; Ord. No. 2009-04, 5-26-09; Ord. No. 2017-15, 12-11-17)
- Methods of reducing flood losses (Ord. No. 2006-06, 3-13-06))
- Basis for establishing the areas of special flood hazard and permitting requirements (Ord. No. 2006-06, 3-13-06; Ord. No. 2009-04, 5-26-09; Ord. No. 2017-15, 12-11-17)
- Designation, duties, and responsibilities of the floodplain administrator (Ord. No. 2006-06, 3-13-06)
- Permit and variance procedures for a floodplain development permit (Ord. No. 2006-06, 3-13-06)
- Construction standards for new construction and substantial improvements to minimize flood damage (Ord. No. 2006-06, 3-13-06; Ord. No. 2009-04, 5-26-09; Ord. No. 2017-15, 12-11-17)
- Review of proposed subdivisions and land use areas to minimize flood damage (Ord. No. 2006-06, 3-13-06; Ord. No. 2009-04, 5-26-09; Ord. No. 2017-15, 12-11-17)

Chapter 26 – Emergency Management
Provisions under this chapter include:

- Establishment of the Wharton Emergency Management Organization (Code 1978, § 7-1; Ord. No. 2003-08, 8-11-03)

- Identification of the powers, duties, and responsibilities of the Emergency Management Director (Code 1978, § 7-2)
- Development of an emergency management plan to establish and designate divisions and functions; assign responsibilities, tasks, duties, and powers; and designate officers and employees to carry out the provisions of this division (Code 1978, § 7-3)

Chapter 27 – Emergency Medical Services
Provisions under this chapter include:

- Agreement with Emergency Services District (ESD) #3 to provide EMS services for their established service area including the city (Ord. No. 2011-08(Corr.), 5-9-2011)

Chapter 30 – Fire Prevention and Protection
Provisions under this chapter include:

- Adoption of the International Fire Code, 2018 edition (Ord. No. 2000-18, § I, 9-11-00; Ord. No. 2002-11, § I, 5-28-02; Ord. No. 2006-21, 10-23-06; Ord. No. 2012-11, 9-10-12; Ord. No. 2019-19, 8-26-19)
- Creation of the Office of Fire Marshal (Ord. No. 2012-15, 10-22-12)
- Regulations on the use, possession, and sale of fireworks (Ord. No. 2012-15, 10-22-12)

Chapter 34 – Health and Sanitation
Provisions under this chapter include:

- Ban on outdoor burning (Code 1978, § 9-1)

Appendix A. Subdivisions
Provisions under this chapter include:

- Established rules, regulations, and standards governing the subdivision of land (Ord. No. 82-8, 3-22-82; Ord. No. 87-4, 2-9-87)
- Defines the process and permits required (Ord. No. 82-8, 3-22-82; Ord. No. 87-4, 2-9-87)
- It established standards and specifications for the construction of roads and drainage (Ord. No. 73-2, 1-22-73; Ord. No. 75-22, 11-10-75; Ord. No. 76-25, 12-13-76; Ord. No. 82-6, 3-8- 82; Ord. No. 2004-10, 4-12-04; Ord. No. 2013-11, 6-10-13)

City of Wharton Planning Commission

The Planning Commission is charged with the review, investigation, and recommendation of land use within the City of Wharton. The purpose and goals of the commission are to:

- Make and amend a master plan for the physical development of the city.
- Report to the council proposed zoning regulations and land use plan, and its approval or disapproval of proposed future changes in the zoning plan.
- Exercise control over platting and the subdividing of land within the corporate limits of the city and within an area extending one mile beyond the corporate limits.
- Submit recommended capital improvements for the forthcoming five (5) year period

City of Wharton Economic Development Corporation

The Wharton Economic Development Corporation (WDEC)is dedicated to creating opportunities for economic development through desirable business growth. WDEC manages the affairs of the City's 4B Corporation which promotes economic development in order to eliminate unemployment and underemployment and to promote and encourage employment and the public welfare of, for, and on behalf of the city by developing, purchasing, leasing, implementing, providing, and financing projects.

City of Wharton Floodplain Management

The City of Wharton maintains a Floodplain Administrator appointed by the city manager to ensure and implement the provision of the Wharton County Code of Ordinances and other appropriate sections of 44 CFR (Emergency Management and Assistance – National Flood Insurance Program Regulations) pertaining to floodplain management.

City of Wharton Volunteer Fire Department

The City of Wharton Volunteer Fire Department (VFD) provides fire, rescue, and HAZMAT services for the city and surrounding areas. The department provides automatic mutual aid with Glen Flora VFD, Hungerford VFD, and Boling VFD. The department also maintains a mutual aid agreement with all of Wharton County.

City of Wharton Code Enforcement Department

The City of Wharton Code Enforcement Department is responsible for interpreting and enforcing various city ordinances adopted but the City Council governing nuisances, health, and safety issues, and use of property within the community. Code Enforcement staff works with citizens, property owners, and businesses to achieve and maintain compliance.

City of Wharton Office of Emergency Management

The City of Wharton Office of Emergency Management coordinates with all county fire and EMS services to prepare and plan for emergencies in the City of Wharton. In addition, communication is maintained with county, state, and federal agencies for coordination in the event of large disasters, natural or manmade.

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 WHARTON 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 Wharton County.

TABLE 7-1.
WHARTON COUNTY REGULATORY MITIGATION CAPABILITIES MATRIX

Regulatory Tool (ordinances, codes, plans)	Yes/No	Comments
General plan	No	
Zoning ordinance	No	
Subdivision ordinance	Yes	Wharton County Master Subdivision Policy, 2005 (as amended)
Growth management	No	
Floodplain ordinance	Yes	Flood Damage Prevention Order signed October 22, 2001.
Other special-purpose ordinances (stormwater, steep slope, wildfire)	Yes	Drainage Master Plan, 2010
Building code	No	
Erosion or sediment control program	No	Erosion and sediment control are managed by TCEQ via the general permit with EPA and LCRA
Stormwater management	Yes	Drainage Criteria Manual, 2010
Site plan review requirements	Yes	Contracted to Scheibe Consulting, LLC
Capital improvement plan	No	
Economic development plan	No	
Local emergency operations plan	Yes	Wharton County Basic Emergency Operations Plan
Other special plans	Yes	Wharton County Traffic Safety and Control Plan

TABLE 7-1. WHARTON COUNTY REGULATORY MITIGATION CAPABILITIES MATRIX		
Regulatory Tool (ordinances, codes, plans)	Yes/No	Comments
Flood insurance study or other engineering study for streams	Yes	The Permit and Inspection 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 flood insurance rate maps in conjunction with the NFIP.
Elevation certificates	Yes	The Commissioners' Court of Wharton County keeps records of flood elevation certificates on file in its office.

Notes:

FEMA Federal Emergency Management Agency

FIRM Flood Insurance Pate Map

NFIP National Flood Insurance Program

EPA Environmental Protection Agency

7.1.2 Administrative and Technical Capabilities

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

TABLE 7-2. WHARTON COUNTY ADMINISTRATIVE/TECHNICAL MITIGATION CAPABILITIES MATRIX		
Personnel Resources	Yes/No	Department/Position
Planner/engineer with knowledge of land development/land management practices	No	Outsourced – Scheibe Consulting, LLC
Engineer/professional trained in construction practices related to buildings or infrastructure	No	Outsourced – Scheibe Consulting, LLC
Planner/engineer/scientist with an understanding of natural hazards	No	Outsourced – Scheibe Consulting, LLC
Personnel skilled in GIS	No	Outsourced – Scheibe Consulting, LLC
Full-time building official	Yes	Managed by the county (when necessary)
Floodplain manager	Yes	Permits & Inspections (Monica Martin)
Emergency manager	Yes	Judge; Emergency Management Coordinator (Andy Kirkland)
Grant writer	No	Outsourced as needed
Other personnel	No	
GIS data: Hazard areas	No	Outsourced – Scheibe Consulting, LLC
GIS data: Critical facilities	No	Outsourced – Scheibe Consulting, LLC

TABLE 7-2. WHARTON COUNTY ADMINISTRATIVE/TECHNICAL MITIGATION CAPABILITIES MATRIX		
Personnel Resources	Yes/No	Department/Position
GIS data: Building footprints	No	Outsourced – Scheibe Consulting, LLC
GIS data: Land use	No	Outsourced – Scheibe Consulting, LLC
GIS data: Links to Assessor's data	No	Outsourced – Scheibe Consulting, LLC
Warning systems/services (Reverse 911 callback, cable override, outdoor warning signals)	Yes	Nixle reverse 911 notification system, neighborhood warning procedures; Wharton County manages
Other	Yes	Local Radio Station; Social Media
Notes: GIS Geographic Information System		

7.1.3 Financial Capabilities

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

TABLE 7-3. WHARTON COUNTY FINANCIAL MITIGATION CAPABILITIES MATRIX	
Financial Resources	Accessible/Eligible to Use (Yes/No)
Community Development Block Grants	Yes
Capital improvements project funding	No
Authority to levy taxes for specific purposes	Yes
Fees for water, sewer, gas, or electric services	No
Impact fees for new development	No
Incur debt through general obligation bonds	Yes; No current debt
Incur debt through special tax bonds	No
Incur debt through private activities	No
Withhold spending in hazard-prone areas	No
Other	No

7.2 CITY OF EAST BERNARD

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 East Bernard.

TABLE 7-4. CITY OF EAST BERNARD REGULATORY MITIGATION CAPABILITIES MATRIX		
Regulatory Tool (ordinances, codes, plans)	Yes/No	Comments
General plan	Yes	East Bernard Comprehensive Plan was created in 2005 to help the city prepare for and manage growth.
Zoning ordinance	No	
Subdivision ordinance	Yes	East Bernard Subdivision Policy signed November 18, 2019
Growth management	No	
Floodplain ordinance	Yes	Adopted the Standard for Floodplain Management (2004).
Other special-purpose ordinances (stormwater, steep slope, wildfire)	No	
Building code	Yes	East Bernard adopted the International Building Code and International Residential Code (2015 editions).
Erosion or sediment control program	No	Erosion and sediment control are managed by TCEQ via the general permit with EPA.
Stormwater management	No	Stormwater management is managed by the LCRA.
Site plan review requirements	Yes	Contracted to the county.
Capital improvements plan	No	
Economic development plan	No	
Local emergency operations plan	No	East Bernard works in conjunction with the Wharton County Emergency Management.
Other special plans	No	East Bernard Comprehensive Traffic Safety and Control Plan
Flood insurance study or other engineering study for streams	Yes	FEMA floodplain maps indicate flood insurance is necessary along the San Bernard River.
Elevation certificates	No	The Commissioners' Court of Wharton County keeps records of flood elevation certificates on file in its office.

Notes:
FEMA Federal Emergency Management Agency
LCRA Lower Colorado River Authority
TCEQ Texas Commission on Environmental Quality
EPA Environmental Protection Agency

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 East Bernard.

**TABLE 7-5.
CITY OF EAST BERNARD ADMINISTRATIVE/TECHNICAL MITIGATION CAPABILITIES MATRIX**

Personnel Resources	Yes/No	Department/Position
Planner/engineer with knowledge of land development/land management practices	No	Outsourced to Kelly Kaluza Inc.
Engineer/professional trained in construction practices related to buildings or infrastructure	No	Outsourced to the county (when necessary); Permits & Inspections (Monica Martin)
Planner/engineer/scientist with an understanding of natural hazards	No	Outsourced to Kelly Kaluza Inc.
Personnel skilled in GIS	No	
Full-time building official	No	Managed by the county (when necessary)
Floodplain manager	No	Outsourced to the County (when necessary); Permits & Inspections (Monica Marton)
Emergency manager	Yes	City Secretary
Grant writer	No	Outsourced 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 911 callback, cable override, outdoor warning signals)	No	Management of the Callback system is Wharton Co.
Other	Yes	The local radio stations and social media

Notes:
GIS Geographic Information System

7.2.3 Financial Capabilities

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

TABLE 7-6. CITY OF EAST BERNARD FINANCIAL MITIGATION CAPABILITIES MATRIX	
Financial Resources	Accessible/Eligible to Use (Yes/No)
Community Development Block Grants	Yes
Capital improvements project funding	No
Authority to levy taxes for specific purposes	Yes
Fees for water, sewer, gas, or electric services	No
Impact fees for new development	No
Incur debt through general obligation bonds	Yes; No current debt
Incur debt through special tax bonds	No
Incur debt through private activities	No
Withhold spending in hazard-prone areas	No
Other	No

7.3 CITY OF EL CAMPO

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 El Campo.

TABLE 7-7. CITY OF EL CAMPO REGULATORY MITIGATION CAPABILITIES MATRIX		
Regulatory Tool (ordinances, codes, plans)	Yes/No	Comments
General plan	Yes	The El Campo Comprehensive Plan (updated 2017) was created to help the city prepare for and manage growth.
Zoning ordinance	Yes	Chapter 10, Unified Development Code – City of El Campo Zoning Ordinance (2000, as amended). UDC was adopted in 2019, but Zoning was approved well before.
Subdivision ordinance	Yes	Chapter 10, Article 10.12, Subdivision Regulations (2014, as amended).
Growth management	No	
Floodplain ordinance	Yes	Chapter 3, Article 3.04, Flood Damage Prevention (2006, as amended).
Other special-purpose ordinances (stormwater, steep slope, wildfire)	Yes	Adopted Stormwater Management Code, Chapter 14 in City Code. Reference Wharton Co. DCM (2020, as amended).
Building code	Yes	El Campo adopted the International Building Code and International Residential Code (2015 editions)
Erosion or sediment control program	Yes	Within Design Manual (2020, as amended).
Stormwater management	Yes	Within Design Manual (2020, as amended).

TABLE 7-7. CITY OF EL CAMPO REGULATORY MITIGATION CAPABILITIES MATRIX		
Regulatory Tool (ordinances, codes, plans)	Yes/No	Comments
Site plan review requirements	Yes	Managed by the Building Official and Public Works Department.
Capital improvements plan	Yes	2021 Capital Improvements Plan
Economic development plan	Yes	Managed by the City Development Corporation of El Campo who manages the use of 4A sales tax.
Local emergency operations plan	Yes	Public Safety Emergency Operations Plan
Other special plans	No	
Flood insurance study or other engineering study for streams	Yes	FEMA floodplain maps indicate flood insurance is necessary along the Tres Palacios and Blue Creek.
Elevation certificates	Yes	Building Official reviews Elevation Certificates.

Notes:
FEMA Federal Emergency Management Agency
UDC Unified Development Code
DCM Drainage Criteria Manual

7.3.2 Administrative and Technical Capabilities

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

TABLE 7-8. CITY OF EL CAMPO ADMINISTRATIVE/TECHNICAL MITIGATION CAPABILITIES MATRIX		
Personnel Resources	Yes/No	Department/Position
Planner/engineer with knowledge of land development/land management practices	Yes	City Planning Director; list of Engineering Consultants on an as-needed basis.
Engineer/professional trained in construction practices related to buildings or infrastructure	Yes	Public Works Department, Building Official, and City Planning Director; list of Engineering Consultants on an as-needed basis.
Planner/engineer/scientist with an understanding of natural hazards	Yes	Public Works Department, Building Official, and City Planning Director; list of Engineering Consultants on an as-needed basis.
Personnel skilled in GIS	Yes	Public Works Department, and Planning Department.
Full-time building official	Yes	Inspection Department
Floodplain manager	Yes	Public Works Department
Emergency Management Coordinator	Yes	Emergency Management Coordinator

TABLE 7-8. CITY OF EL CAMPO ADMINISTRATIVE/TECHNICAL MITIGATION CAPABILITIES MATRIX		
Personnel Resources	Yes/No	Department/Position
Grant writer	Yes	All departments; also use consultants on an as-needed basis.
Other personnel	No	
GIS data: Hazard areas	No	
GIS data: Critical facilities	No	
GIS data: Building footprints	No	
GIS data: Land use	Yes	Public Works Department and Planning Department
GIS data: Links to Assessor's data	Yes	Public Works Department and Planning Department
Warning systems/services (Reverse 911 callback, cable override, outdoor warning signals)	Yes	Smart 911 (Rave) system (Reverse 911 system).
Other	Yes	Local radio station; Social Media; bi-weekly newspaper.
Notes:		
GIS Geographical Information System		

7.3.3 Financial Capabilities

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

TABLE 7-9. CITY OF EL CAMPO 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	Water and Sewer utility fees
Impact fees for new development	No (Drainage Infrastructure Fee)
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	Yes

7.4 CITY OF WHARTON

7.4.1 Legal and Regulatory Capabilities

Table 7-10 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 Wharton.

TABLE 7-10.
CITY OF WHARTON REGULATORY MITIGATION CAPABILITIES MATRIX

Regulatory Tool (ordinances, codes, plans)	Yes/No	Comments
General plan	Yes	2018-2028 Wharton Comprehensive Plan was created in 2018 to help the city prepare for and manage growth.
Zoning ordinance	No	
Subdivision ordinance	Yes	Subdivision regulations are included in the Code of Ordinances Appendix A (1964, as amended).
Growth management	Yes	Growth management is accomplished through the 2018-2028 Wharton Comprehensive Plan.
Floodplain ordinance	Yes	Chapter 18 – Article VI, Flood Damage Prevention (2006, as amended).
Other special-purpose ordinances (stormwater, steep slope, wildfire)	Yes	Adopted Wharton County Drainage Criteria Manual. Working on putting together a Drainage Ordinance.
Building code	Yes	The City of Wharton adopted the International Building Code and International Residential Code (2018 editions).
Erosion or sediment control program	Yes	Erosion and sediment control are managed by TCEQ via the general permit with EPA. SWPPP controls are required as per Building Code
Stormwater management	Yes	Adopted Wharton County Drainage Criteria Manual. Working on putting together a Drainage Ordinance.
Site plan review requirements	Yes	Contracted to Jones and Carter and do some in-house reviews
Capital improvements plan	Yes	City of Wharton 2021 Proposed Budget: Street and Drainage
Economic development plan	Yes	Key policies and actions to guide economic development are managed by the Wharton Economic Development Advisory Board.
Local emergency operations plan	No	Wharton works in conjunction with the Wharton County Emergency Management/911 Coordinator.
Other special plans	No	
Flood insurance study or other engineering study for streams	Yes	FEMA floodplain maps indicate flood insurance is necessary along the Wharton River.

TABLE 7-10. CITY OF WHARTON REGULATORY MITIGATION CAPABILITIES MATRIX		
Regulatory Tool (ordinances, codes, plans)	Yes/No	Comments
Elevation certificates	Yes	City of Wharton Building Department keeps track of Elevation Certificates

Notes:
FEMA Federal Emergency Management Agency
LCRA Lower Colorado River Authority

7.4.2 Administrative and Technical Capabilities

Table 7-11 identifies the City of Wharton personnel responsible for activities related to mitigation and loss prevention.

TABLE 7-11. CITY OF WHARTON ADMINISTRATIVE/TECHNICAL MITIGATION CAPABILITIES MATRIX		
Personnel Resources	Yes/No	Department/Position
Planner/engineer with knowledge of land development/land management practices	No	Outsourced – Jones & Carter Engineering
Engineer/professional trained in construction practices related to buildings or infrastructure	Yes	Building Official
Planner/engineer/scientist with an understanding of natural hazards	Yes	Community Development Director
Personnel skilled in GIS	No	Outsourced - Jones & Carter Engineering
Full-time building official	Yes	Code Enforcement Department
Floodplain manager	Yes	Code Enforcement Department
Emergency manager	Yes	Emergency Management Coordinator
Grant writer	Yes	Community Development Director
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 911 callback, cable override, outdoor warning signals)	Yes	Rave – Reverse 911 Call-Back; Outdoor warning system
Other	Yes	Local TV or radio station; Facebook

TABLE 7-11. CITY OF WHARTON ADMINISTRATIVE/TECHNICAL MITIGATION CAPABILITIES MATRIX		
Personnel Resources	Yes/No	Department/Position

Notes:
GIS Geographic Information System

7.4.3 Financial Capabilities

Table 7-12 identifies financial tools or resources that the City of Wharton could use to help fund mitigation activities.

TABLE 7-12.
CITY OF WHARTON 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/Sewer Utility Fee
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	
Wharton County	Medium
City of East Bernard	Medium
City of El Campo	Medium
City of Wharton	Medium

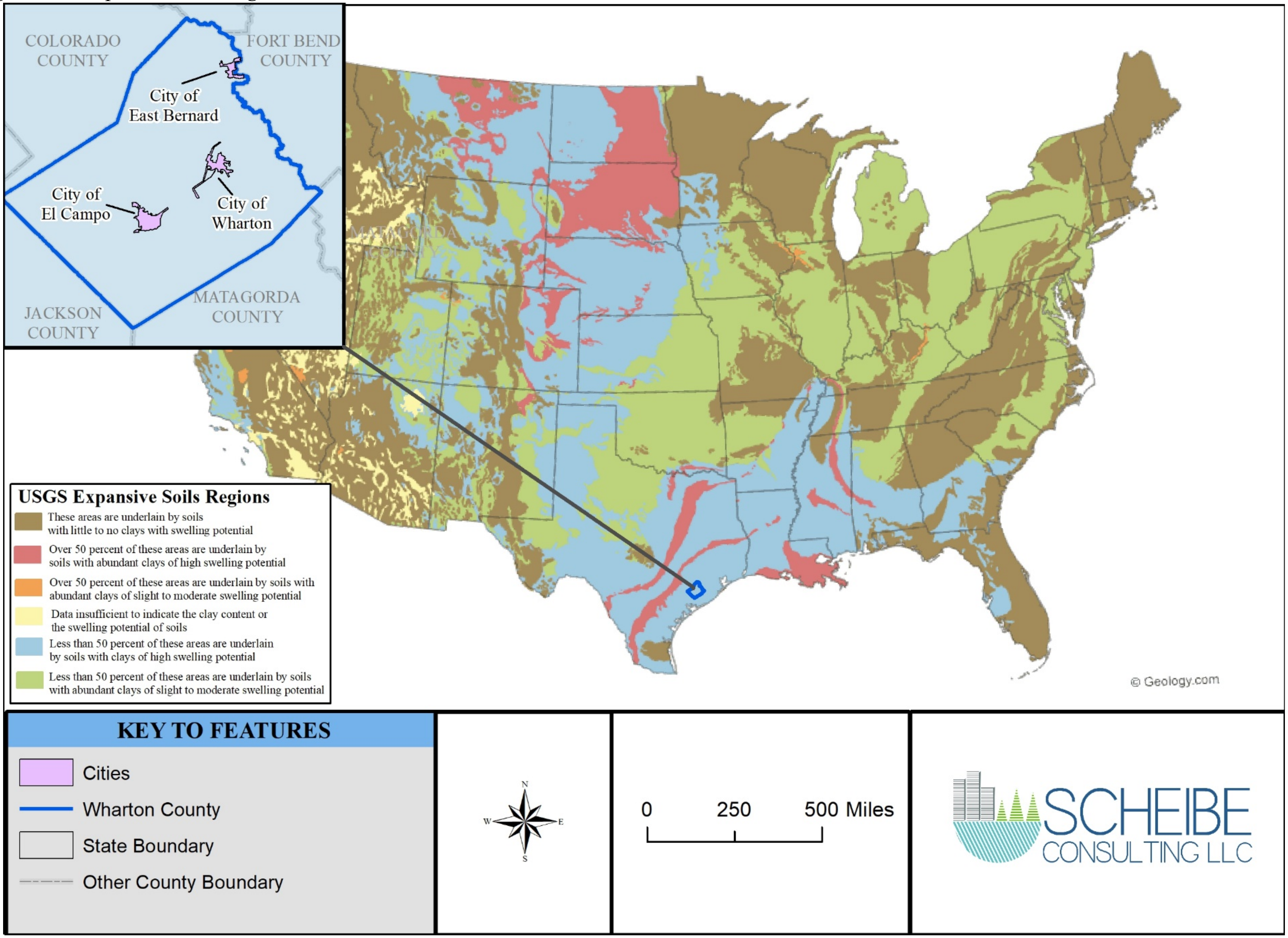
DEFINITIONS

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 of 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 close 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 ground settlement. Swelling soils cause cracked foundations, as well as damage to the upper floors of a building when the motion in the structure is significant. Shrinkage as a 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

Wharton County is mostly underlain by soils with clay that have high shrink-swell properties (Figure 8-1). Expansive soils can cause structural damage, and even though structural foundation issues occur in the Hazard Mitigation Plan (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 Wharton 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 Wharton County and participating communities, 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 Wharton 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.

8.2.3 Frequency

Expansive soil is a condition that is native to Wharton 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. This is due to the area's normal weather consisting of the most annual rainfall in May and September, along with dry summers and less evapotranspiration in the winter. Due to the amount of swelling potential, an event is possible in the next 10 years for Wharton County and participating communities.

Future Events

The large increase in development in the greater Houston-Galveston area, of which Wharton County is a part, could lead to an increase in land subsidence 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 Wharton County and participating communities. Future events are possible in the next 10 years for Wharton County and participating communities.

8.2.4 Severity

The severity of expansive soil is 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 on people or property.

Expansive soil is the hidden force behind basement and foundation problems. The U.S. Dept. of Agriculture (USDA) claims that expansive soils are responsible for more home damage every year than floods, tornadoes, and hurricanes combined. The USDA 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 in Figure 8-1, Wharton County and participating communities are vulnerable to expansive soils as up to 50% of the area is underlain by soils with 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. This applies to all participating communities.

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 the 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, Wharton County and participating communities' 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.

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 Hazards United States Multi-Hazard (HAZUS-MH) system inventory data (updated with 2010 U.S. Census data and 2018 RS Means Square Foot Costs), there are an estimated 15,217 buildings (residential, commercial, and other) with a total asset inventory (excluding contents) value of over $3.4 billion within the type D soil group. Type D soil group is that consisting of over 40% clay. Areas underlain by this soil group are considered the most at risk for expansive soils. See hazard loss tables for community-specific total assessed numbers (e.g., Table 8-1 and Table 8-3). Table 8-1 list the exposed structures and population for the participating communities.

TABLE 8-1 EXPOSED STRUCTURES AND POPULATION					
Jurisdiction	Residential	Commercial	Other*	**Total Structures**	**Total Population**
City of East Bernard	852	57	41	**950**	**2,327**
City of El Campo	4,201	349	192	**4,742**	**12,116**
City of Wharton	2,526	236	85	**2,847**	**7,439**
Unincorporated Area	6,329	182	167	**6,678**	**15,301**
Wharton County Total	**13,908**	**824**	**485**	**15,217**	**37,183**

Note: *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 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

Wharton County and participating communities have a high risk from expansive soils because of the amounts of clay with swelling potential in the soils that underlay the planning area. For the specific rankings given for each entity see ranking tables in chapter 21. Because expansive soils cannot be directly modeled in HAZUS-MH, annualized losses were estimated using geographic information system- (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 of age, 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 structural improvements. The youth and elderly population may require further assistance as dependents if an event were to occur. Table 8-2 shows all vulnerable populations per participating community regardless of the soil type.

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
City of East Bernard	638	28.07	342	15.05	129	5.68
City of El Campo	3402	29.33	1648	14.21	992	8.55
City of Wharton	2317	26.23	1288	14.58	1251	14.17
Unincorporated Area	4,715	25.39	2,741	14.76	1,537	8.28
Wharton County Total	**11,072**	**26.82**	**6,019**	**14.58**	**3,910**	**9.47**

8.6.2 Property

All properties are at some level of 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 counties and communities exposed values to create an annualized loss. Table 8-3 lists the property loss estimates for each participating community compared to the exposed value (excluding content). 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
City of East Bernard	$246,550,000	Negligible	<0.01
City of El Campo	$1,300,853,000	Negligible	<0.01
City of Wharton	$686,117,000	Negligible	<0.01
Unincorporated Area	$1,230,354,000	$1,807	<0.01
Wharton County Total	**$3,463,874,000**	**$1,807**	**<0.01**

Vulnerability Narrative

All participating communities are 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 East Bernard** - The effects of expansive soils are more likely to be felt in the more developed areas of the City, such as along US 90 or SH 60. Property owners face additional 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 likely to not be prepared for its effects. If an event were to occur near a critical facility, such as an area school, government building, or site containing hazardous materials, area residents would be increasingly impacted. Communities implementing Emergency Response Plans help to mitigate these negative impacts.
- **City of El Campo** – 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 (such as emergency response facilities, schools, and homes). If major area thoroughfares, such as US 59, were to be closed or become impassable by an event, response times to the community and mobility in and out of the city would be limited. Structures built without the benefit of building requirements designed to minimize the risk of property damage are more vulnerable as well. Communities unaware of the areas of higher risk, such as with the implementation of hazard mapping, are more at risk as well.
- **City of Wharton** - The effects of expansive soils are more likely to be felt in the more developed areas of the City, such as along TX 183. Property owners face additional 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 likely to not be prepared for its effects. If an event were to occur near a critical facility, such as area schools or emergency response centers, residents would be increasingly impacted. Communities that do not proactively identify the mitigation measures that would mitigate the negative impacts of expansive soils increase their vulnerability as well.
- **Wharton County (Unincorporated Area)** – All of the Unincorporated Areas of Wharton County are vulnerable to expansive soils as up to 50% of the area is underlain by soils with clays of high swelling potential. Critical facilities and structures that have not been inspected for expansive soils may have a greater risk. If an event were to occur in one of these areas (or any rural area) response times could be slow. Residents and business owners who are unaware of the dangers of expansive soils are more vulnerable as well. Communities who monitor the structural integrity of critical facility structures and conduct the improvements needed to major thoroughfares or crossings help to mitigate these risks.

Community Perception of Vulnerability

See the front page of the current chapter for a summary of hazard rankings for Wharton County and participating communities in this HMP update. Chapter 21 gives a detailed description of these rankings and Chapter 22 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 as 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:

- The 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.
- A 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	
Wharton County	Low
City of East Bernard	Low
City of El Campo	Low
City of Wharton	Low

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 an 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

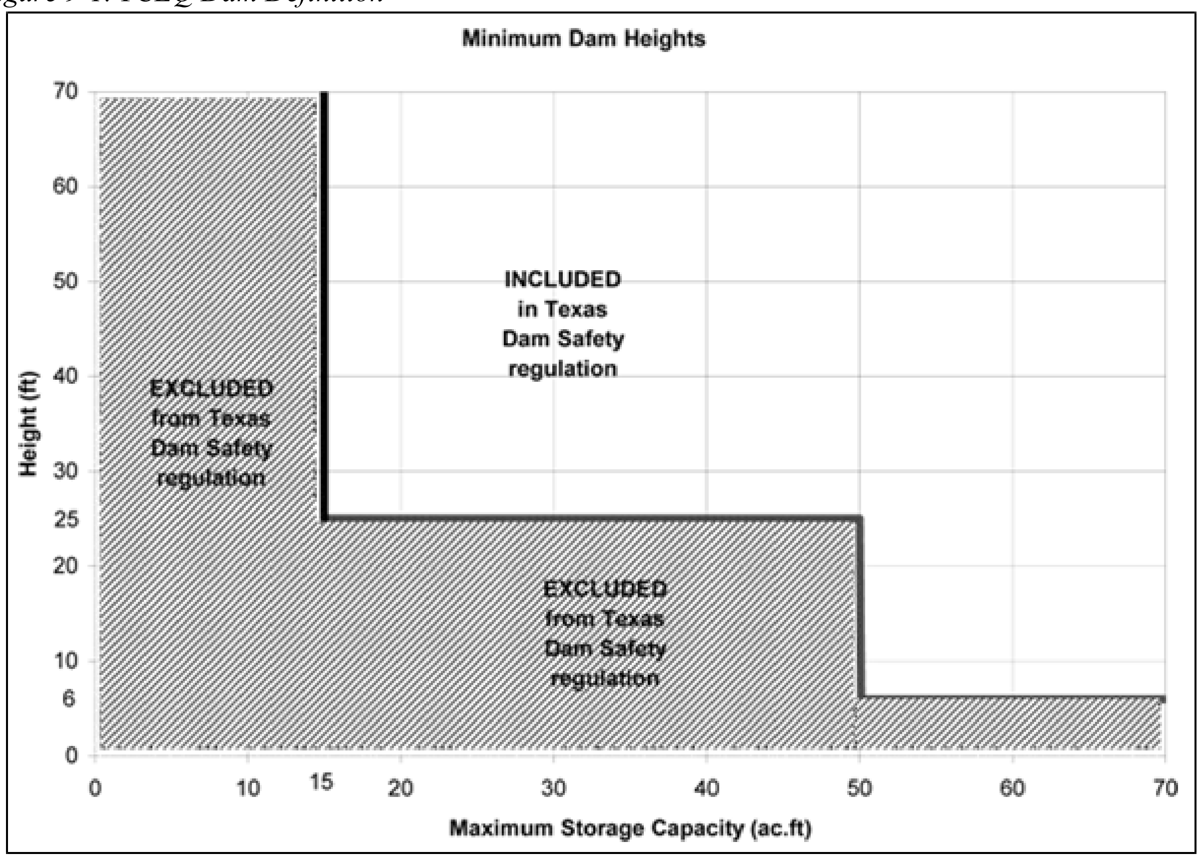
9.1.1 Dams

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 “any barrier, or barriers with an appurtenant structure, constructed for the purpose of either permanently or temporarily impounding water” (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.

According to the TCEQ, a dam in Texas is a barrier with a “height greater than or equal to 25 feet and a maximum storage capacity greater than or equal to 15 acre-feet; a height greater than 6 feet and a maximum storage capacity greater than or equal to 50 acre-feet; are a high- or significant-hazard dam as defined in n §299.14 (relating to Hazard Classification Criteria), regardless of height or maximum storage capacity; or are used as a pumped storage or terminal storage facility” (TCEQ, Ch 1, 2009). Figure 9-1 shows the specifications required for a dam to be regulated by TCEQ.

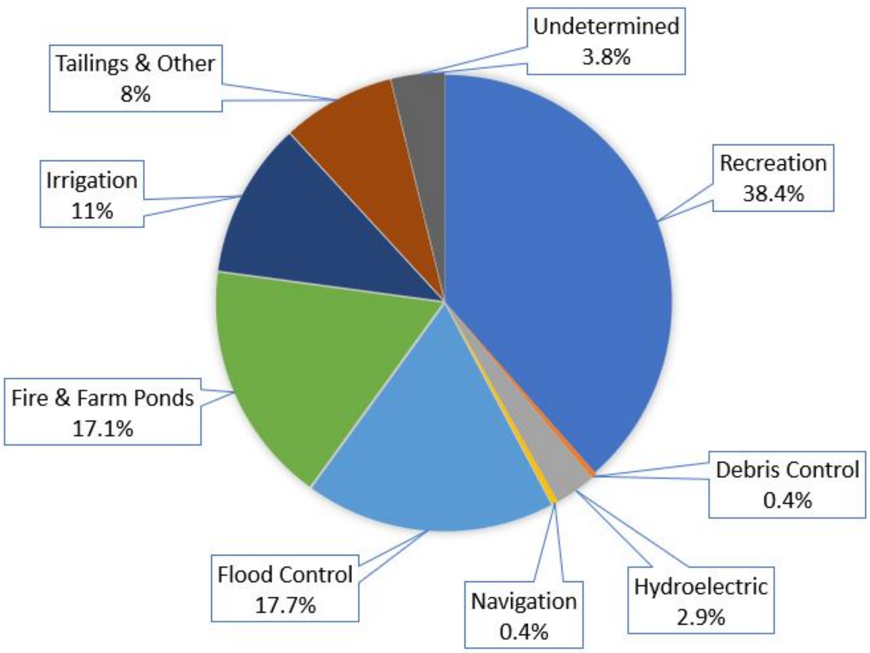
Figure 9-1. TCEQ Dam Definition



Note: From TCEQ, Ch 1, 2009

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 in 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. Almost all the dams in Wharton County are privately owned.

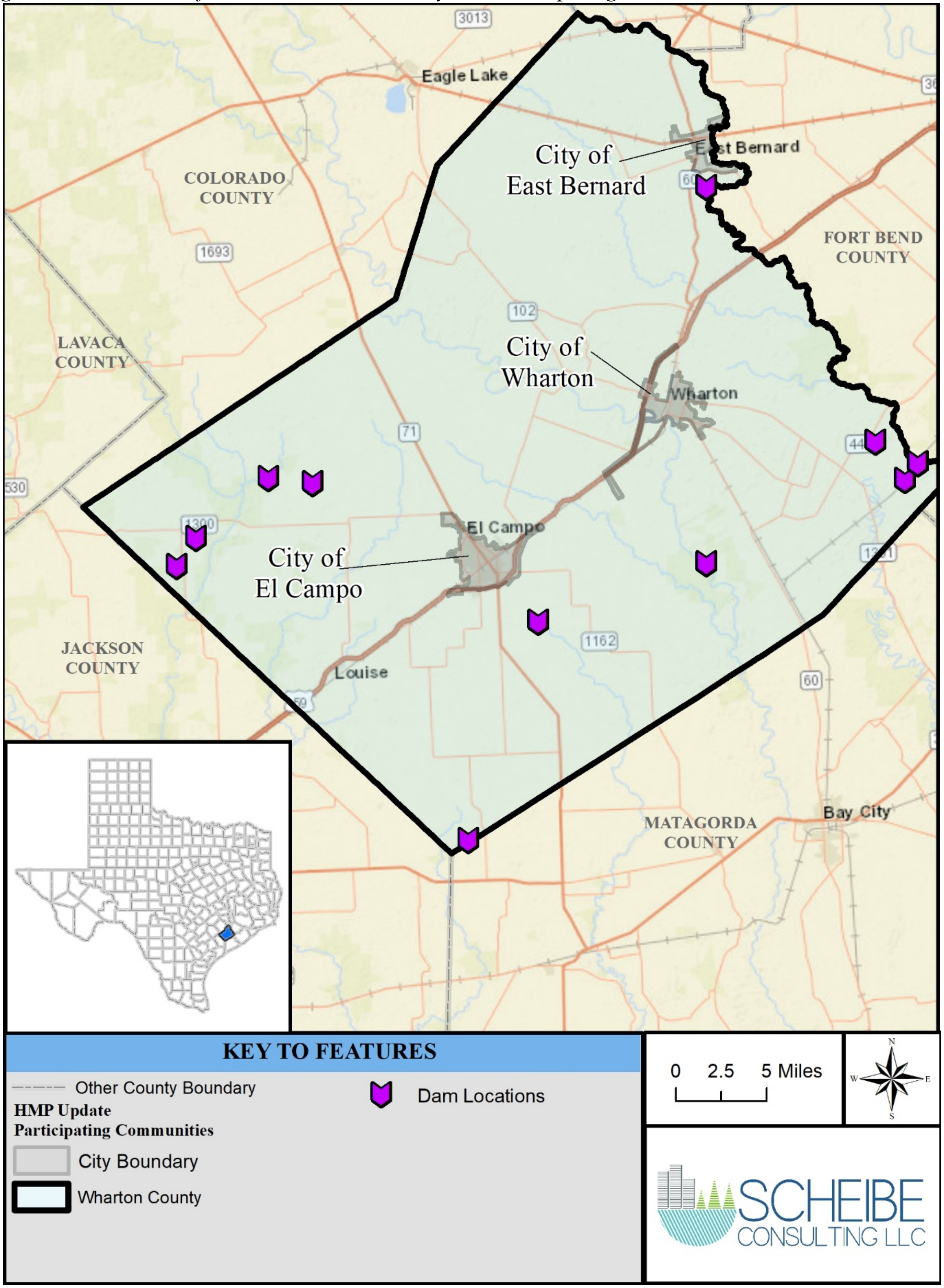
Figure 9-2. Primary Purpose/Benefit of U.S. Dams



Note: From FEMA, Living With Dams

Approximately 9% of the dams in all of Wharton County and participating communities are owned by either the local government or local government agency. The remaining 91% are privately owned. See Figure 9-3 for the location of dams in the participating communities.

Figure 9-3. Locations of Dams in Wharton County and Participating Communities



Note: From HAZUS-MH

9.1.2 Levees

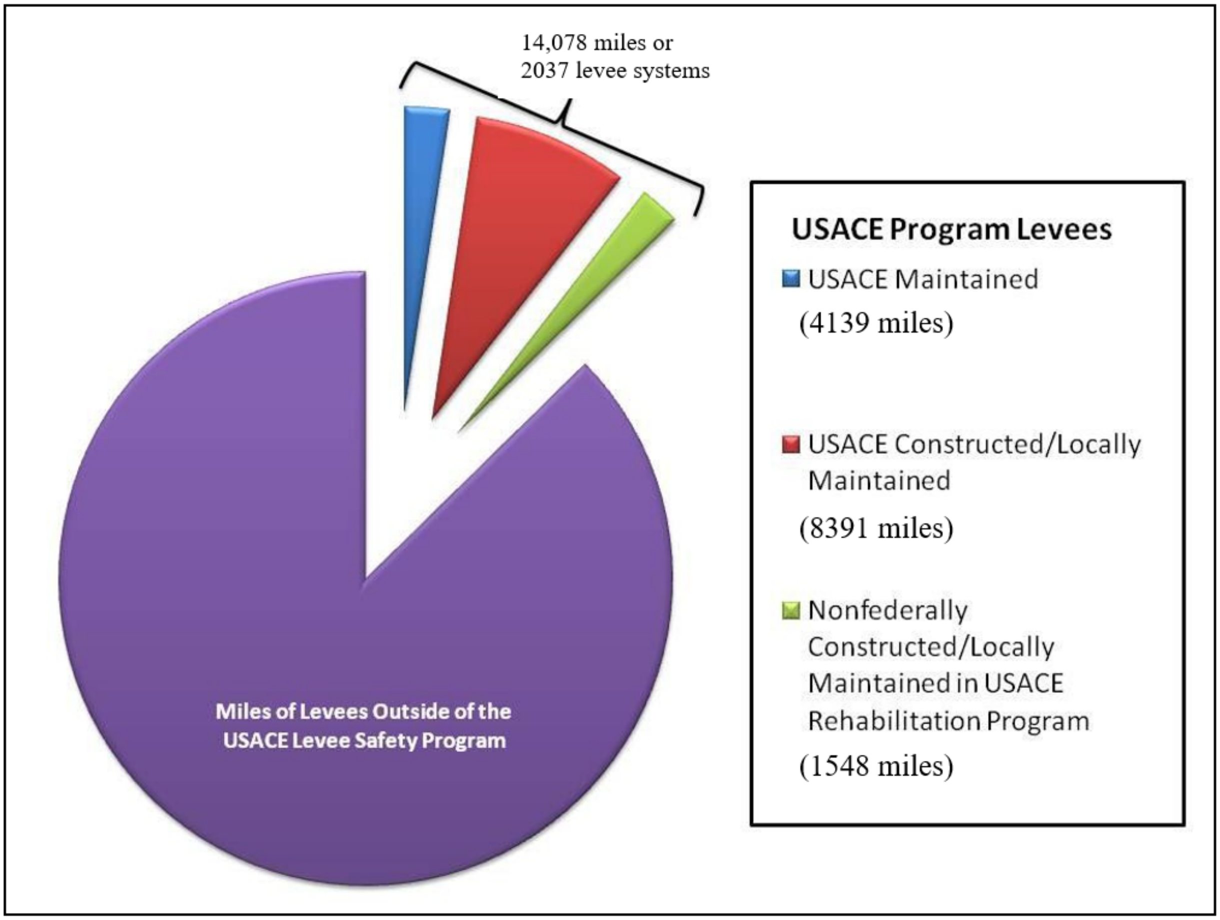
The Federal Emergency Management Agency (FEMA) defines a levee as a "man-made structure, usually, an earthen embankment, designed and constructed in accordance with sound engineering practices to contain, control, or divert the flow of water so as to provide protection from temporary flooding." The terms 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 risks. 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 the 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. Wharton County and participating communities do have known levees (See Figure 9-5). Wharton County contains four levees according to the National Levee Database (NLD) and local knowledge. These levees are the Colorado River Levee, Jarvis Creek Levee, and the West Bernard Creek Levee. All these levees are located within the Wharton County Unincorporated area. The Cities of East Bernard, El Campo, and Wharton do not have any levees inside their city limits although plans for a levee system within the city limits of Wharton are proposed. Additional small private levees may exist which are unaccounted for.

Flooding can happen anywhere, but certain areas are especially prone to serious flooding. To help communities understand the 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 consider these factors. If the risk level for property changes, so may the requirement to carry flood insurance.

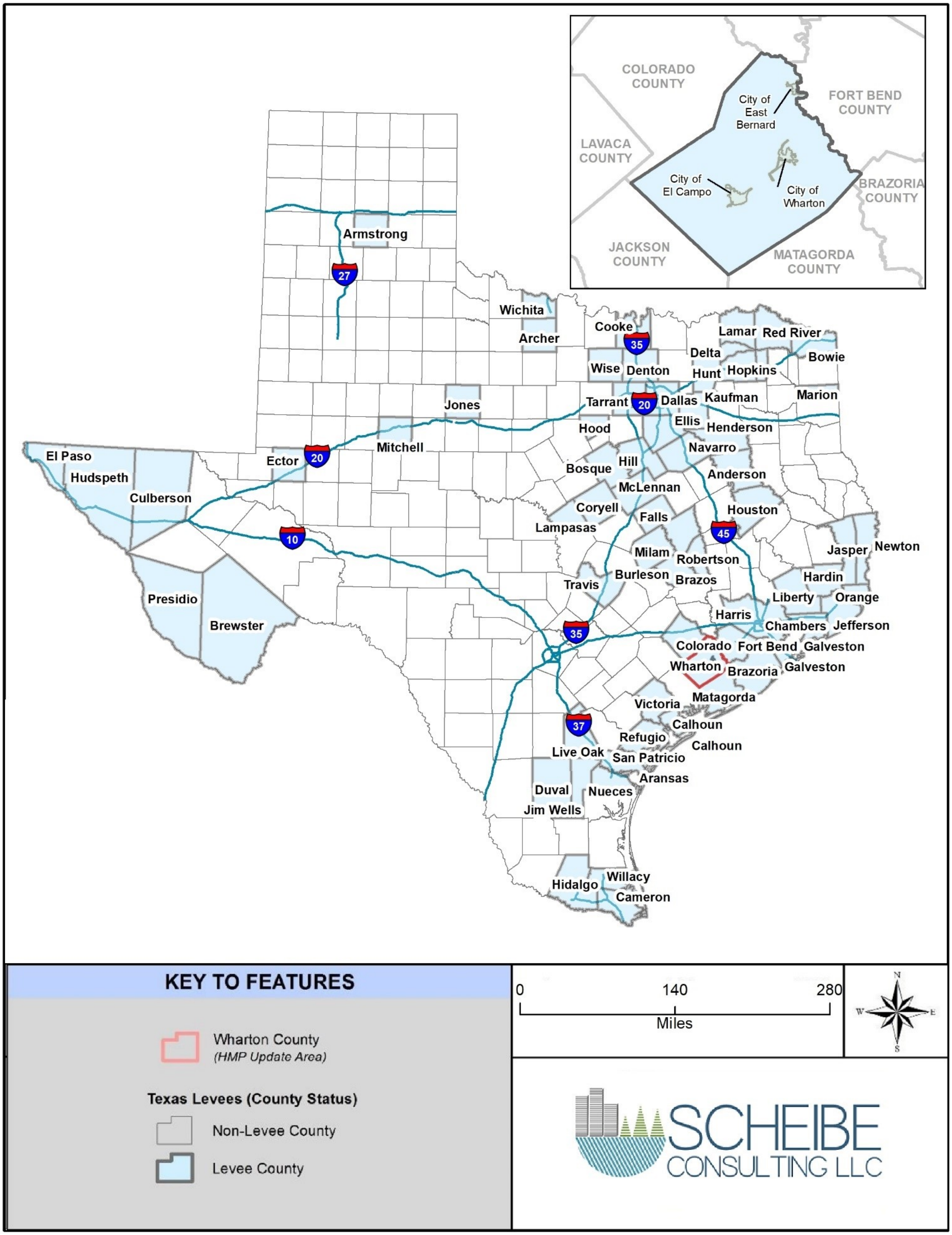
Levee accreditation is FEMA's recognition that a levee is reasonably certain to contain the base (1% annual chance exceedance, sometimes referred to as the 100-year flood) regulatory flood. In order to be accredited, levee owners must certify to FEMA that the levee will provide protection from the base 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.

Figure 9-4. U.S. Levee Systems



Note: From USACE

Figure 9-5. Counties in Texas 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 of 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 USACE NLD. 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 HAZUS-MH database did not list any levees in Wharton County. However, the FEMA MLI database did contain levees for Wharton County. In addition, there may be private levees located within the county and participating cities 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 reevaluating 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 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 the 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 fewer 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. Four of the dams in Wharton 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
City of East Bernard	0	0
City of El Campo	0	0
City of Wharton	0	0
Unincorporated Areas	11	7
Wharton County Total	**11**	**7**
Note: Dam data provided by the National Inventory of Dams (NID) in 2018		

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.

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:

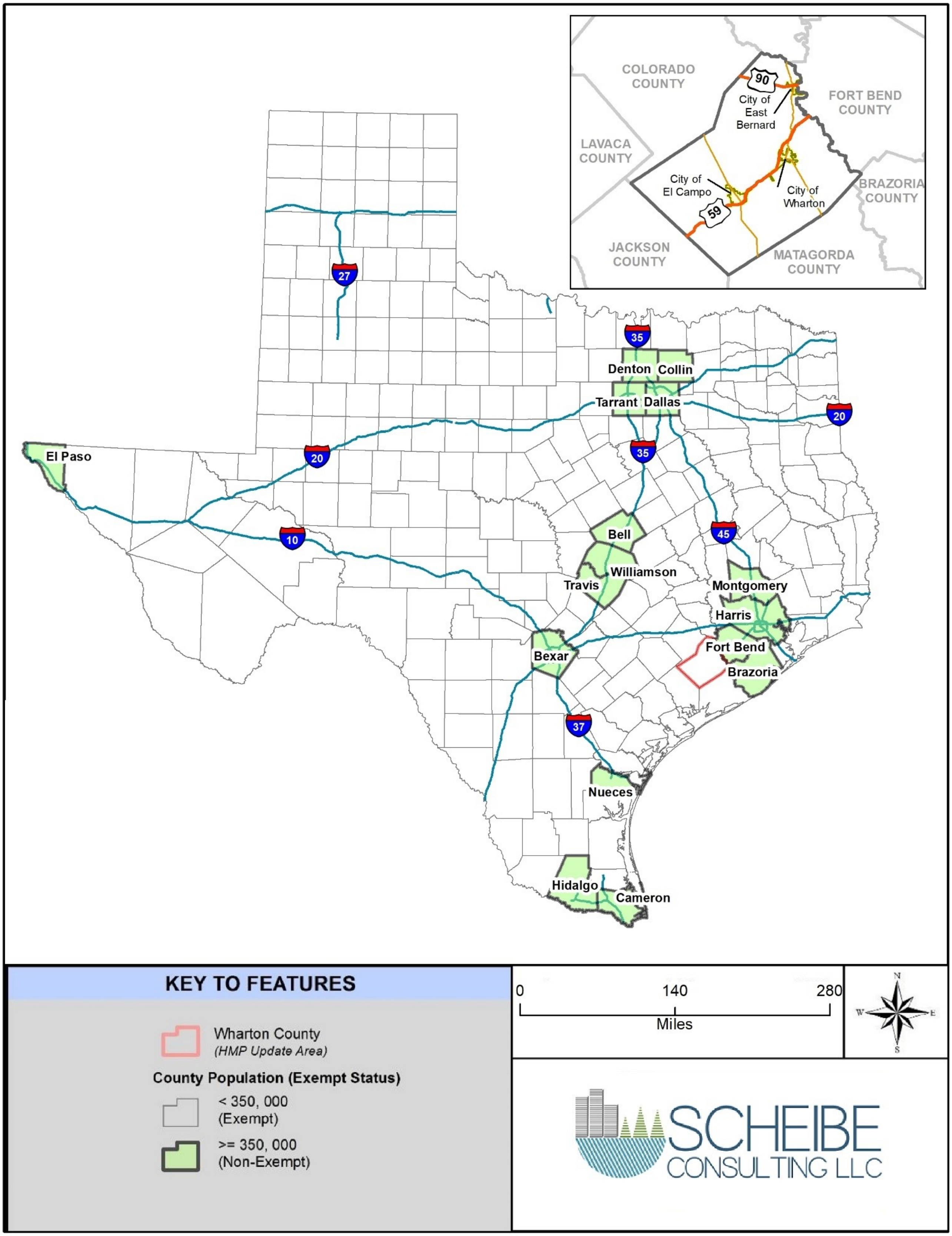
- Potential dam safety problems
- Complaints about constructing and operating a project
- Safety concerns related to natural disasters
- Issues concerning compliance with the terms and conditions of a license

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

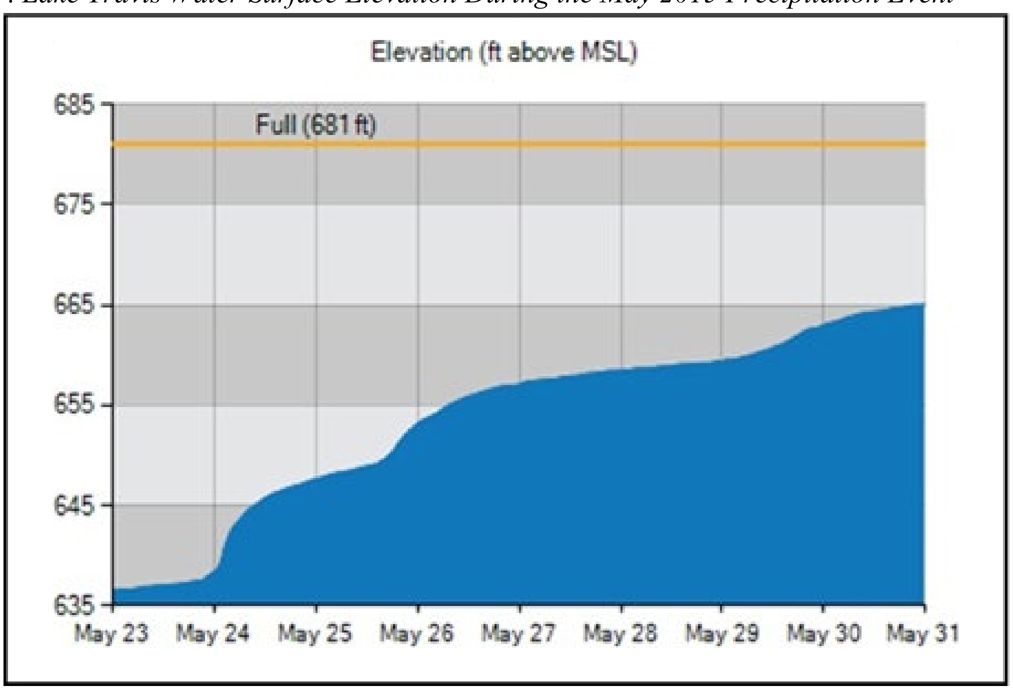
There are approximately 7,324 dams in the inventory of dams in Texas. Two major dam failures occurred in the City of Austin, which is not a participating jurisdiction in this effort. The last failure for the city was in 1915. There have been no previous dam failure events in Wharton County and the participating 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.

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



9.2.2 Location

Dam locations are based on the 2018 USACE National Inventory of Dams. This database lists 11 dams in Wharton County, all of which are in the Unincorporated area. Figure 9-8 shows locations of the dams in the county and participating cities with potential dam inundation extents and population densities. The FEMA MLI data provided a listing of levee locations in Texas. Figure 9-5 shows counties with levees in Texas and Figure 9-9 shows levee locations in Wharton County. These levees have not been certified as proving protection from the 100-year floodplain (See section 9.1.2 for more information on certification). All of the existing levees in Wharton County are not located near populated areas. The levee near the City of Wharton is located on the southern edge of the city, not along the populated town center. All of the levees in the participating jurisdiction are earthen and not certified (not used to remove people and property out of the 100-year flood plain).

There is 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 are not known.

The risks of a dam failure are spread throughout the county while that of a levee failure is limited to the City of Wharton and the southern portions of the county. The planning area could be impacted by several high-hazard dams that are located outside of the county. If a failure of a high-hazard dam occurred, it could result in loss of life. Other high-hazard dams are located outside of the county and their drainages enter Wharton County and participating communities either by direct drainage through parts of the planning area or by inflow into the Colorado River or San Bernard River upstream from Colorado County. Wharton County has not experienced dam breaches immediately upstream of or within the participating communities, thus the overall chance of this occurring is minimal, but still considered possible, therefore the frequency of an event is classified as 'Low' (event not probable in the next 100 years). Additionally, major dams located outside of the planning area that could affect the participating communities, including Cedar Creek Dam and Tom Miller Dam are located approximately 65 and 165 miles, respectively, upstream of Wharton County, along the Colorado River. Because of these two dams' upstream location, any major dam breach will minimally affect Wharton County. A detailed description of exposure and vulnerability per jurisdiction is described in Chapter 9.5 and Chapter 9.6.

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

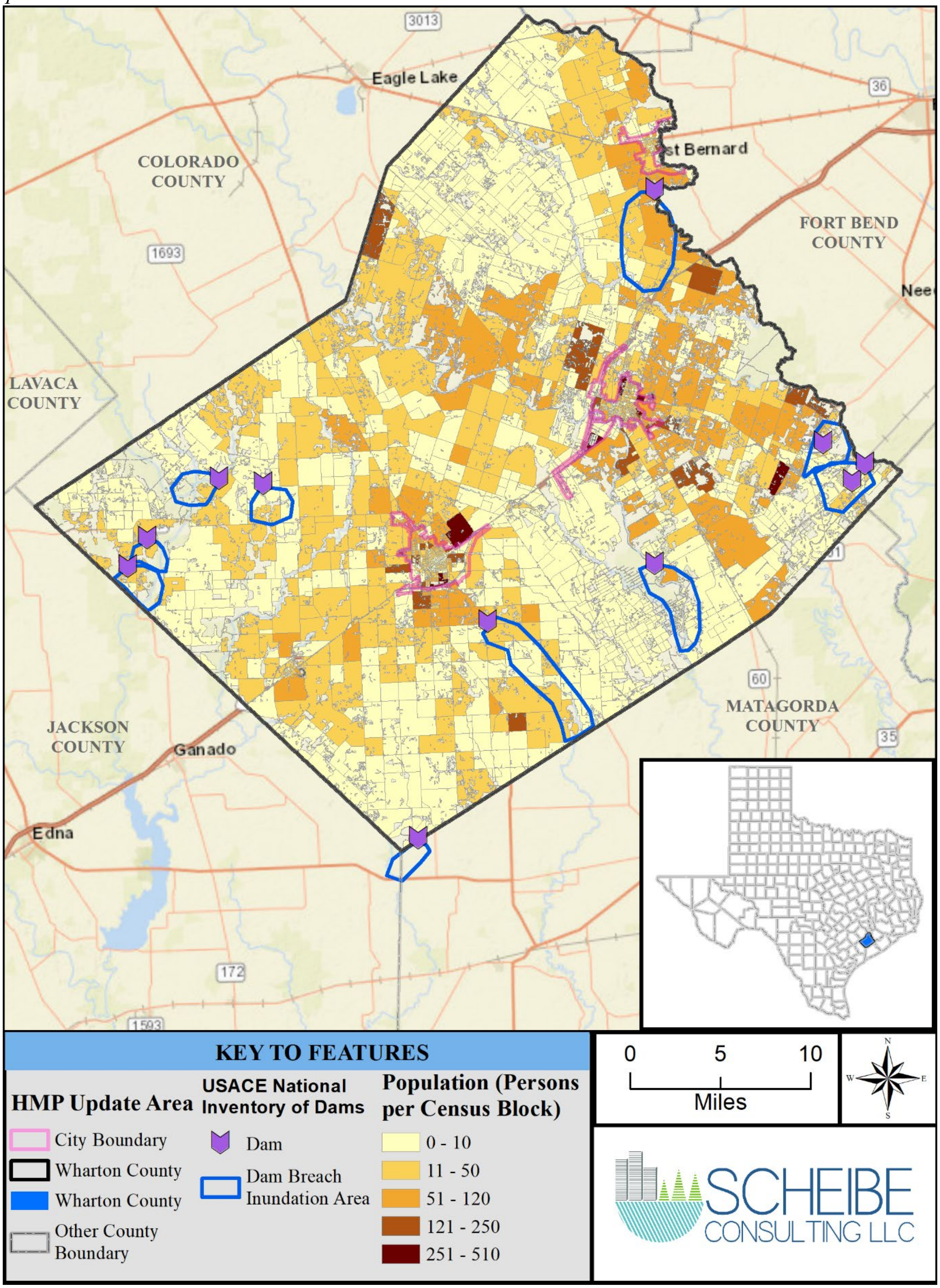
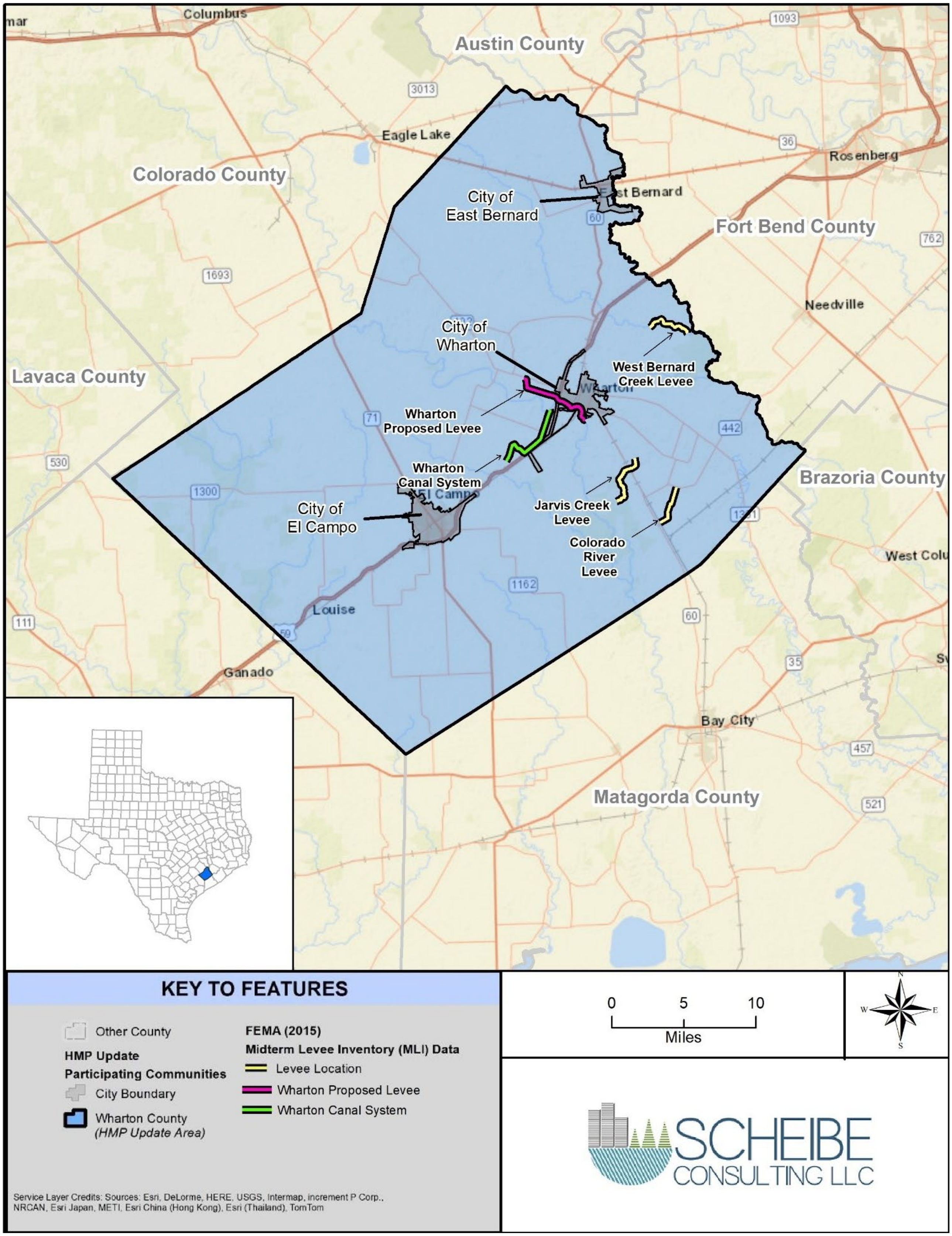


Figure 9-9. Levees in Wharton County



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 Wharton County and the participating communities are considered rare (event not probable in the next 100 years). This same 'Low' probability applies to future events (events not probable in the next 100 years).

9.2.4 Severity

USACE and TCEQ developed the classification system shown in Table 9-2 and Table 9-3 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 9-3 shows the specifications required for a dam to be regulated by TCEQ.

Overall, future dam failure impacts would likely be rare and limited in Wharton County, largely affecting the downstream areas during a failure event. Roads closed due to dam failure floods could result in transportation disruptions due to the limited number of roads in the county. The maximum inundation depth for a dam breach would be in line with the height of the dam (See Table 9-4). Small dams in the rural parts of the unincorporated area of the county do not have the data available to predict breach analysis inundation effects on local road crossings. Existing road closure policies and emergency management practices will be used. The Colorado River at the City of Wharton has a bank full stage of 20 feet and a Flood Stage of 39 feet. The San Bernard River at East Bernard has an action stage of 13', and a flood stage of 17'. Participating communities use gauges for measurements, monitoring of conditions, road closures, and emergency conditions during events.

TABLE 9-2.
USACE HAZARD POTENTIAL CLASSIFICATION

Hazard Category	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

Notes:

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.

From 7 CFR Appendix A-Subpart E-Part 1724

TABLE 9-3.
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)

Note: From Title 30 Texas Administrative Code, Ch 299, Subchapter B, Rule §299.14

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 an 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 Wharton 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 VULNERABILITY

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. Wharton County and participating communities have property and population that may be affected by a failure event at a registered dam or levee and remain vulnerable to unaccounted for private structures. Due to the lack of previous events, local knowledge, and no high hazard dams or certified levees in the area, the overall probability of occurrence is considered rare or unlikely in the next 100 years and therefore classified as "Low".

Table 9-4 below lists 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 are susceptible to human, economic, and environmental impact from a failure (Table 9-2 and Table 9-3). This table includes major upstream dams outside of the planning area that may affect Wharton County participating communities. 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 Wharton County, largely affecting the downstream areas during a failure event. Roads closed due to dam failure floods could result in transportation disruptions due to the limited number of roads in the county.

TABLE 9-4.
WHARTON COUNTY AND PARTICIPATING COMMUNITIES DAM EXTENTS

Dam Name	Community	Dam Height (feet)	Max Discharge (cubic feet/second)	Max Storage (acre feet)
CARLSON FRANCIS RESERVOIRS	Wharton County Unincorporated Area	7	NA	209
E S ROTHROCK TRUST LAKE NO 1 DAM	Wharton County Unincorporated Area	24	244	340
EG GOFF DAM	Wharton County Unincorporated Area	9	NA	63
HUTCHINS LAKE DAM	Wharton County Unincorporated Area	9	NA	108
NEWGULF LAKE LEVEE	Wharton County Unincorporated Area	18	3,701	20,609
NEWGULF OFF-CHANNEL RESERVOIR LEVEE	Wharton County Unincorporated Area	18	1,498	2,596
RESERVOIR NO 4 DAM	Wharton County Unincorporated Area	7	NA	210
RICHARDS NO 2 LEVEE	Wharton County Unincorporated Area	8	160	194
LANE CITY DIVERSION DAM	Wharton County Unincorporated Area	36	NA	305
ROCKIN RANCH LAKE DAM	Wharton County Unincorporated Area	6	NA	50
TEXAS GULF INC RESERVOIR DAM	Wharton County Unincorporated Area	10	NA	2,875
Dams Located Outside Planning Area				
TOM MILLER DAM**	City of Austin	85	1,517,697	115,404
CEDAR CREEK DAM**	Fayette County Unincorporated Area	102	1,152	88,628

Notes:
**Major Dams upstream of participating Communities
Dam data provided by the National Inventory of Dams (NID) in 2018

9.5.1 Population

Exposed 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 an adequate warning from a television or radio emergency warning systems. Table 9-5 lists the exposed structures and population for the participating communities based on the estimated inundation areas. Participating communities have a population that may be affected by an event, due to the lack of previous events, local knowledge and no high hazard dams in the area, the overall probability of occurrence is minimal and therefore classified as ‘Low’.

9.5.2 Property

According to HAZUS-MH data analysis, within the participating communities in the HMP update area, there are an estimated 1,122 buildings (residential, commercial, and other) within the possible risk area. Other types of buildings in this report include agricultural, educational, religious, and governmental structures. See hazard loss tables for community-specific total assessed numbers (Table 9-7). Table 9-5 lists the number of structures and population which are within the approximate inundation areas show in Figure 9-8. This table is an approximation and does not account for structures and population within inundation areas for undocumented structures.

TABLE 9-5.
EXPOSED STRUCTURES AND POPULATION

Jurisdiction	Residential	Commercial	Other *	**Total Structures**	**Total Population**
City of East Bernard	0	0	0	**0**	**0**
City of El Campo	0	0	0	**0**	**0**
City of Wharton	0	0	0	**0**	**0**
Wharton County Unincorporated Area	1,050	38	34	**1,122**	**2,462**
Wharton County Total	**1,050**	**38**	**34**	**1,122**	**2,462**

Note: *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 the destruction of downstream habitat and could have detrimental effects on many species of animals.

9.6 EXPOSURE

Dam failure inundation mapping for the planning area was not available to allow HAZUS-MH loss estimations to be modeled. Due to this data deficiency, for both levees and dams, 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 Wharton 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 affected, the likelihood of this occurring (based on historical events, and local knowledge) is minimal. Roads closed due to dam failure floods could result in transportation disruptions due to the limited number of roads in the rural areas of the HMP update area.

After profiling and analyzing the dam and levee information (including general background, historical occurrences, extent, exposure, and vulnerability), the risk analysis was discussed and among the participating members. Based on local knowledge, lack of previous events, no high hazard dams in the immediate or upstream area, no certified levees affected by100-year floodplain requirements, and the overall probability of a minimal occurrence, all participating communities classified their respective jurisdictions as ‘Low’.

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 years of age, and the elderly. See Table 9-6 for vulnerable populations per participating community in the inundation area.

TABLE 9-6.
VULNERABLE POPULATION

Jurisdiction	Youth Population (< 16)	% of Total Population	Elderly Population (> 65)	% of Total Population	Economically Disadvantage (Income <$20,000)	% of Total Population
City of East Bernard	0	0	0	0	0	0
City of El Campo	0	0	0	0	0	0
City of Wharton	0	0	0	0	0	0
Wharton County Unincorporated Area	676	27.46	333	13.53	192	7.80
Wharton County Total	**676**	**27.46**	**333**	**13.53**	**192**	**7.80**

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 to the dam breach) may risk the most damage.

Loss estimations for dam hazards are not based on HAZUS-MH modeled damage functions, because detailed dam 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 9-7 lists the property loss estimates for each participating community given exposed building value (excluding content). 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 9-7.
LOSS ESTIMATES FOR DAM EVENT

Jurisdiction	Exposed Value	Annualized Loss	Annualized Loss Percentage
City of East Bernard	$0	Negligible	<0.01
City of El Campo	$0	Negligible	<0.01
City of Wharton	$0	Negligible	<0.01
Unincorporated Area	$250,341,000	Negligible	<0.01
Wharton County Total	**$251,041,000**	**Negligible**	**<0.01**

Vulnerability Narrative

The entire participating communities are equally at risk of a dam/levee breach. Communities with dams inside as well as upstream of their jurisdictions are the most vulnerable. Table 9-6 lists the vulnerable population per community. Table 9-7 lists the estimated annualized losses in dollars for each participating community. The previous tables list the approximate exposed structures to an unlikely event. Based on previous occurrences (0), local knowledge and no high hazard dams in the area, the overall probability of occurrence is minimal and therefore classified as 'Low'.

- **City of East Bernard** - The City of East Bernard does not have any documented dams or levees within the city limits. Undocumented private levees or dams which were not identified during this analysis may exist outside the city limits with potential to impact the community. With no known significant or high hazard dams upstream of the city, no known previous events, and local knowledge, the City of East Bernard is classified as 'Low' probability for a future event.
- **City of El Campo** - The City of El Campo does not have any documented dams or levees within the city limits. Undocumented private levees or dams which were not identified during this analysis may exist outside the city limits with potential to impact the community. With no known significant or high hazard dams upstream of the city, no known previous events, and local knowledge, the City of El Campo is classified as 'Low' probability for a future event.

- **City of Wharton** – The City of Wharton does not have any documented dams or levees within the city limits. Undocumented private levees or dams which were not identified during this analysis may exist outside the city limits with potential to impact the community. With no known significant or high hazard dams upstream of the city, no known previous events, and local knowledge, the City of Wharton is classified as 'Low' probability of future events. It should be noted that there is planned construction of a levee which could affect the City of Wharton in the future. For the purpose of this hazard mitigation plan, the impacts of the proposed levee have not been evaluated.
- **Wharton County (Unincorporated Area)** – Wharton County Unincorporated Areas do not have any high or significant hazard dams within the County. While an upstream event may affect the county, the extremely minimal chance occurrence (as based on previous events, local knowledge, and dam hazard classification). Undocumented private dams and levees unaccounted for in the hazard analysis may exist throughout the planning area and have potential to impact the community during a failure event. Based on the hazard analysis and no documented previous events, the community can be described as at a 'Low' probability of future exposure.

Community Perception of Vulnerability

See the front page of the current chapter for a summary of hazard rankings for Wharton County and participating communities in this plan update. Chapter 21 gives a detailed description of these rankings and Chapter 22 addresses mitigations actions for this hazard vulnerability. It should be noted that although the City of Wharton, El Campo, and East Bernard are not currently at risk of a dam/levee failure, future dams or levees may be constructed to mitigate hurricane and/or flood risks which currently are present in these communities. As a result, there are some mitigation actions that are listed in this plan reference dams and/or levees as possible future actions needed to mitigate flood and hurricane risk.

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 records. 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.
- The county should maintain accreditation of the levees in Wharton County.

Chapter 10.
DROUGHT AND EXTREME HEAT

DROUGHT AND EXTREME HEAT RANKING		
Jurisdiction	**Drought**	**Extreme Heat**
Wharton County	High	High
City of East Bernard	Medium	High
City of El Campo	Medium	High
City of Wharton	Low	Medium

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 a meteorological drought but before a 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 streamflow and as lake, reservoir, and groundwater levels. There is a time lag between the 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 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 2016). 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, such as that defined by the National Oceanic and Atmospheric Administration (NOAA) in 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.

Figure 10-1. Heat Index Table

NWS 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

Note: From NOAA National Weather Service

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 of 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, a long-term wet circulation pattern can 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 Wharton County. Annual precipitation in the populated areas of the planning area is approximately 40 to 48 inches per year. Various streams and tributaries are contributing to the 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. 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 Wharton County (and participating communities), are usually limited, typically with periods of dryness and moderate drought. These drought conditions are shown as D0 to D2 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. During March 2015, portions of Wharton County (and participating communities) were still experiencing D0 drought conditions. However, the drought conditions changed in May 2015 with heavy spring rains falling over the Texas region. According to the Office of the State Climatologist at Texas A&M University 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. 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 for June 2015. This was the first time in 3 years that none of the state fell within the U.S. Drought Monitor's most severe classification. Almost all of Wharton County (and participating communities) no longer experienced drought and area reservoirs were 100% full or experienced large capacity gains during the spring and early summer of 2015.

Figure 10-5 shows the state's current drought conditions for March 2020. This was the first time in 6 years that Wharton County experienced a level D3 extreme drought. Figure 10-6 shows the state's current drought conditions as of April 2021. Wharton County has shown abnormally dry to moderate drought conditions since the previous year.

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 such as online 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 affect Wharton County and participating communities equally.

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

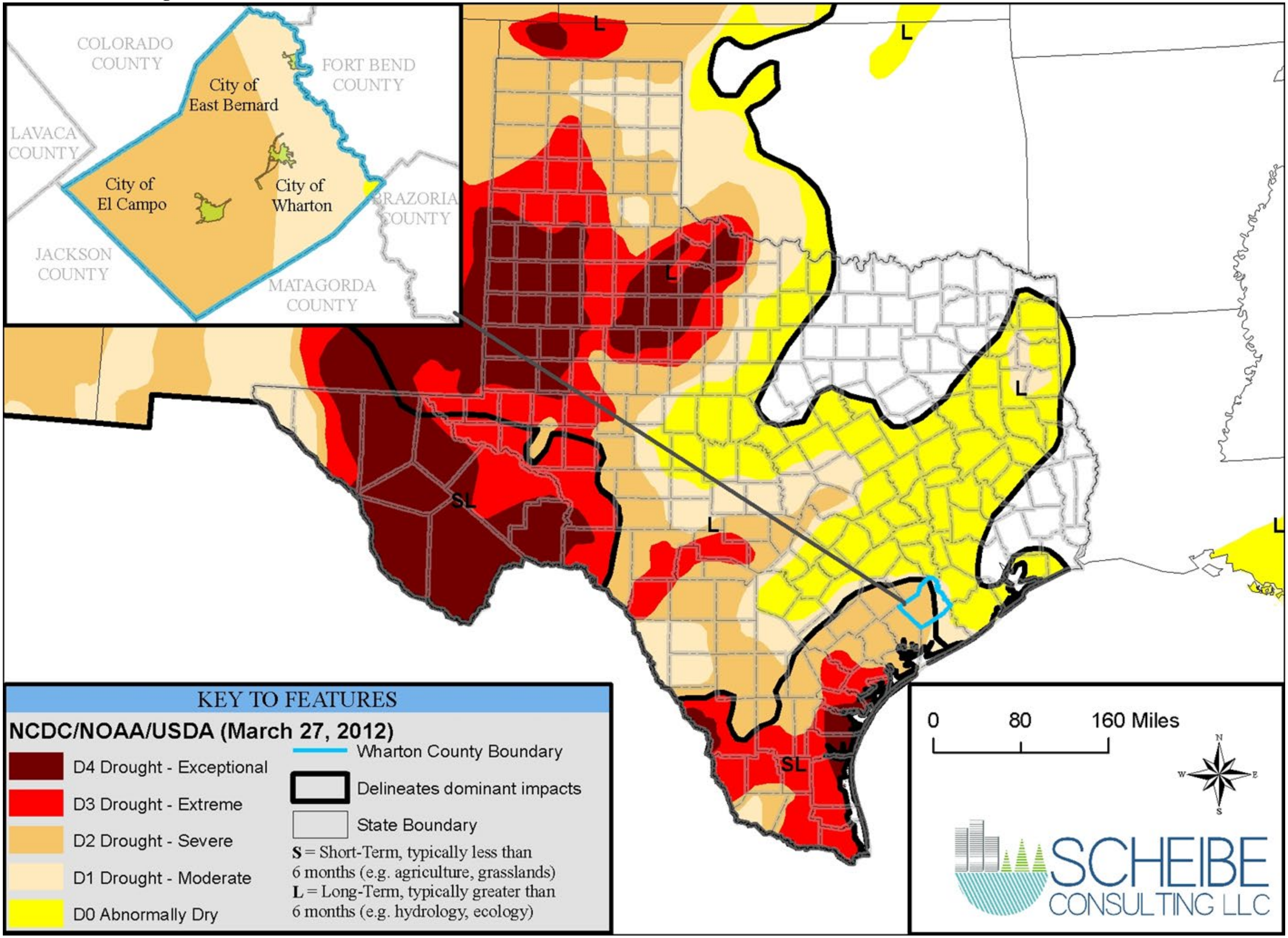


Figure 10-3. U.S. Drought Monitor, March 17, 2015

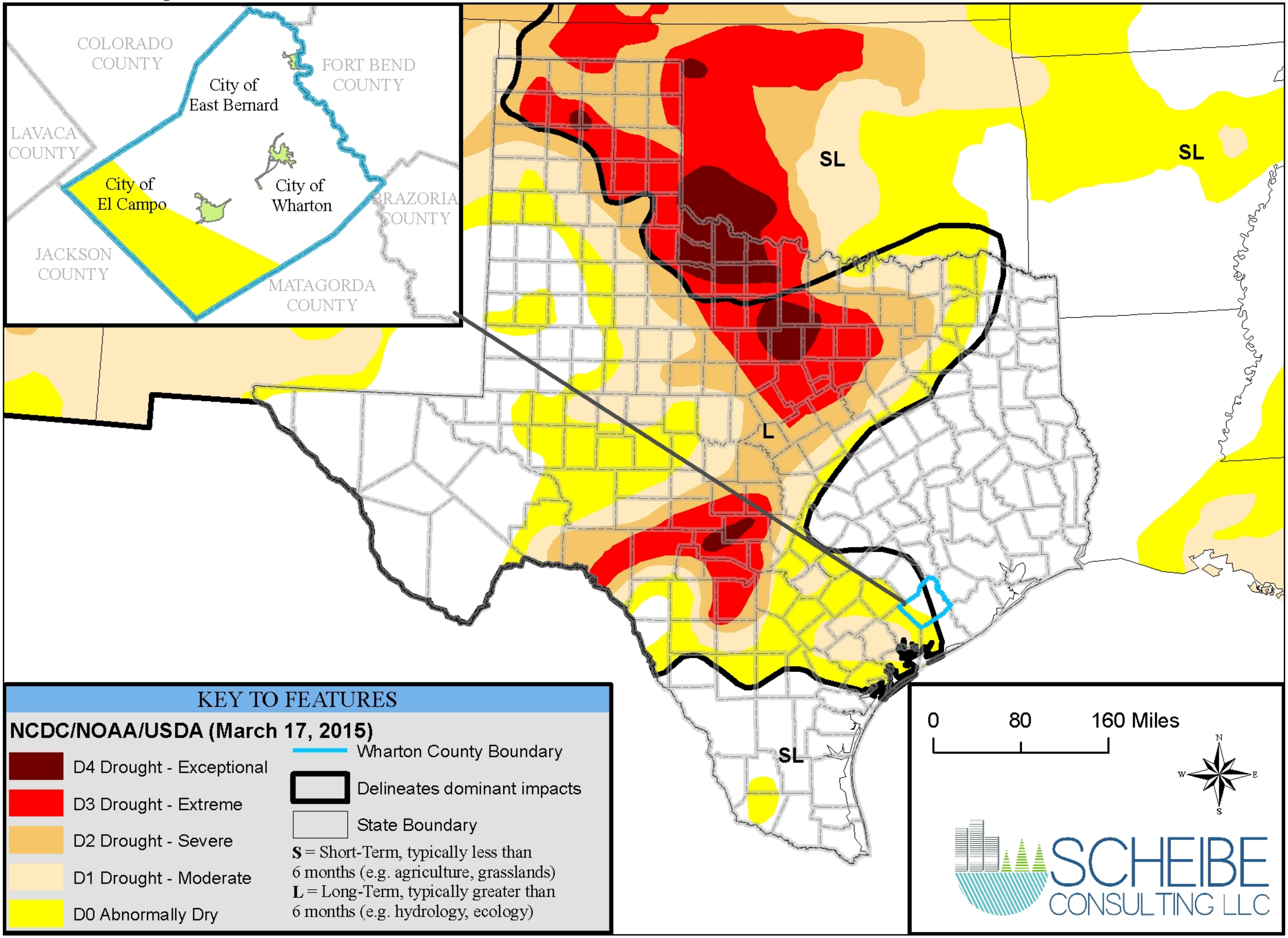


Figure 10-4. U.S. Drought Monitor, June 16, 2015

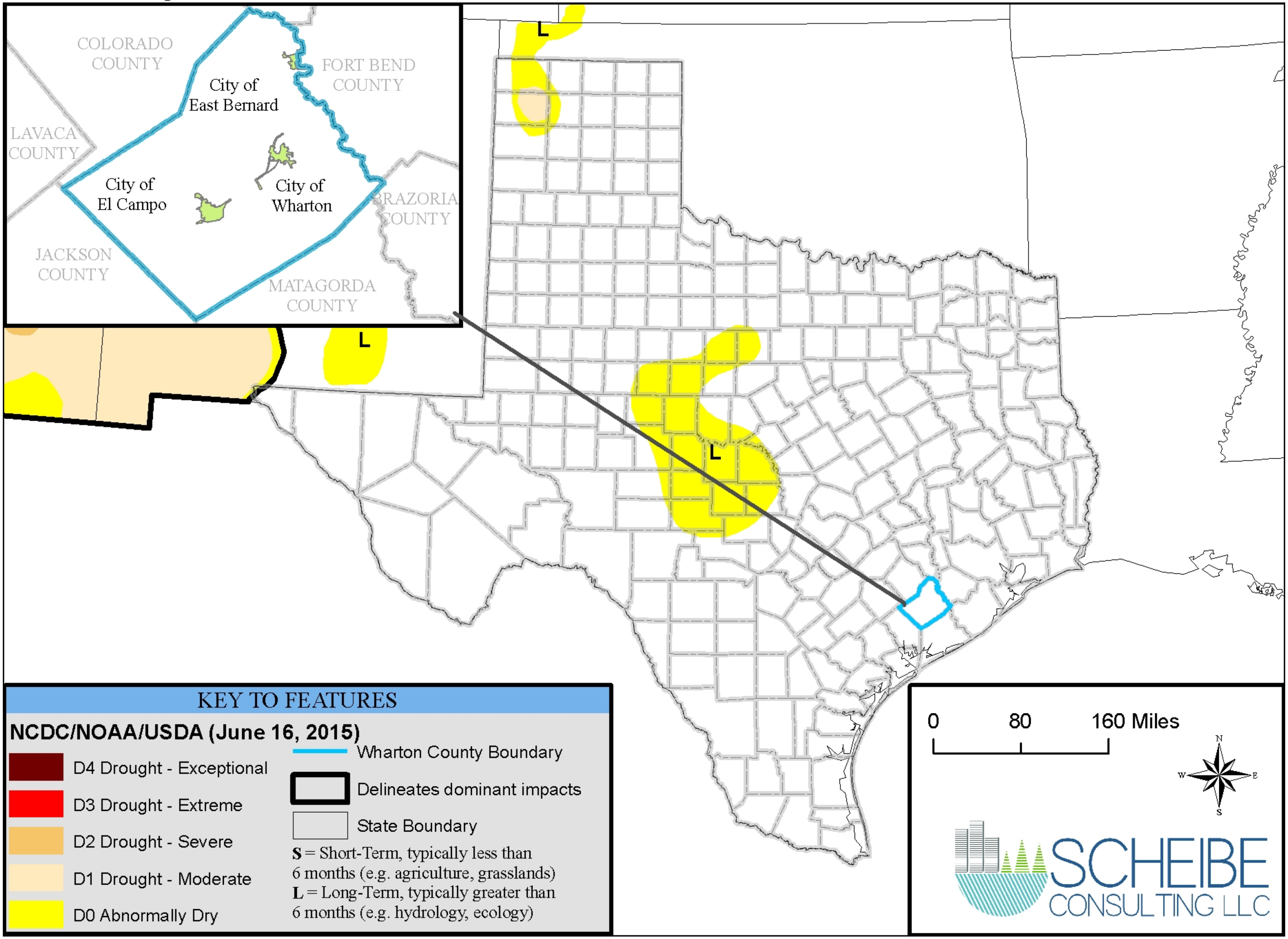


Figure 10-5. U.S. Drought Monitor, March 17, 2020

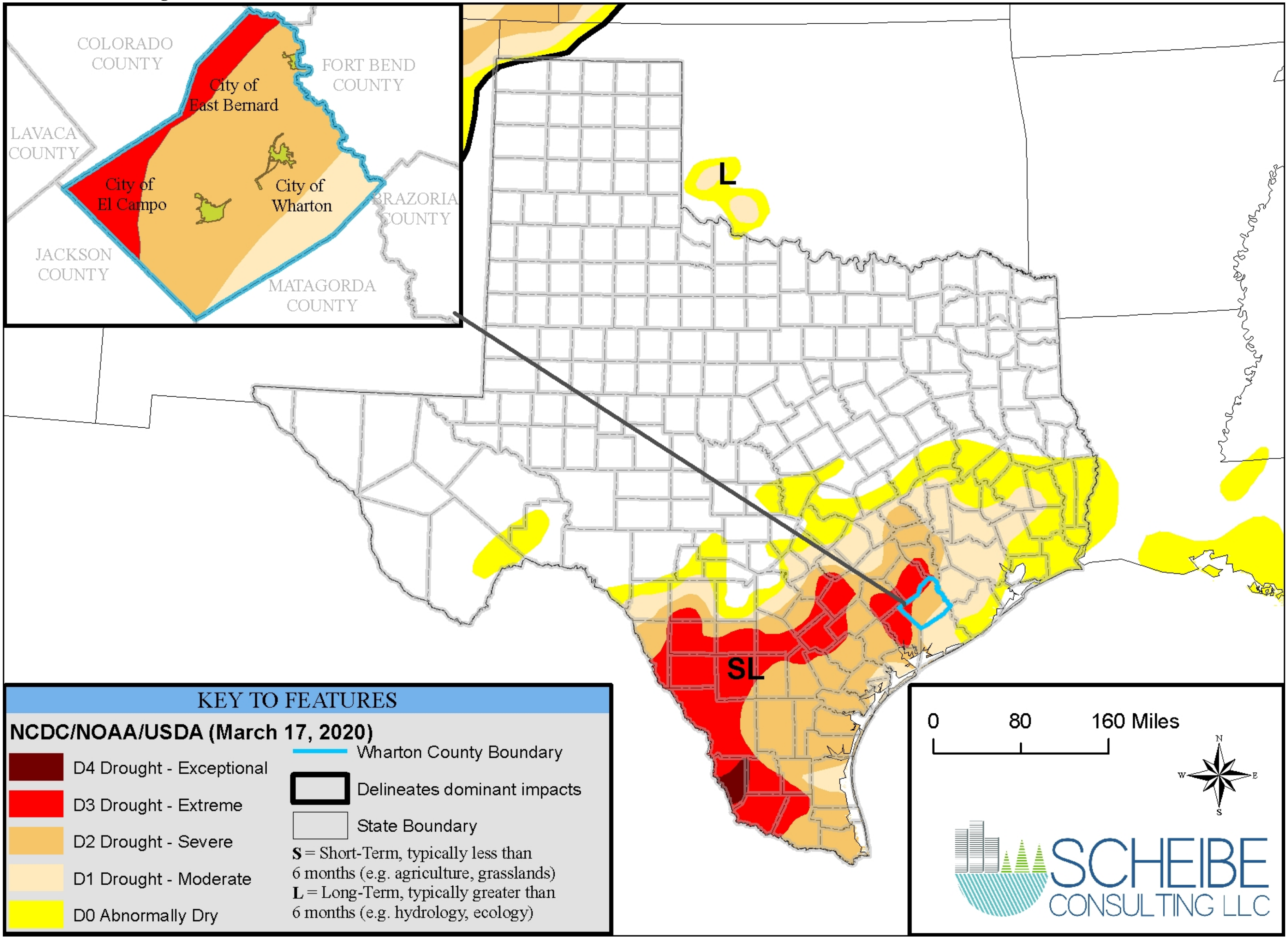
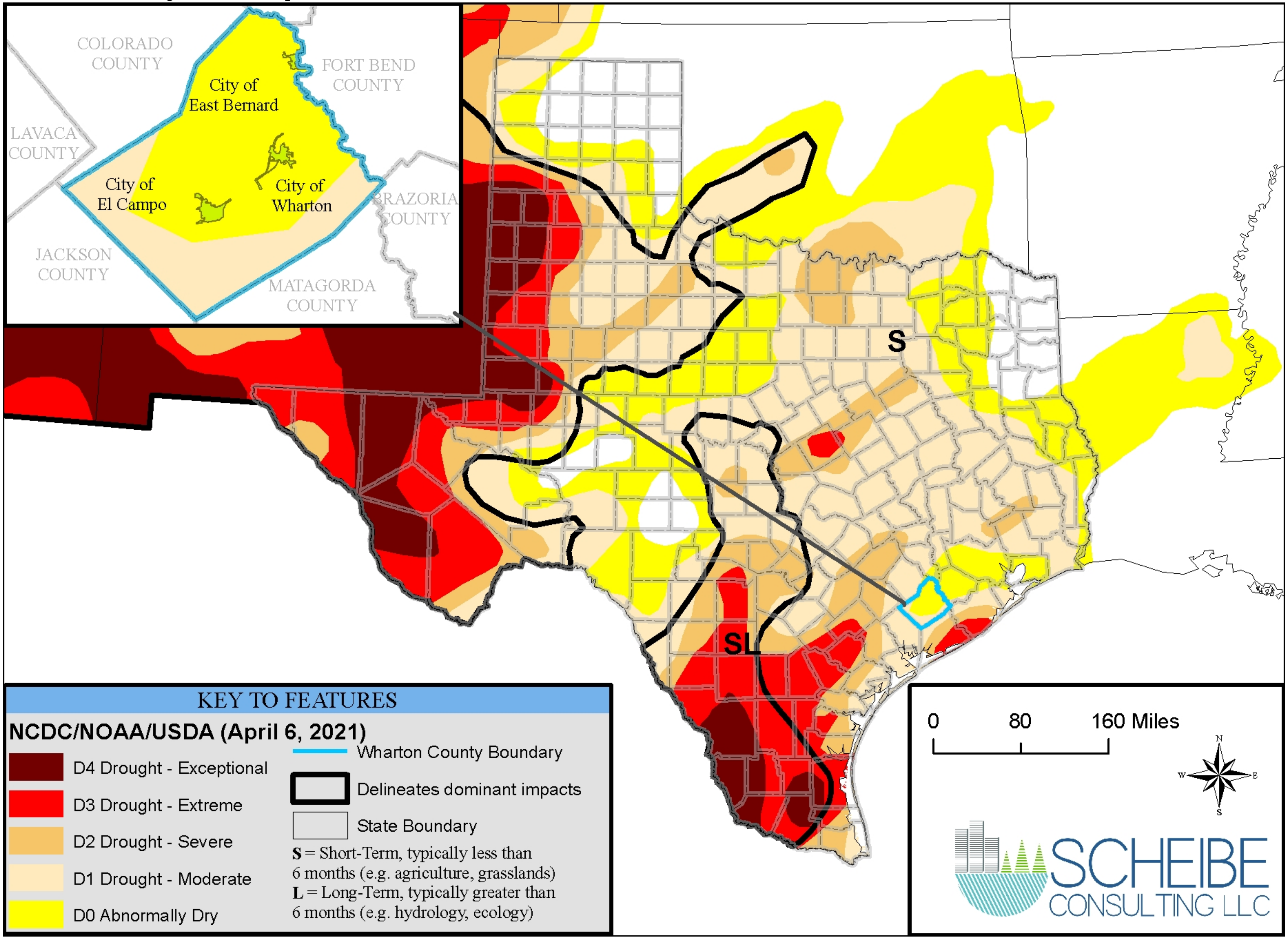


Figure 10-6. U.S. Drought Monitor, April 6, 2021



The Drought Impact Reporter

The Drought Impact Reporter contains information on impacts from droughts that affected Wharton County and participating communities between January 2005 and April 2021. Most of the impacts were classified as "agriculture" (1,505). Other impacts include "society and public health" (241), "fire" (912), "tourism and recreation" (89), "water supply and quality" (901), "energy" (18), "business and industry" (62), "plants and wildlife" (894), and "relief, response, and restrictions" (699). 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 the 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 the 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 a 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 the 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 to a 2016 EPA study, a total of more than 9,000 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 (NCDC), a strong heatwave affected Texas in the summers of 1999, 2000, and 2011. During these heatwaves, 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 Wharton County recorded by NOAA weather stations. NOAA weather station climate data consists of information collected from May 1904 to September 2011 by Pierce 1 E (USC00417020) weather station augmented with data from October 2011 to March 2021 from El Campo (USC00412786) weather station. These temperatures are experienced throughout the entire planning area (City of East Bernard, City of El Campo, City of Wharton, and Wharton County Unincorporated Areas).

TABLE 10-1. MAXIMUM TEMPERATURE DATA SUMMARIES													
Statistic	**Years**	**JAN**	**FEB**	**MAR**	**APR**	**MAY**	**JUN**	**JUL**	**AUG**	**SEP**	**OCT**	**NOV**	**DEC**
Highest Recorded Maximum	1904-2021	85	95	97	99	100	105	107	108	112	100	94	93
Highest Recorded Minimum	1904-2021	73	72	76	79	82	85	87	88	81	80	75	75
Average Maximum	1904-2021	63.7	66.9	73.3	79.7	85.6	90.9	93.3	94.3	90.0	83.5	73.5	65.7
Average Days with a Maximum Above 90	1904-2021	0.0	0.0	0.2	0.8	6.4	21.5	26.8	27.4	18.6	6.4	0.2	0.1

Notes:
Temperatures are in degrees Fahrenheit
From NOAA Weather Station Climate Data (May 1904 – March 2021)

10.2.2 Location

Drought

The 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 (up to 4 weeks) and is used to quantify drought's impacts on agriculture during the growing season. The index can vary significantly from week to week and indicates normal conditions at the beginning and end of the growing season. Figure 10-7 shows this index for the week ending on April 17, 2021.
- The Palmer Z Index measures short-term drought on a monthly scale. Figure 10-8 shows this index for March 2021.
- 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 10-9 and Figure 10-10 show this index for March 2014 and May 2015 to show the change in PDI after the May 2015 rain. Figure 10-11 shows the most current index of March 2021.
- 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 10-12 shows this index for March 2021.
- 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 10-13 shows the 24-month SPI map from April 2019 through March 2021.

Figure 10-7. Crop Moisture Index (Week Ending April 17, 2021)

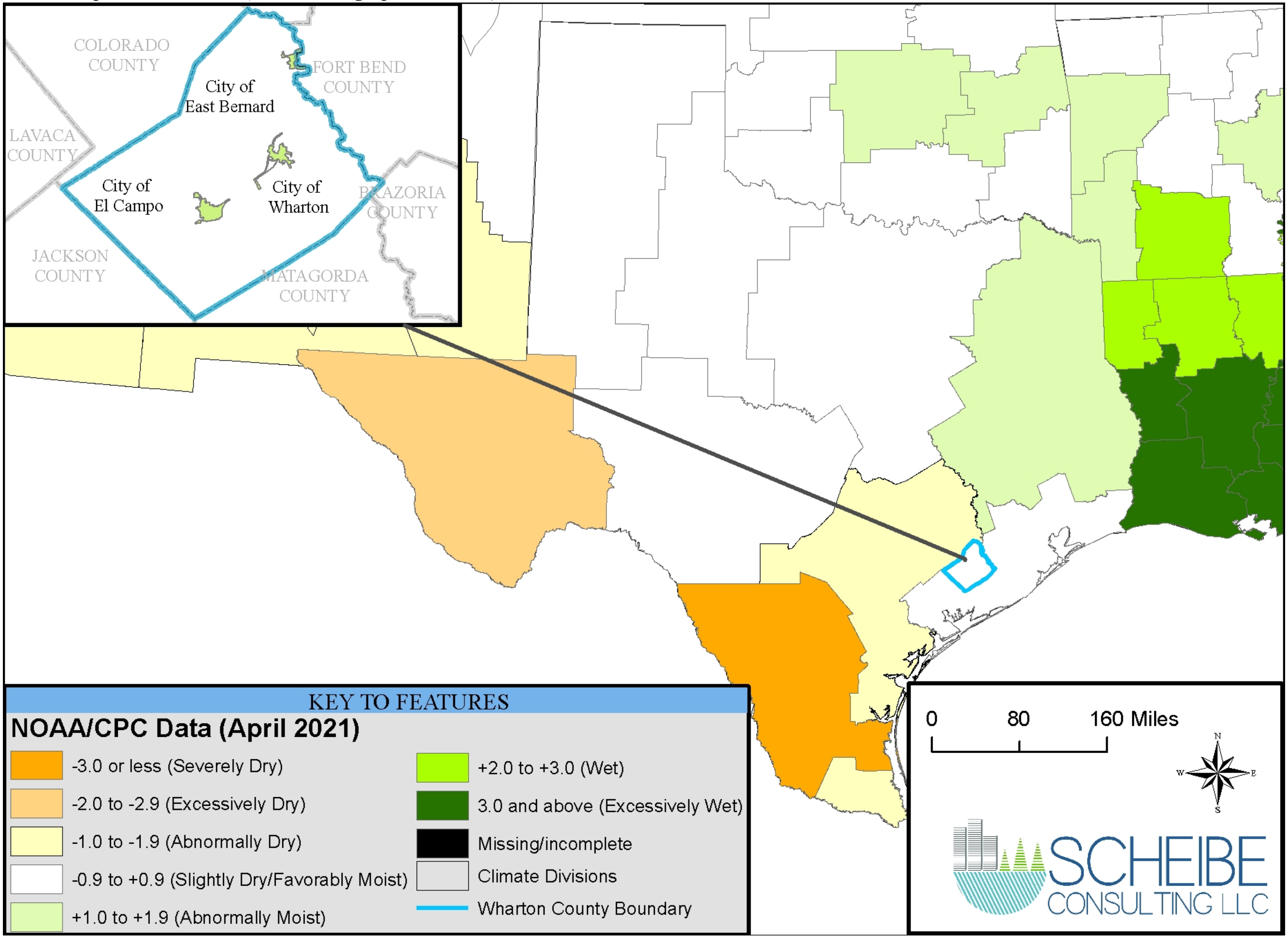


Figure 10-8. Palmer Z Index Short-Term Drought Conditions (March 2021)

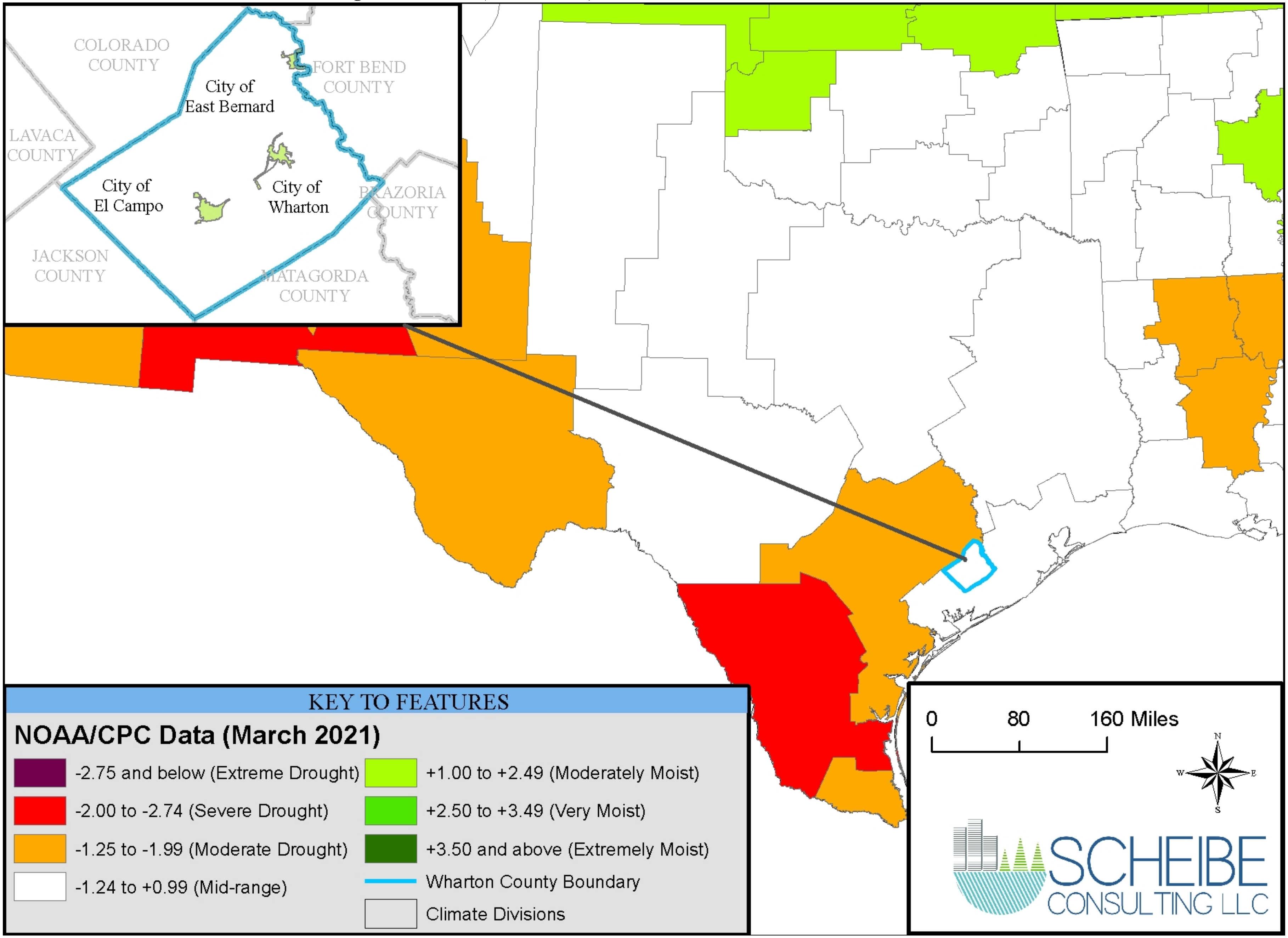


Figure 10-9. Palmer Drought Index (March 2014)

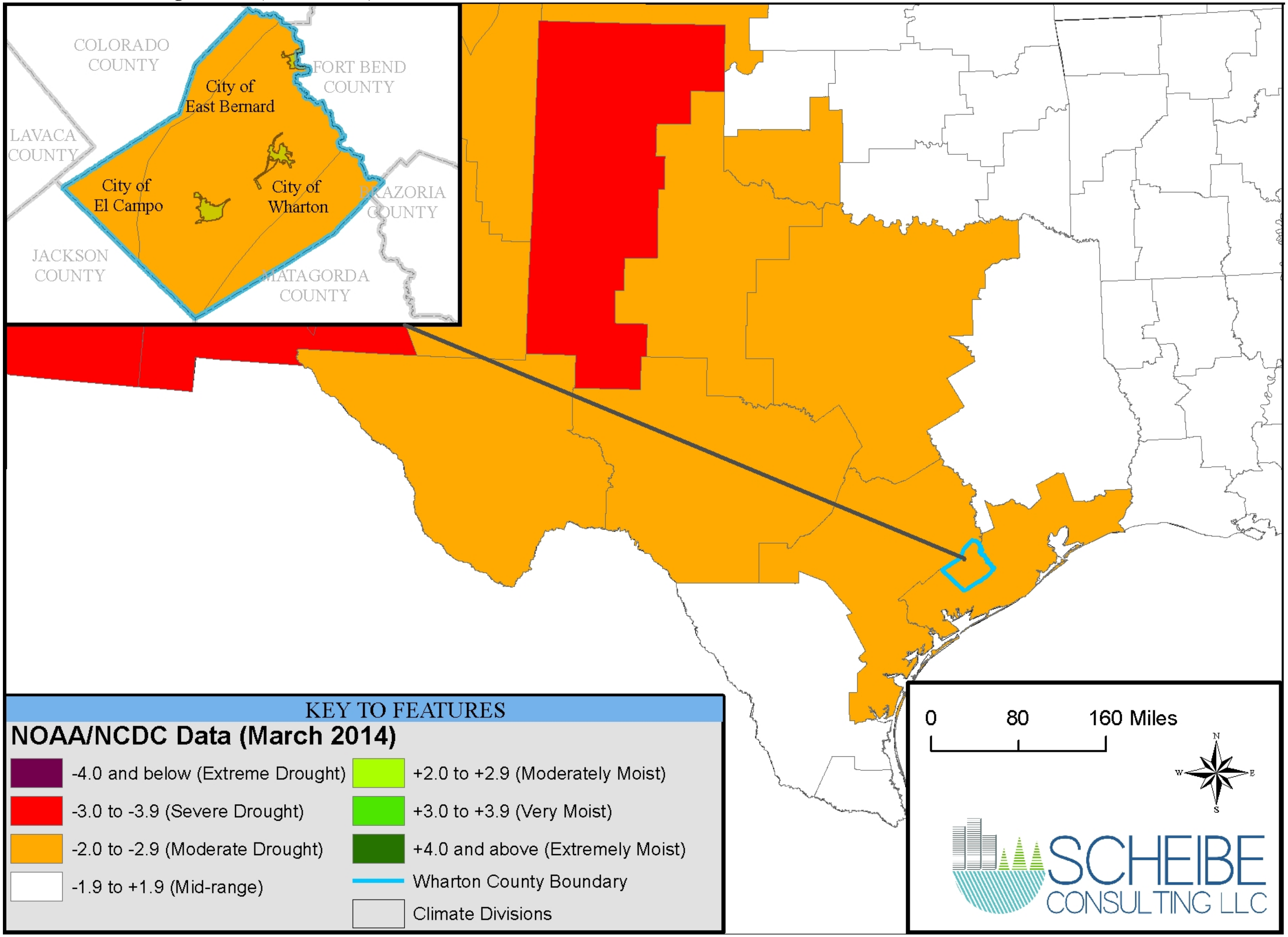


Figure 10-10. Palmer Drought Index (May 2015)

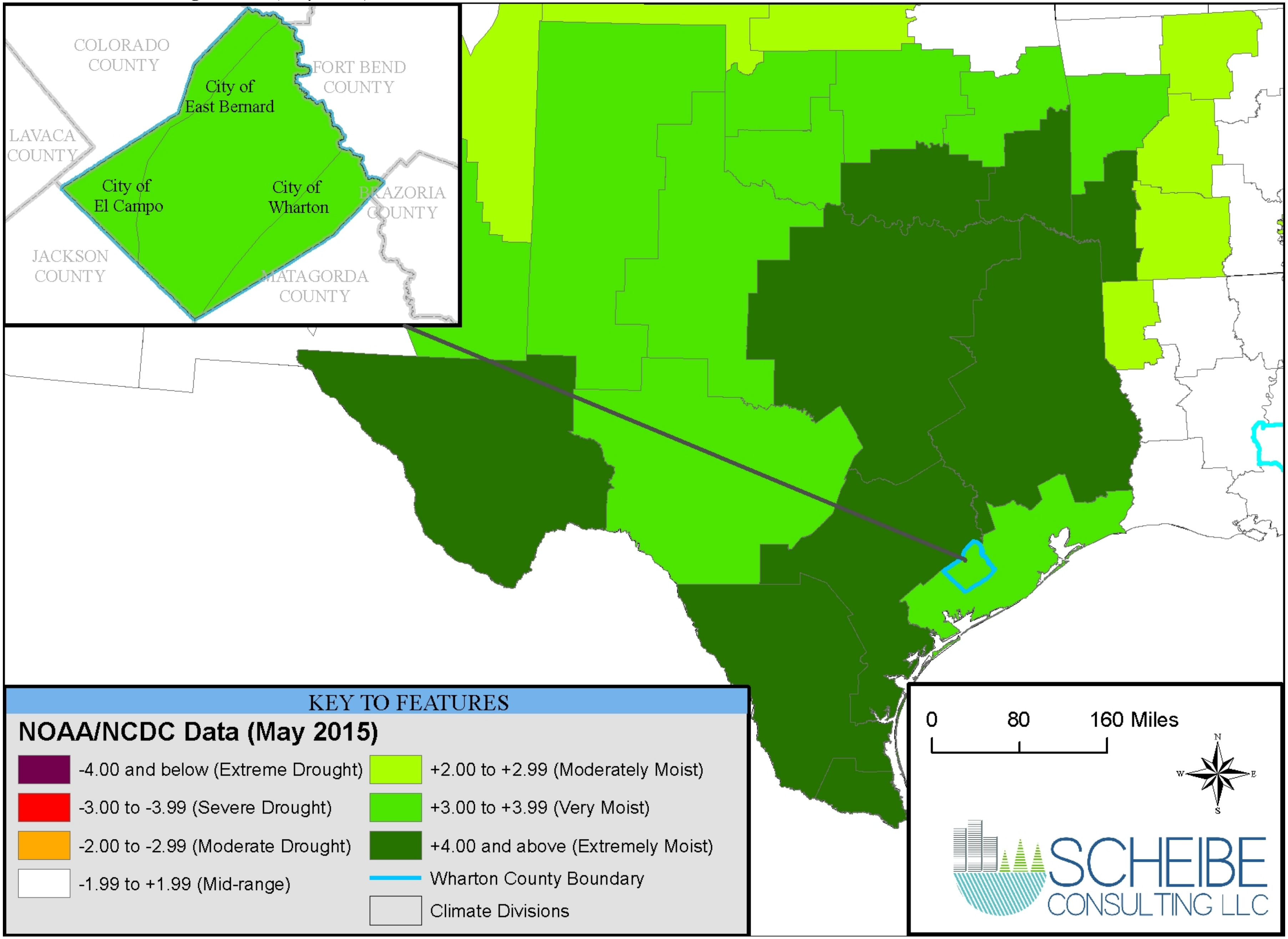


Figure 10-11. Palmer Drought Index (March 2021)

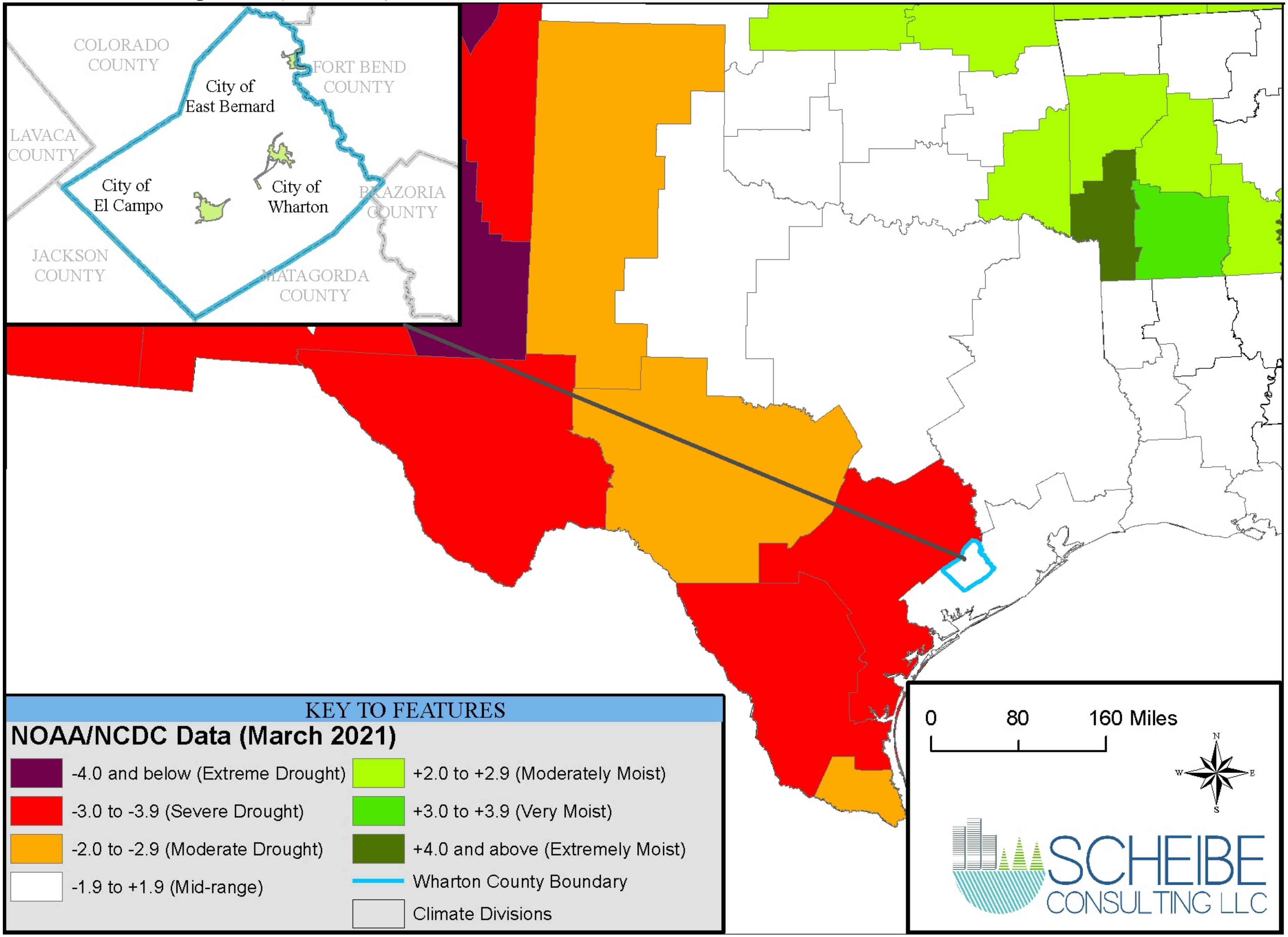


Figure 10-12. Palmer Hydrological Drought Index Long-Term Hydrologic Conditions (March 2021)

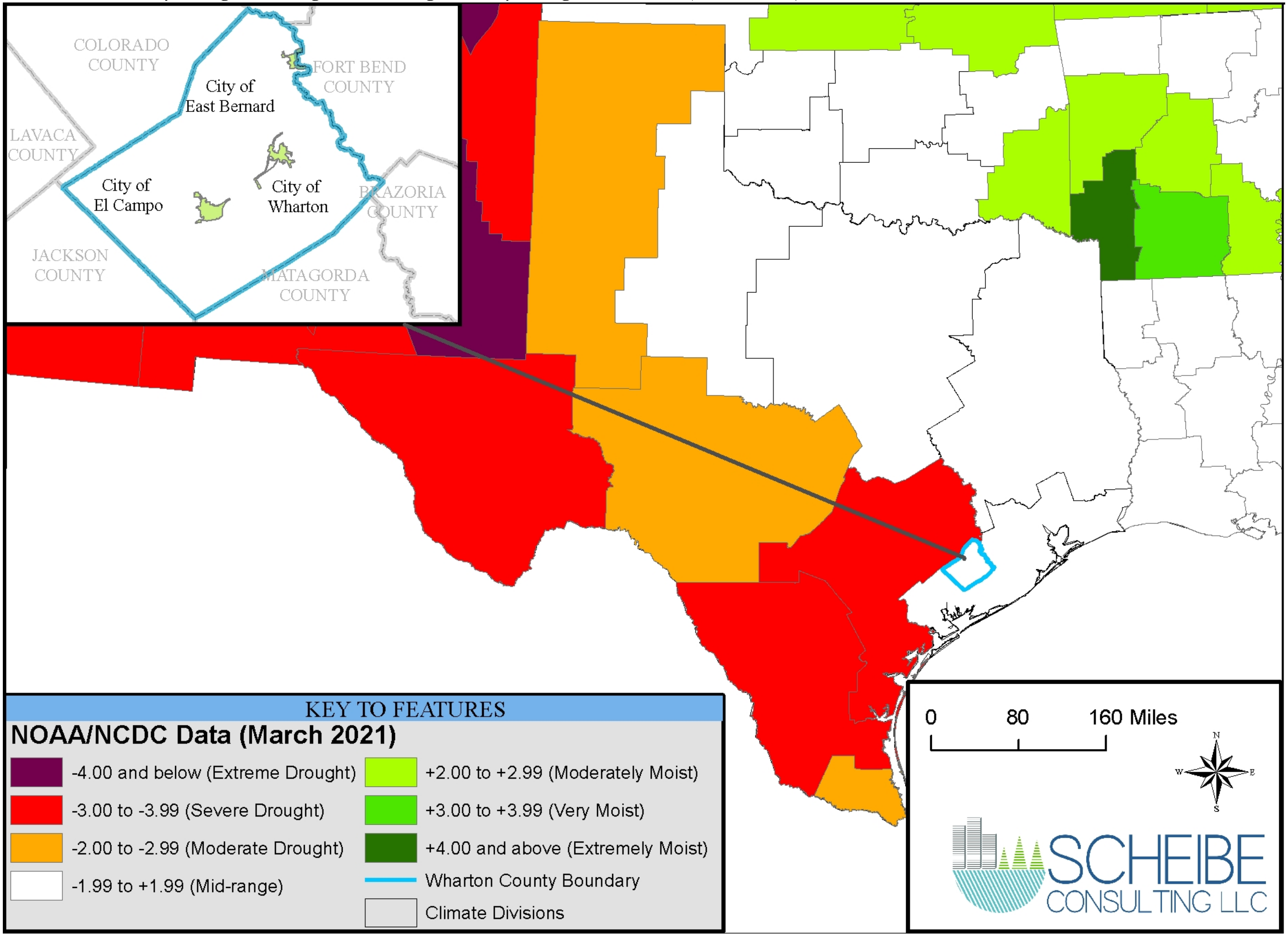
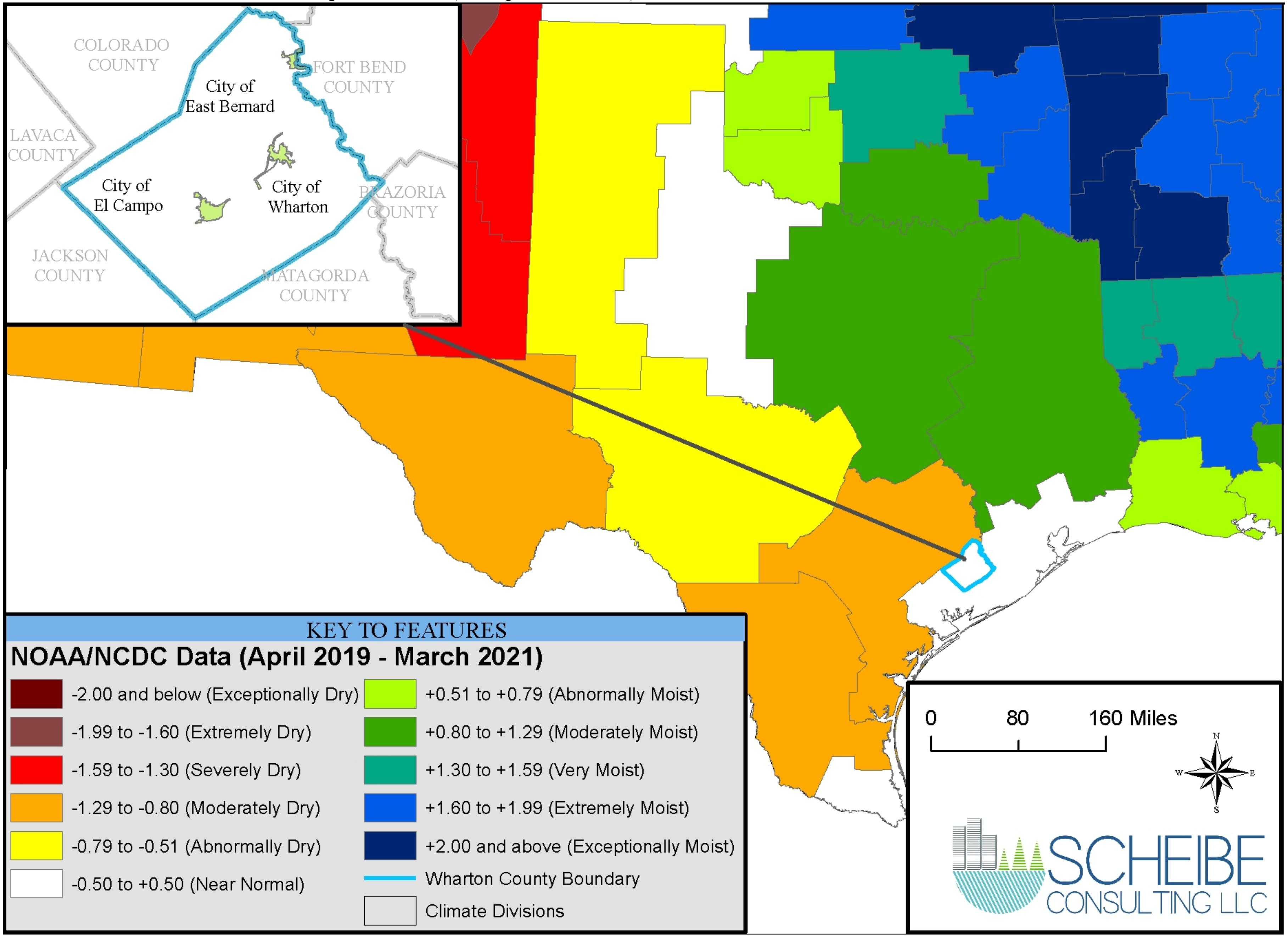


Figure 10-13. 24-Month Standardized Precipitation Index (through March 2021)



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 portions 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. A total of 9 drought events occurred within 50 miles of Wharton County from 1950 to 2010. Table 10-2 lists notable past drought events for Wharton County and the participating communities in this HMP update.

TABLE 10-2.
HISTORIC DROUGHT EVENTS IN WHARTON COUNTY (1996-2021)

Date	Estimated Damage Cost			
	Property	Crops	Injuries	Deaths
April 1996	$0	$0	0	0
May 1996	$20,000,000	$40,000,000	0	0
June 1996	$20,000,000	$40,000,000	0	0
May 1998	$20,000,000	$40,000,000	0	0
June 1998	$20,000,000	$40,000,000	0	0
July 1998	$0	$0	0	0
August 1998	$0	$0	0	0
August 2000	$0	$0	0	0
September 2000	$0	$0	0	0
August 2011	No Data	No Data	No Data	No Data

Extreme Heat

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

The record highs for Texas occur from May through October. The Wharton County (and participating communities) area experiences an average of four 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 future drought in Wharton and participating communities is likely, with an event possible in the next 8 years or less. According to information from the NCDC, Wharton County had 3 documented drought years between 1996 and 2021. Based on this historical information, the probability of a drought occurring in any given year is 12% (About 1 in 8 years). The same frequency (1 in 8 years) applies to the future probability. The level of probability for the entire community is therefore classified as "High"

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

Extreme Heat

On average, Wharton County and participating communities have experienced an average of 108.3 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 weather station data). This level of heat is considered an extreme danger for the area due to the moderate to high humidity levels combined with 90°F dry bulb temperature resulting in a heat index above 105. Wharton County and participating communities can expect similar numbers in the future (108.3 days per year and highly likely). With this frequency, the probability for extreme heat is classified as "High".

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.

Based on historical evidence, Wharton County and participating communities can expect to experience a drought up to the most sever level (D4) during future events. That being said, the probability of an event of such a severity level is considered low. Typical drought event impacts on Matagorda County are considered moderate. Moderate drought typically means less than 25% to 50% of the property (mainly agricultural) is severely damaged; injuries/illnesses are treatable or do not result in permanent disability; 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 forests 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 the 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 stream flows are lowest.

Additionally, there is an 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 heatstroke. 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. This is defined as less than 25% to 50% of the 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.

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 depend 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. 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 (updated 2016) (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. 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 the 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 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-MH, annualized losses were estimated using 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-MH data inventory (updated 2010 U.S. Census data and 2018 RS Means Square Foot Costs), and the 2017 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 impacted by drought and extreme temperatures. For drought Figure 10-14 profiles the county and participating cities' agriculture use, which could all be potentially impacted by drought. The exposure rate for the entire HMP update area is approximately $208,540,000 based on the USDA's 2017 Census of Agriculture (See Table 10-5). 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.

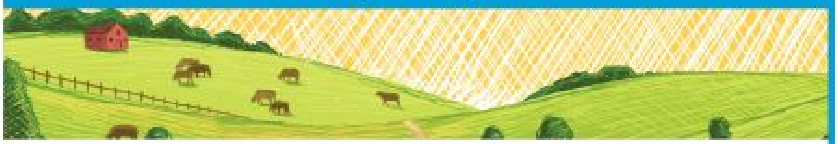
TABLE 10-3
EXPOSED STRUCTURES AND POPULATION

Jurisdiction	Residential	Commercial	Other *	**Total Structures**	**Total Population**
City of East Bernard	909	62	43	**1,014**	**2,272**
City of El Campo	4,465	352	200	**5,017**	**11,602**
City of Wharton	3,299	321	138	**3,758**	**8,832**
Unincorporated Area	6,799	210	181	**7,190**	**18,574**
Wharton County Total	**15,472**	**945**	**562**	**16,979**	**41,280**

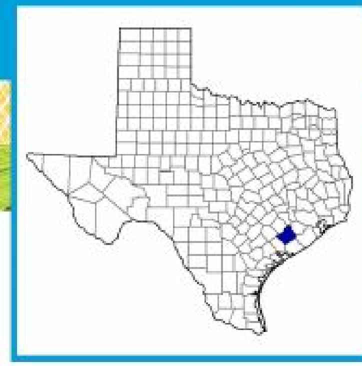
Note: *Other includes industrial, agricultural, religious, governmental, and educational classifications.

Figure 10-14. USDA Census of Agriculture Wharton County Profile 2017

2017 CENSUS OF AGRICULTURE *County Profile*



Wharton County
Texas



Total and Per Farm Overview, 2017 and change since 2012

	2017	% change since 2012
Number of farms	1,500	-3
Land in farms (acres)	535,305	-19
Average size of farm (acres)	357	-16
Total	($)	
Market value of products sold	208,540,000	-44
Government payments	14,777,000	+8
Farm-related income	9,719,000	-57
Total farm production expenses	176,474,000	-43
Net cash farm income	56,562,000	-45
Per farm average	($)	
Market value of products sold	139,026	-42
Government payments (average per farm receiving)	26,867	+61
Farm-related income	20,248	-42
Total farm production expenses	117,649	-41
Net cash farm income	37,708	-43

1 Percent of state agriculture sales

Share of Sales by Type (%)

Crops	86
Livestock, poultry, and products	14

Land in Farms by Use (%) [a]

Cropland	61
Pastureland	33
Woodland	5
Other	2

Acres irrigated: 56,668
11% of land in farms

Land Use Practices (% of farms)

No till	4
Reduced till	4
Intensive till	14
Cover crop	1

Farms by Value of Sales

	Number	Percent of Total [a]
Less than $2,500	548	37
$2,500 to $4,999	179	12
$5,000 to $9,999	164	11
$10,000 to $24,999	192	13
$25,000 to $49,999	91	6
$50,000 to $99,999	108	7
$100,000 or more	218	15

Farms by Size

	Number	Percent of Total [a]
1 to 9 acres	152	10
10 to 49 acres	483	32
50 to 179 acres	419	28
180 to 499 acres	204	14
500 to 999 acres	92	6
1,000 + acres	150	10

USDA **United States Department of Agriculture**
National Agricultural Statistics Service

www.nass.usda.gov/AgCensus

2017 CENSUS OF AGRICULTURE *County Profile*

Market Value of Agricultural Products Sold

	Sales ($1,000)	Rank in State [b]	Counties Producing Item	Rank in U.S. [b]	Counties Producing Item
Total	**208,540**	**22**	**254**	**486**	**3,077**
Crops	**179,249**	**2**	**253**	**194**	**3,073**
Grains, oilseeds, dry beans, dry peas	74,447	3	232	543	2,916
Tobacco	-	-	-	-	323
Cotton and cottonseed	49,444	16	174	28	647
Vegetables, melons, potatoes, sweet potatoes	1,359	35	188	662	2,821
Fruits, tree nuts, berries	1,030	48	225	467	2,748
Nursery, greenhouse, floriculture, sod	49,275	4	155	62	2,601
Cultivated Christmas trees, short rotation woody crops	-	-	43	-	1,384
Other crops and hay	3,695	54	251	690	3,040
Livestock, poultry, and products	**29,291**	**103**	**254**	**1,352**	**3,073**
Poultry and eggs	112	82	235	1,021	3,007
Cattle and calves	23,219	86	254	697	3,055
Milk from cows	(D)	78	94	(D)	1,892
Hogs and pigs	(D)	(D)	216	(D)	2,856
Sheep, goats, wool, mohair, milk	34	172	247	1,959	2,984
Horses, ponies, mules, burros, donkeys	259	107	254	806	2,970
Aquaculture	5,123	3	79	64	1,251
Other animals and animal products	(D)	37	229	(D)	2,878

Total Producers [c]	**2,431**
Sex	
Male	1,631
Female	800
Age	
<35	242
35 – 64	1,317
65 and older	872
Race	
American Indian/Alaska Native	6
Asian	18
Black or African American	215
Native Hawaiian/Pacific Islander	-
White	2,175
More than one race	17
Other characteristics	
Hispanic, Latino, Spanish origin	197
With military service	221
New and beginning farmers	730

Percent of farms that:

Have internet access	67
Farm organically	1
Sell directly to consumers	1
Hire farm labor	25
Are family farms	96

Top Crops in Acres [d]

Cotton, all	80,643
Corn for grain	69,499
Rice	30,369
Forage (hay/haylage), all	25,779
Sorghum for grain	18,383

Livestock Inventory (Dec 31, 2017)

Broilers and other meat-type chickens	627
Cattle and calves	57,475
Goats	436
Hogs and pigs	133
Horses and ponies	1,580
Layers	7,670
Pullets	34
Sheep and lambs	700
Turkeys	38

See 2017 Census of Agriculture, U.S. Summary and State Data, for complete footnotes, explanations, definitions, commodity descriptions, and methodology.
[a] May not add to 100% due to rounding. [b] Among counties whose rank can be displayed. [c] Data collected for a maximum of four producers per farm.
[d] Crop commodity names may be shortened; see full names at www.nass.usda.gov/go/cropnames.pdf. [e] Position below the line does not indicate rank.
(D) Withheld to avoid disclosing data for individual operations. (NA) Not available. (Z) Less than half of the unit shown. (-) Represents zero.

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-MH, annualized losses were estimated using 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-MH inventory data (updated with 2010 Census Data and 2018 RS Means Square Foot Costs), and the 2017 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

Drought

The planning partnership has the ability to minimize any impacts on residents and water consumers in the county and participating cities should several consecutive dry years occur. No significant life or health impacts are anticipated as a result of drought within the planning area

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
City of East Bernard	638	28.07	342	15.05	129	5.68
City of El Campo	3402	29.33	1648	14.21	992	8.55
City of Wharton	2317	26.23	1288	14.58	1251	14.17
Unincorporated Area	4,715	25.39	2,741	14.76	1,537	8.28
Wharton County Total	**11,072**	**26.82**	**6,019**	**14.58**	**3,910**	**9.47**

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 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 (%)
Wharton County Total	**208,540,000**	**4,800,000**	**2.30**

Extreme Heat

Typically, the only impact extreme heat has on general building stock is increased demand for 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 $5,000 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 Chapter 10.2.1, the participating communities also experience the following for both drought and extreme heat events:

- **City of East Bernard -** 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. Communities that have not developed or implemented a Drought Contingency Plan or Emergency Response Plan are more vulnerable to the effects of drought. Residents who are uninformed of the benefits of water conservation or how to effectively apply it are at an increased risk as well.
- **City of El Campo -** The City of El Campo 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 and water conservation tactics are more vulnerable. Communities that do not have Drought Contingency or Emergency Response Plans increase their risk as well.
- **City of Wharton -** The City of Wharton 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. Due to the rural landscape of the area and dry climate, during times of drought and extreme heat events, water restrictions could be enforced. Communities that have not identified the areas and facilities of higher risk to the negative impacts of drought increase their vulnerability. Those who do not have mitigation plans in place or techniques to fund them are more at risk as well.

- **Wharton 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 Wharton County's Unincorporated Areas, response times restoring outages caused by a blackout could be lengthy. This would have a greater effect on the young, elderly, and economically disadvantaged. Communities not implementing wildfire mitigation measures are increasing their risk to potential negative impacts of this hazard 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.

Community Perception of Vulnerability

See the front page of the current chapter for a summary of hazard rankings for Wharton County and participating communities in this plan update. Chapter 21 gives a detailed description of these rankings and Chapter 22 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 highways 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 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

The 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 Wharton 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 the frequency of extreme heat events.
- The effects of recent droughts have exposed the vulnerability of the planning area's 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 the power supply and water rights.
- Development of mitigation- or response-based state drought plans.

Chapter 11.
EARTHQUAKE

EARTHQUAKE RANKING	
Wharton County	Low
City of East Bernard	Low
City of El Campo	Low
City of Wharton	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. The 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 website 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 a magnitude; or by the impact on people and structures, measured as intensity.

Magnitude

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

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

Estimates of moment magnitude roughly match the local magnitude scale (ML) commonly called the Richter scale. One advantage of the Mw 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, the Mw 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 are similar to the passing of a truck.

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 are 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 are 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 is great in substantial buildings, with partial collapse. Buildings shifted off foundations.

X. Some well-built wooden structures are destroyed; most masonry and frame structures are 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 are 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 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 list 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%

Note:
a. PGA measured in percentage of gravity (g), where g is the acceleration of gravity
From 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 a 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, 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 soil's 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 Wharton 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 Wharton 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 Wharton County and the participating communities since 1847, the earliest date data is available.

11.2.2 Location

While Texas does face some earthquake hazards, 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 in Texas.

Figure 11-1. Texas Earthquakes (1847-2021)

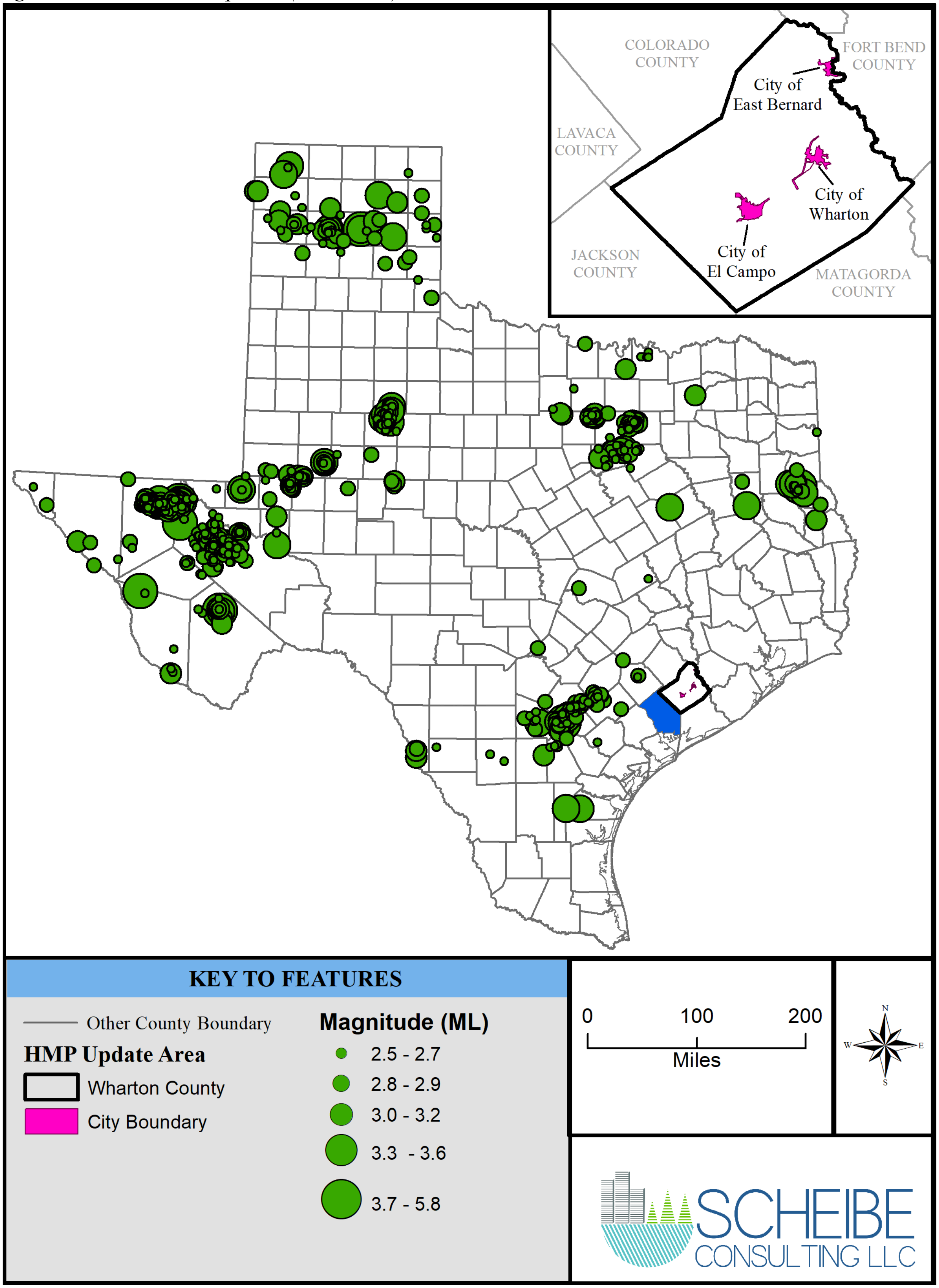
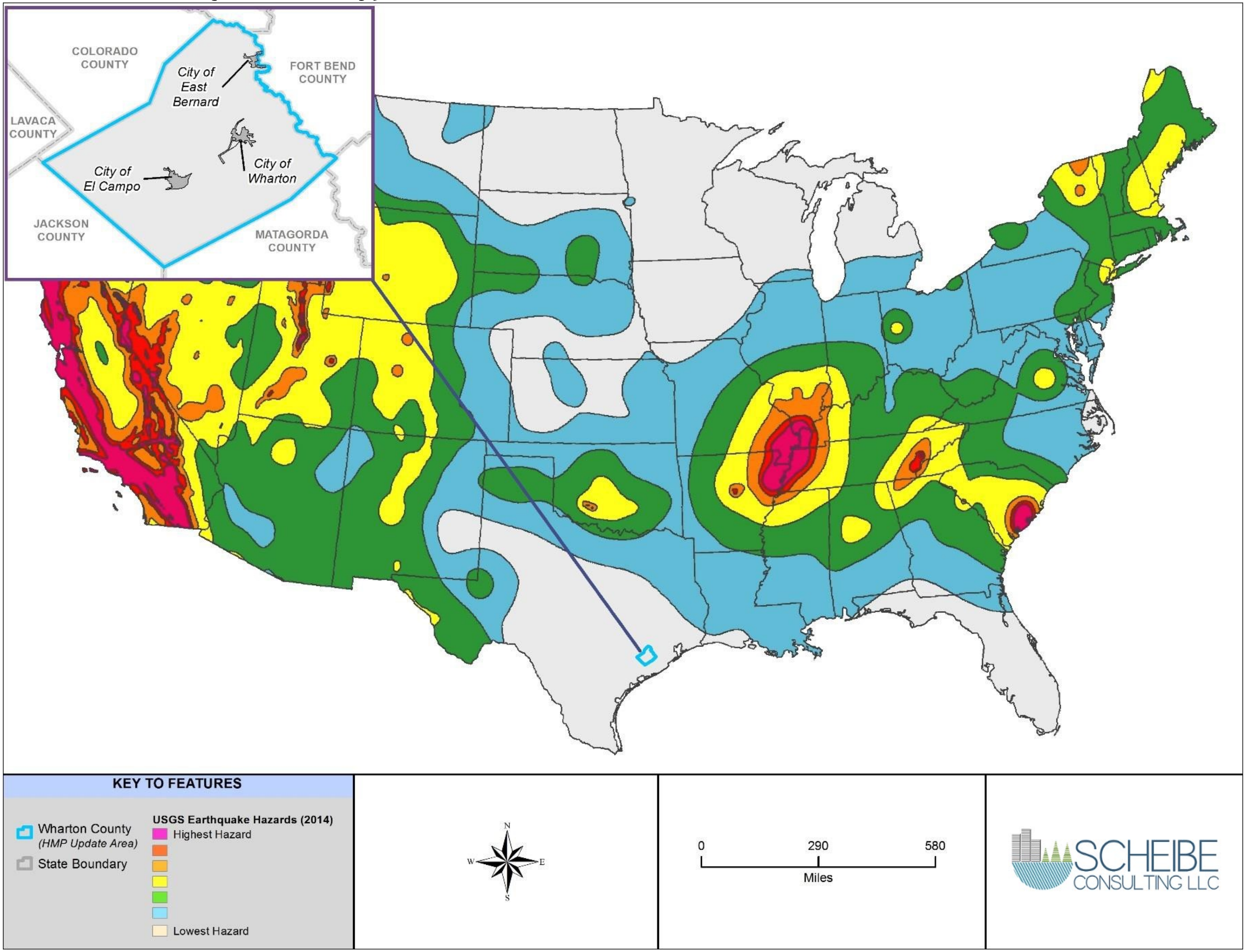


Figure 11-2. Probabilistic Earthquake Hazard Map for the U.S.



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 near future is unlikely (event not probable in the next 100 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 Wharton County and the participating community is 2 percent or less. Overall, the probability of a damaging earthquake somewhere in Wharton 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 Wharton County and the participating communities is low (event not probable in next 100 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 Wharton 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 the 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 in Figure 11-3. The PGA is measured in numbers of g's (the acceleration associated with gravity). A future 500-Year HAZUS-MH probabilistic-event scenario for Wharton County produced a PGA of 0.0148, which is lower than the FEMA PGA minimum requirement (3%g) for earthquake analysis profiling. 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; 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)

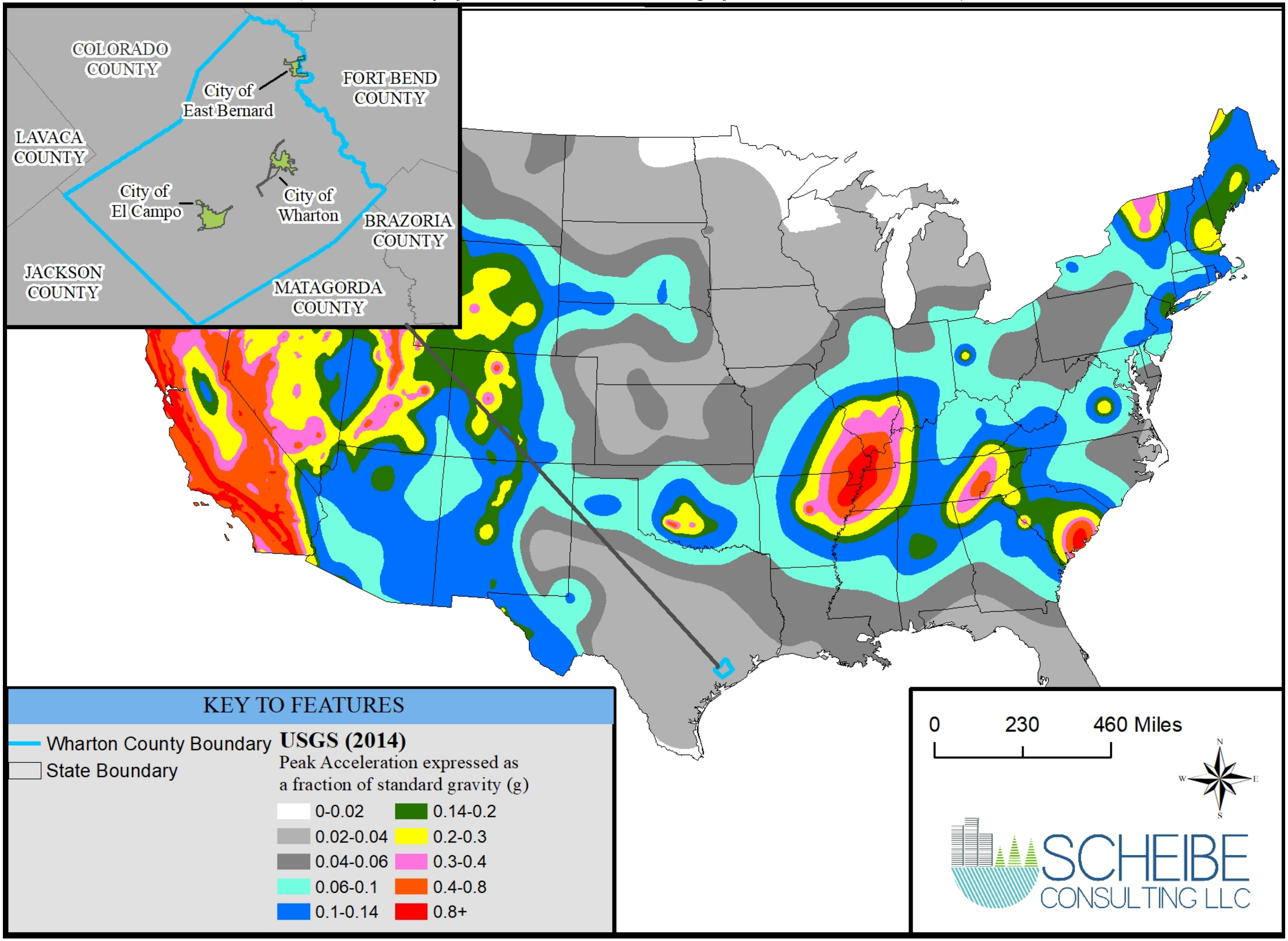
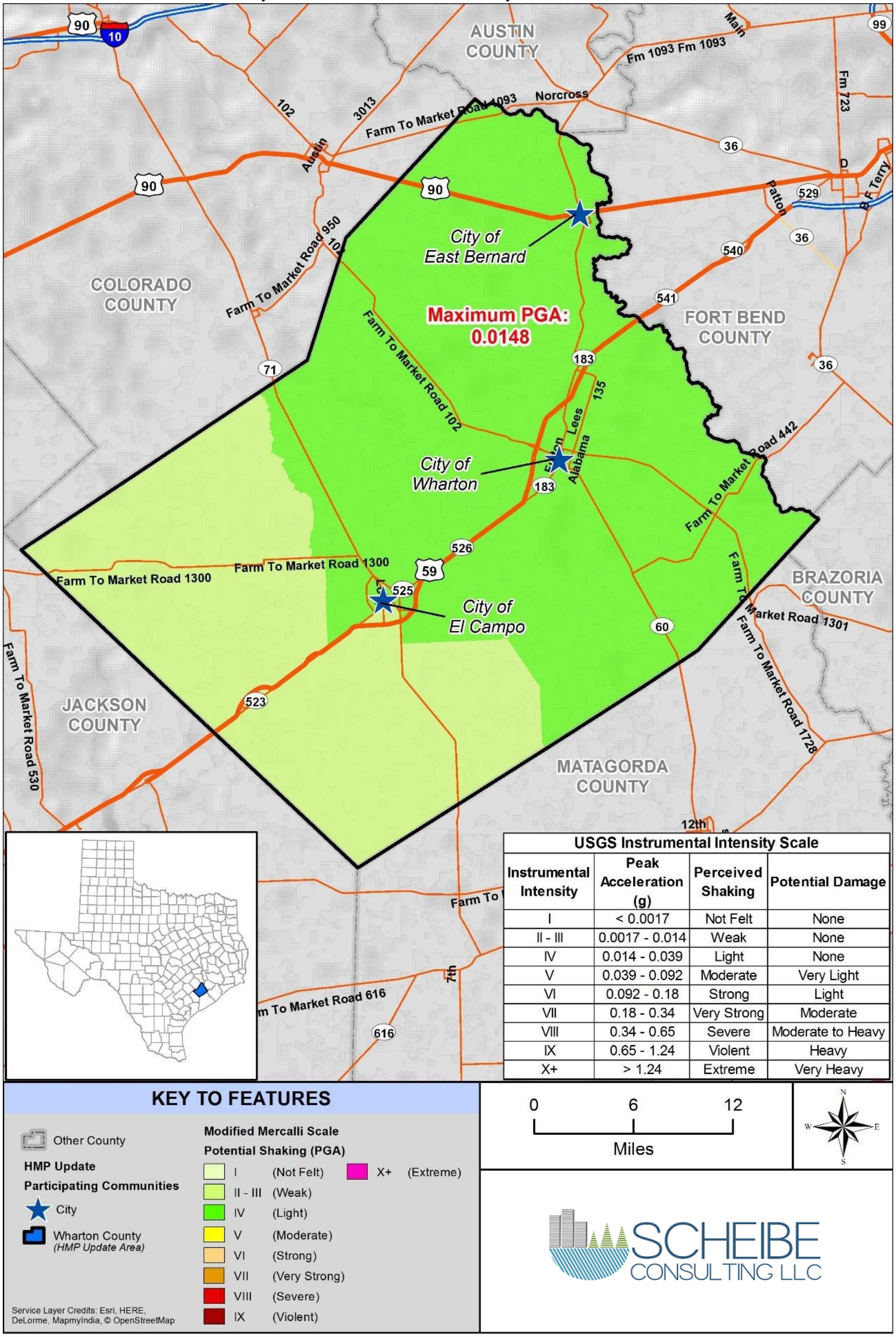


Figure 11-4. 500-Year Probability Event in Wharton County



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

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 participating cities and the historical earthquake record is short, accurate estimations of magnitude, timing, or location of future dangerous earthquakes in Wharton 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 of 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

All structures, people, and infrastructure within the participating communities are vulnerable to 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. Wharton County and all participating communities PGA are less than 2%g (.02) and there have been no recorded earthquakes in or near the HMP update area. Furthermore, Wharton County and participating communities do not have any geologic fault lines running through their jurisdiction (See Figure 11-1). Therefore, only a minimum level-1 HAZUS-MH analysis was profiled using the 500-year probability event scenario.

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 entire county population is at extremely minimal risk. The degree of exposure is dependent on many factors, including the age and construction type of the structures people live in, the soil types 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 HAZUS-MH inventory data (updated with 2010 U.S. Census data and 2018 RS Means Square Foot Costs), there are 16,979 buildings within the census blocks that define the planning area with an asset replaceable value of almost $3.9 billion (excluding contents). About 91% of these buildings (and 75% of the building value) are associated with residential housing. 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 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 the 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 the 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

All structures, people, and infrastructure within the participating communities are vulnerable to earthquake damage, however, due to the low risk of occurrence, only a minimum level-1 HAZUS-MH 500-year probability event analysis was conducted. The 500-Year HAZUS-MH modeled event for Wharton County and the participating communities produced a maximum PGA of 1.48%g (Figure 11-4), which is lower than the FEMA PGA minimum requirement for earthquake analysis (3%g). A future event could produce potential shaking of 0.0148 PGA in magnitude during a 500-year event in Wharton County (and all participating communities) creating a 'weak' to 'light' perceived shaking with no potential damage based 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 Wharton County and the participating communities, annualized economic losses from the HAZUS-MH 500-Year modeled event produced $0. Wharton County and participating communities can expect no loss of functionality for critical facilities and infrastructures, utility, transportation, and other essential services, but an event causing such damage is not considered impossible.

Vulnerability Narrative

- **City of East Bernard** - The City of East Bernard is classified as 'Low' due to a PGA of less than 2%, the number of previous events (0), probability of future events (minimal), and local knowledge. A future probabilistic event is expected to cause little to no damage to the area.
- **City of El Campo** - The City of El Campo is classified as 'Low' due to a PGA of less than 2%, the number of previous events (0), probability of future events (minimal), and local knowledge. A future probabilistic event is expected to cause little to no damage to the area.
- **City of Wharton** – The City of Wharton is classified as 'Low' due to a PGA of less than 2%, the number of previous events (0), probability of future events (minimal), and local knowledge. A future probabilistic event is expected to cause little to no damage to the area.
- **Wharton County (Unincorporated Area)** - There are no fault lines throughout the Unincorporated Areas of Wharton County. The closest fault lines are located approximately 55 miles to the west in Fayette and Gonzales counties. However, if an earthquake were to occur in the Unincorporated Areas of Wharton County, damages to critical facilities and major thoroughfares (such as US 59 or US 90) could delay emergency service support from neighboring communities. Rural residents and property are more vulnerable as response times could be limited. Rural roadways with single-lane crossings or crossings currently in need of improvements increase the risk and vulnerability to these residents as emergency response efforts would be further compromised. Future events in the Unincorporated Areas of Wharton County are considered 'Low'.

Community Perception of Vulnerability

See the front page of the current chapter for a summary of hazard rankings for Wharton County and participating communities in this plan update. Chapter 21 gives a detailed description of these rankings and Chapter 22 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 and participating cities. 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 and participating cities.
- 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 individual events.
- The cost of retrofitting buildings to meet earthquake seismicity standards may be cost-prohibitive.
- Dams located in the county and participating cities may not have been engineered to withstand probable seismic events.
- Information regarding the liquefaction susceptibility of soils in the planning area is lacking.

Chapter 12.
FLOOD

FLOOD RANKING	
Wharton County	High
City of East Bernard	High
City of El Campo	High
City of Wharton	High

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 is 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. The 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 the 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 a river. General rain floods can result in considerably large volumes of water. Because the rate of rise is slow and the time available for a 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 a 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 shows the number of flash floods in each county from 1986 to 1999. Wharton County lies just south of the “Flash Flood Alley”.

Thunderstorm floods occur 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. It is worth noting that the recent snowstorm of 2021 resulted in significant snow accumulation in the headwaters of the Colorado River, it was an extremely unusual event with essentially no flood risk impacts downstream and into Wharton County.

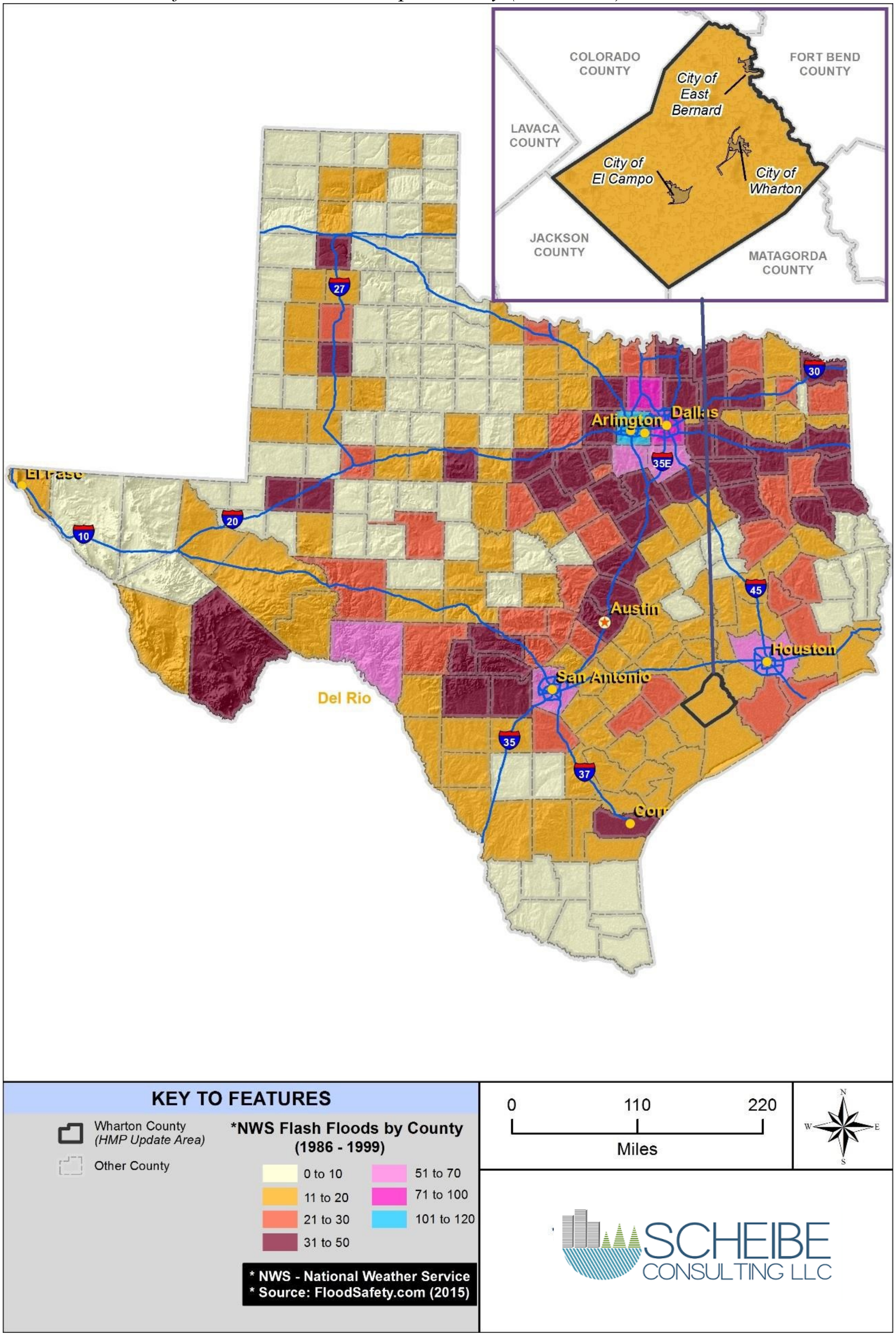
Hurricanes and Tropical Storms

The United States has a significant hurricane problem. More than 60% of the U.S. population lives 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.

Wharton County, being a Texas Coastal Bend 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 deadliest of all, inland flooding. Rain-triggered flooding is not just limited to coastlines as 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, Hurricane Harvey, 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)



12.1.2 Floodplain

A floodplain is an 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 period of time. 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 bodies of water, 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; the land is fertile and suitable for farming; transportation by water is easily accessible; the 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.

12.1.6 Community Rating System

The Community Rating System (CRS) is a voluntary program within the NFIP that encourages floodplain management activities that exceed the minimum NFIP requirements. Flood insurance premiums are discounted to reflect the reduced flood risk resulting from community actions meeting the following three goals of the CRS:

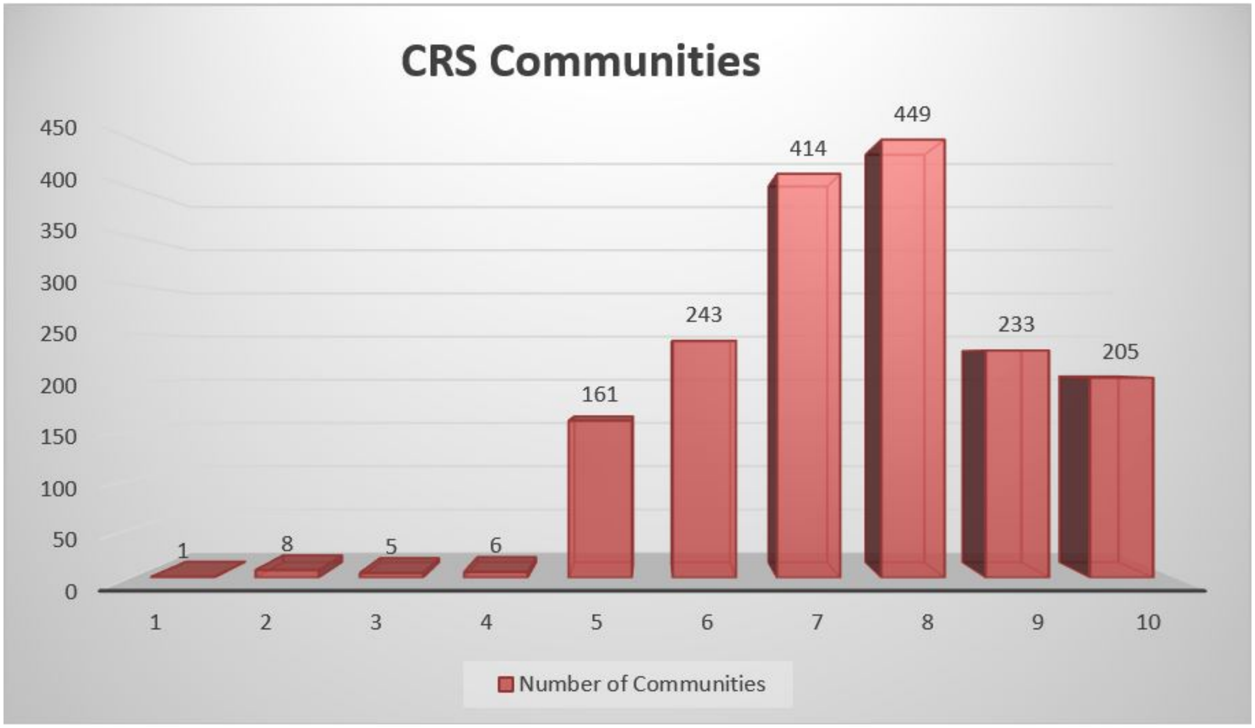
- Reduce flood losses
- Facilitate accurate insurance rating
- Promote awareness of flood insurance

For participating communities, flood insurance premium rates are discounted in increments of 5%. For example, a Class 1 community would receive a 45% premium discount, and a Class 9 community would receive a 5% discount. (Class 10 communities are those that do not participate in the CRS; they receive no discount.) The CRS classes for local communities are based on 18 creditable activities in the following categories:

- Public information
- Mapping and regulations
- Flood damage reduction
- Flood preparedness.

Figure 12-2 shows the nationwide number of CRS communities by class as of April 2021, when there were 1,211 communities receiving flood insurance premium discounts under the CRS program.

Figure 12-2. CRS Communities by Class Nationwide as of April 2021.



CRS activities can help to save lives and reduce property damage. Communities participating in the CRS represent a significant portion of the nation's flood risk; over 66% of the NFIP's policy base is located in these communities. Communities receiving premium discounts through the CRS range from small to large and represent a broad mixture of flood risks. Of the communities involved in this HMP updated, only the City of Wharton participates in the CRS program.

12.2 HAZARD PROFILE

Texas has the most flash flood deaths of any state in the country. Although Wharton County and participating communities do not fall in the "Flash Flood Alley" area of Texas, it is still susceptible to flash flood events every year. 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, Wharton County and participating communities in this HMP update have had significant seasonal floods along the Colorado and San Bernard 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. By far the highest risk areas for flash flooding are regions of overflow from the Colorado River, primarily being the upper headwaters of Peach Creek, Caney Creek, and Baughman Slough. During Hurricane Harvey, the headwaters of these specific creeks became inundated with overflows from the Colorado River that rushed through neighborhoods causing extreme flooding in a very short period of time. In some cases, the flooding extends were up to the eves of homes.

Flooding in the county and participating cities 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, but some level of additional work is still needed on this front.

The potential for flooding can change and increase through various land-use changes and changes to the 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 NCDC Storm Events Database includes flood events that occurred in Wharton County and participating communities between 1965 and 2019. Table 12-1 provides a summary of the results of these statistics. Events listed as Wharton County and participating communities in the table below affected large portions of the HMP update area. Specific events described for each participating community are counted and described below. Large flood storms may have affected additional jurisdictions.

TABLE 12-1.
SUMMARY OF HISTORIC FLOODS IN WHARTON COUNTY AND PARTICIPATING COMMUNITIES (1965-2019)

Location	Property Damage	Crop Damage	Injuries	Deaths
Lane City	$8,000.00	-	0	0
El Campo	$376,000.00	$2,000.00	4	0
Wharton County	$1,365,000.00	$20,000.00	1	0
City of Wharton	$604,000.00	-	0	0
East Bernard	$115,000.00	-	3	0

Note:
From NOAA Storm Events Database

Notable incidents from the NDCD Storm Events Database (and confirmed by local data) in Wharton County and participating communities are described below:

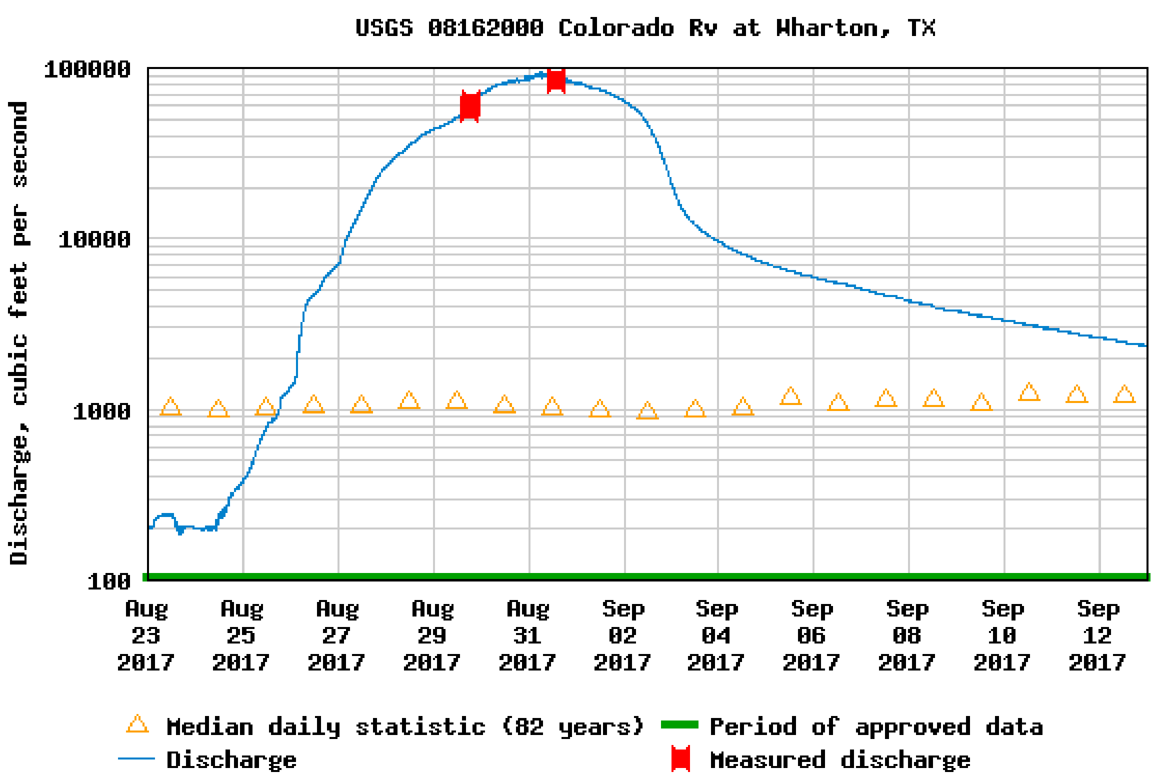
- April 4, 1997 – Intense rainfall rates of 3 to 4 inches per hour caused street flooding throughout the county and led to many inundated homes in El Campo. In total, the associated property damage was $50,000, but no injuries or fatalities were reported.
- April 11, 1997 – Heavy rains led to flooding throughout Wharton County, where numerous streets were reported to be flooded. In the City of Wharton, one house was flooded. No injuries or fatalities were associated with the storm, but the event resulted in $15,000 in property damage.

- October 17, 1998 – Major flooding occurred across the northwest part of Wharton County, inundating homes along FM 102. Some Elm Grove subdivision homes in northern Wharton County were inundated with up to one foot of water. No injuries or property damage were associated with the event, but the storm did cause $50,000 in property damage.
- August 30, 2001 – A series of upper-level disturbances produced heavy and rain and some severe weather across the southern portions of southeast Texas. Rainfall rates of one inch per hour up to 6 hours at a time were recorded in multiple counties, including Wharton County. Heavy rainfall caused numerous road closures throughout the county and led to $75,000 in property damage. No injuries or fatalities were associated with the storm.
- September 1, 2001 – Widespread flooding occurred throughout southeastern Texas, including the western portion of Wharton County. The sheriff's office reported secondary roads flooded as a result of the storm. The event caused $20,000 in property damage, but no injuries or fatalities were reported.
- July 14, 2002 – In the Town of Hungerford, intense rains caused several roads to be flooded and inundated two homes. No injuries or fatalities were reported, but property damage totaled $25,000.
- September 7, 2002 – Flash flooding occurred in Wharton, leading to inundated homes within the city. The storm caused $95,000 in property damages, but no injuries or fatalities were reported.
- November 17, 2003 – Severe weather occurred throughout southeastern Texas as a nearly stationary group of thunderstorms repeatedly developed in the area. Neighboring counties were significantly affected by tornadoes and thunderstorms, causing over 300 homes to be flooded. Property damage for the City of Wharton totaled $15,000, as flooding occurred in and around the city limits. No injuries or fatalities were associated with the event.
- June 23, 2004 – Heavy rains led to flash flooding in Wharton and caused several rescues from inundated homes. The storm caused $70,000 in property damage, but no injuries or fatalities were recorded.
- June 24, 2004 – Flash flooding in the City of Wharton led to several roads being inundated throughout the city. No injuries or fatalities were associated with the storm, but property damage totaled $15,000.
- November 21, 2004 – Thanksgiving Day flood of 2004 - Major widespread flooding occurred throughout the county, with evacuations in Louise and over 200 El Campo residents rescued by boat or high-water vehicles. Numerous roads and bridges were flooded and impassable, including two sections of Highway 59 between Wharton and El Campo and between El Campo and the Jackson County line. The event resulted in $2.1 million of property damage, with 59 homes sustaining major damage and another 225 receiving minor damage. No injuries or fatalities were reported.
- 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 floodwaters 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 recorded 9.41 inches of rain over the same time period. Wharton County received an average of 3 to 4 inches of precipitation throughout the county, according to NWS. On May 26, the Colorado River reached a peak flow of approximately 50,000 cubic feet per second (Figure 12-3), and reached an elevation of approximately

50 feet, exceeding its flood stage by approximately 11 feet (Figure 12-4). No flood damages were reported. There were no injuries or fatalities in Wharton County.

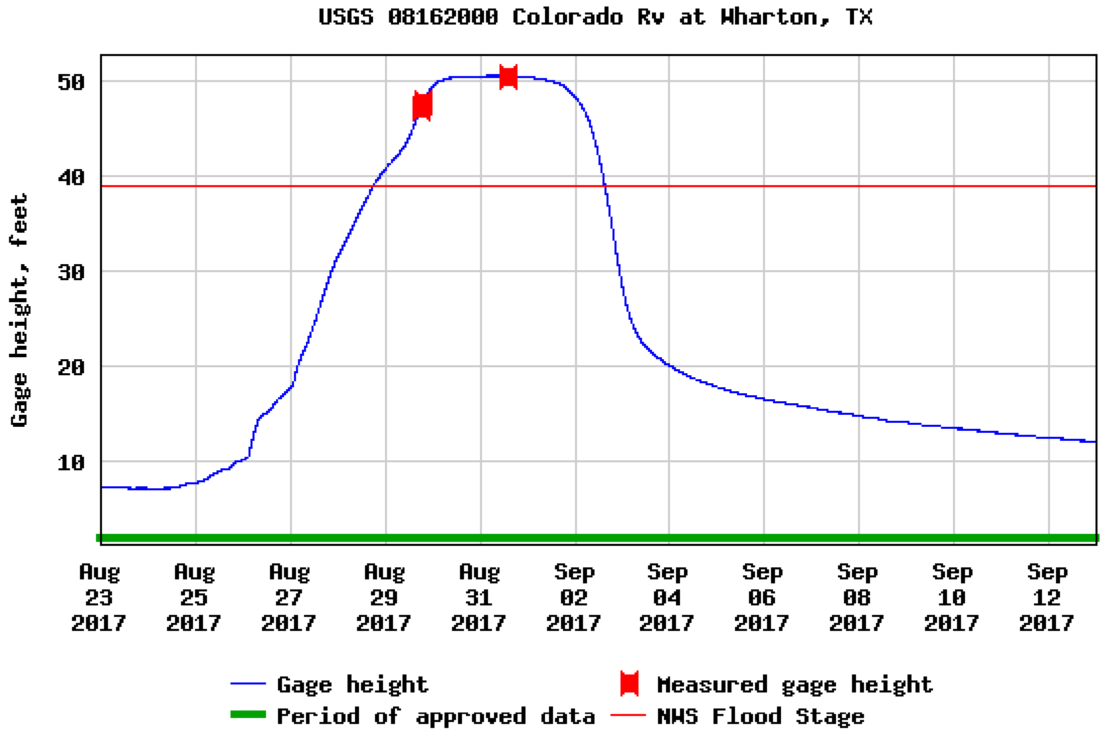
- April 17, 2016 – Known as the Tax Day Flood, heavy rains battered Wharton County and the surrounding areas beginning on April 17th, 2016 releasing as much as 17 inches of rain in the area. These storms triggered major flooding throughout the planning area and a disaster was declared for Wharton along with 15 other counties in Texas. Evacuations and school closures occurred throughout the planning area as a result of the flooding. In the City of Wharton, the Colorado River passed its flood stage of 39 feet to 48.29 feet in the early hours of April 22nd according to the USGS Guage in the City of Wharton. These high waters lead to mandatory evacuations along its route. In East Bernard and Boling, the San Bernard River passed its flood stage reaching a gauge height of 35.54 feet according to the USGS Guage near the town of Boling.
- Aug 25-29, 2017 – An extreme Hurricane event occurred throughout the Central and Upper Texas Coastline over the Labor Day holiday. A large volume of precipitation fell within a relatively short period of time, resulting in damaging floodwaters throughout the region. According to NWS, observed rainfalls totals of 40 inches in less than 48 hours with a new North American rainfall total record of 51.88 inches in the Cedar Bayou area of Houston. Total rainfall in Wharton County was measured in the range of 6 to 30 inches generally ranging having lower rainfall totals in the western portion and higher totals in the eastern portion. On Aug. 31, the Colorado River reached a peak flow of approximately 92,700 cubic feet per second at the City of Wharton USGS Gauge and reached a gauge height of approximately 50.46 feet. Extensive flood damages were reported with large portions of the City of Wharton, East Bernard, and Wharton County inundated with floodwaters for days.

Figure 12-3. Colorado River Flow Near the City of Wharton During Hurricane Harvey



Note: From USGS

Figure 12-4. Colorado River Flood Stage Near the City of Wharton During Hurricane Harvey



Note: From USGS

12.2.2 Location

The Lower Colorado Watershed runs centrally through the middle of Wharton County. Most of the eastern half of the county is covered by the San Bernard Watershed. The Navidad Watershed covers the northwestern section while the East Matagorda Bay Watershed covers the southwestern, and eastern sections of Wharton County. Due to its relatively flat topography, few substantial waterways contribute to the Colorado River or Tres Palacios River and instead empty into Matagorda Bay or the Gulf of Mexico. The San Bernard River and other significant creeks, including Jones Creek, Caney Creek, East Mustang, and West Mustang serve as conduits for many bayous and sloughs throughout Wharton County.

Many small, private dams exist throughout the county and participating cities, primarily for agricultural water supply. The one large-scale water supply reservoir in the County (The LCRA Lane City Reservoir) has no natural drainage area to it but rather is filled by a pump station along the Colorado River, and acts as an elevated water supply storage. There are no major flood control reservoirs or dams in the County but it is worth noting that the highland lake reservoirs in the Austin area can have impacts to flood risk in Wharton County due to releases. The LCRA has indicated that their flood control releases from the highland lakes can only reasonably be managed down to Columbus, TX, which is well upstream of Wharton County. This means that the LCRA cannot guarantee the impacts of flood releases from their reservoirs in Wharton County.

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 of Mexico, but Wharton County has traditionally been out of the way of the effects of a coastal surge. Flood risk is also realized by agricultural practices in the County. More row crops and fewer rice farms can result in additional flood risk.

The floodplain boundary extents for most of the creeks, streams, rivers, and lakes in Wharton County and the participating communities have been mapped by FEMA during its Map Modernization Program (circa 2006). Current FIRMs are available countywide and have an effective date of 12/21/2017. The main difference between the 2006 MapMod floodplains and the 2017 updates was the addition of detailed mapped along the San Bernard River. The resulting FIRMs provide an official depiction of flood hazard risks and risk premium zones for each community and properties located within it. While the FEMA digital flood data is recognized as the official flood maps, more recent flood studies have been performed by the County and Cities including the modeling of 14 watersheds under the 2010 Wharton County Drainage Master Plan and the more recent Tri-County Study of the Lower Colorado River. These two additional flood risk datasets have not been submitted to FEMA for review but they are considered locally to be the best available data. It should be noted that riverine flooding, stormwater flooding, and flood-related losses often do occur outside of delineated SFHAs.

Wharton County and the participating communities have 214,850 acres in the 100-year floodplain and 249,960 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
City of East Bernard	652	1,069
City of El Campo	2,450	2,600
City of Wharton	2,888	4,130
Unincorporated Area	208,860	242,161
Wharton County Total	**214,850**	**249,960**

Figure 12-5 shows the SFHAs in Wharton County. Figures 12-6 through 12-8 show the SFHAs for each participating community.

Figure 12-5. Special Flood Hazard Areas in Wharton County and Participating Communities

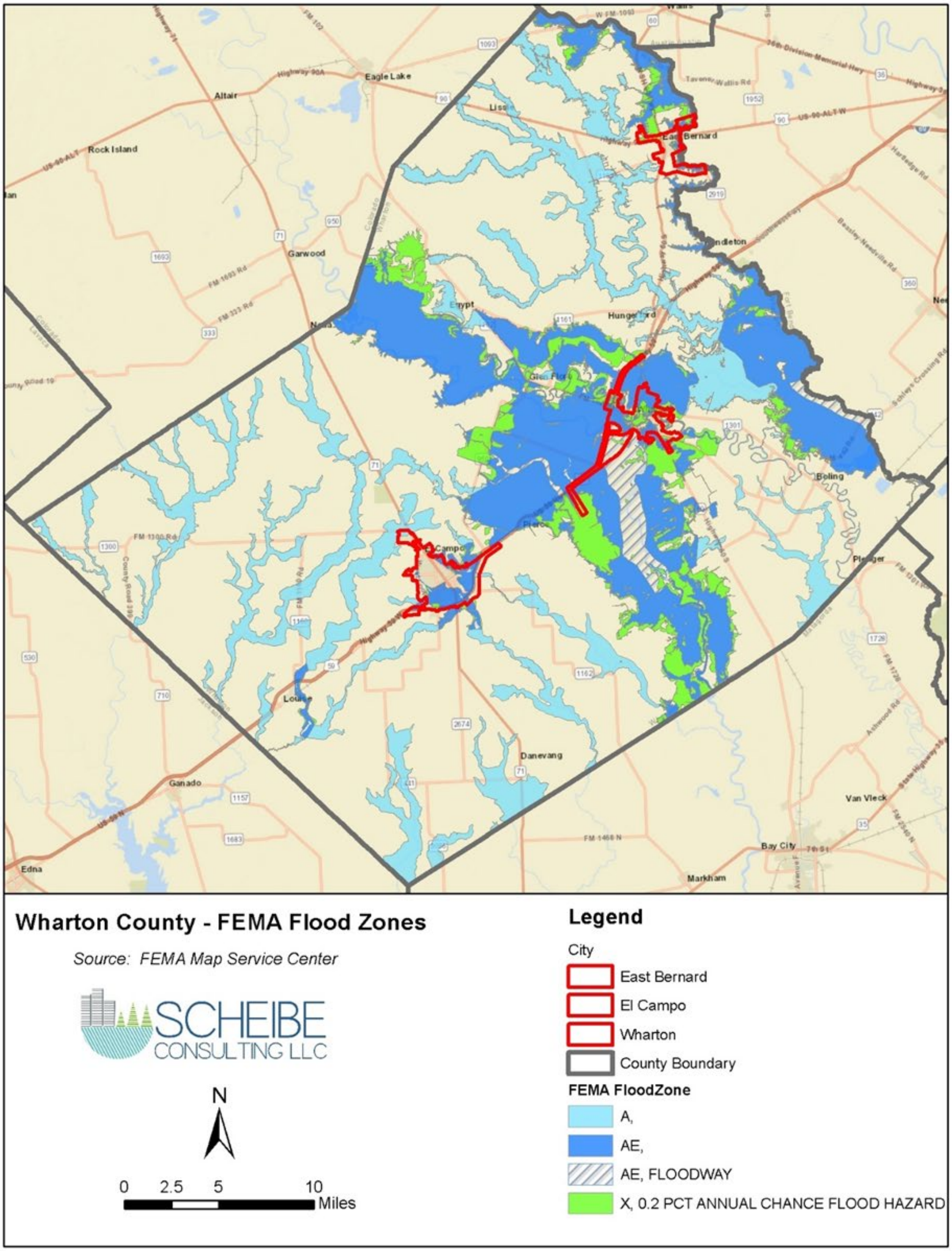


Figure 12-6. Special Flood Hazard Areas in the City of East Bernard

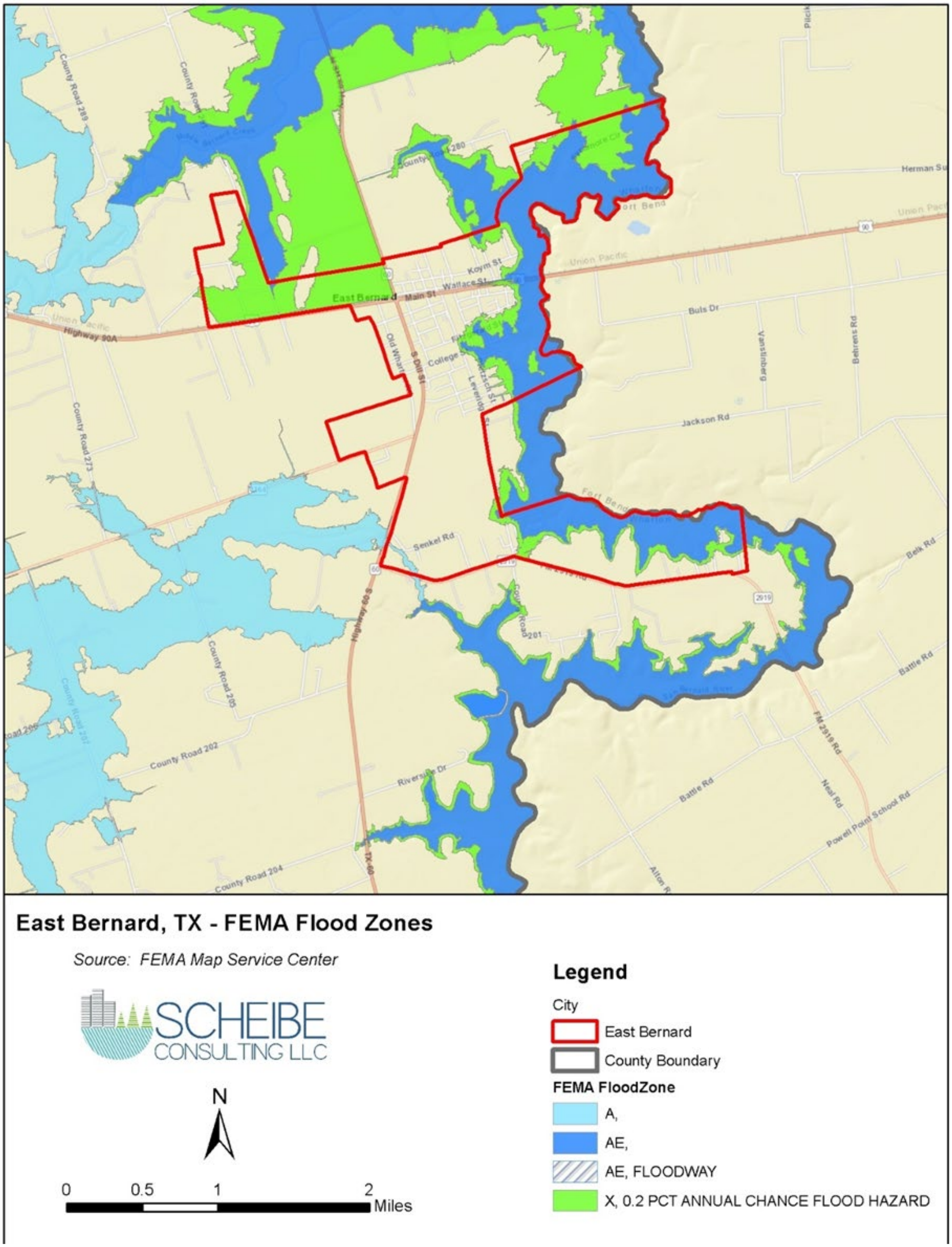


Figure 12-7. Special Flood Hazard Areas in the City of El Campo

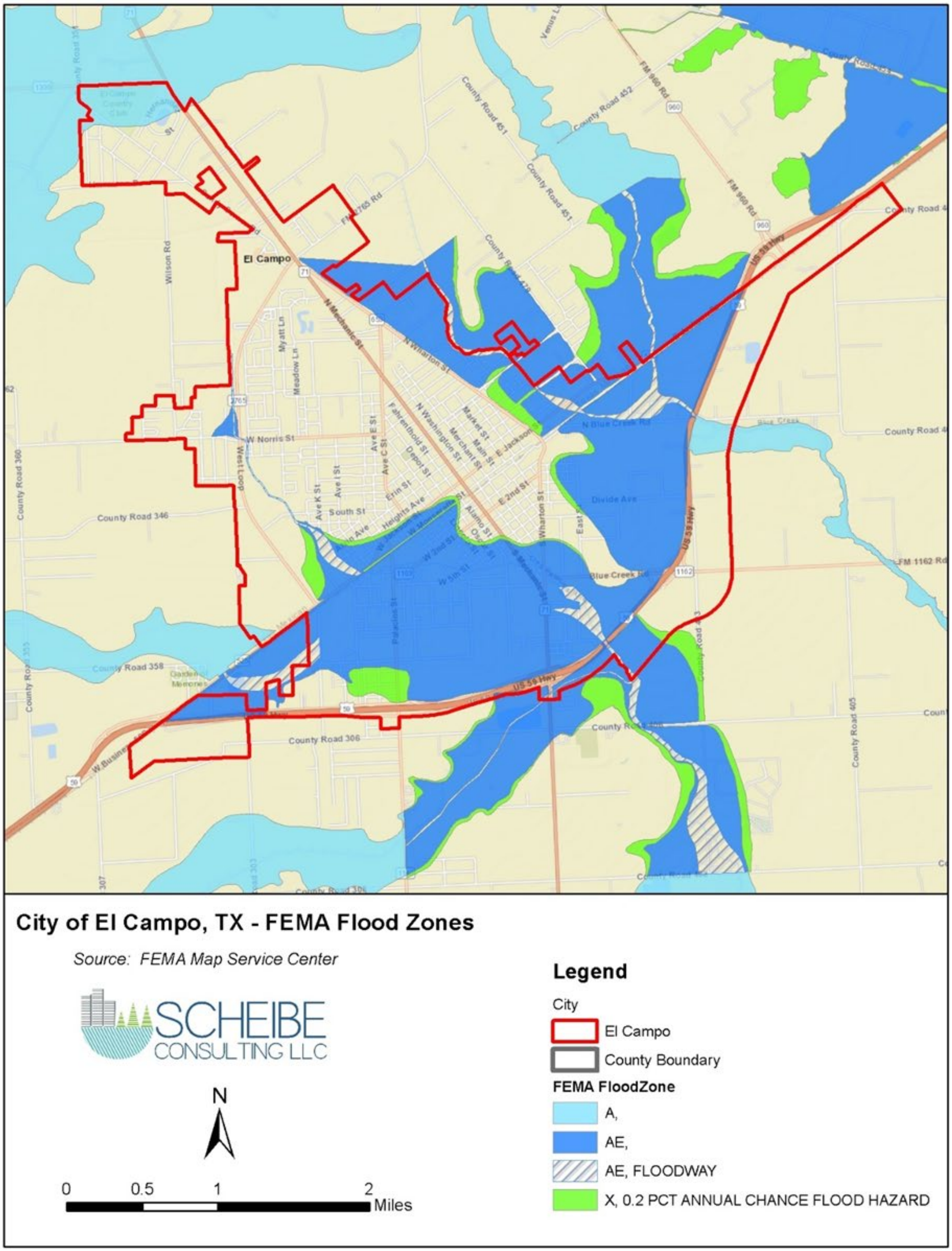
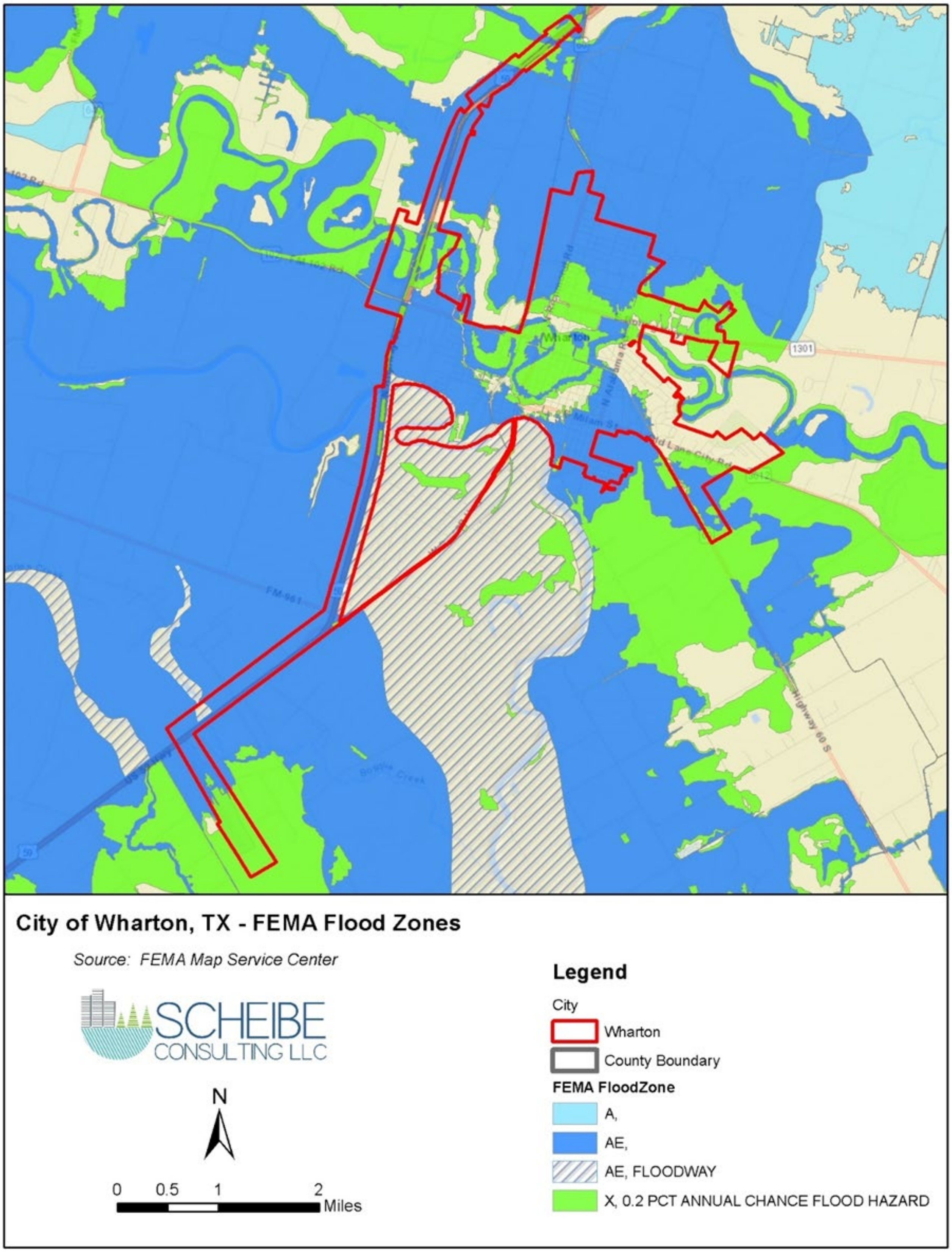


Figure 12-8. Special Flood Hazard Areas in the City of Wharton



12.2.3 Frequency

Seasonal flooding on the Colorado River and San Bernard River has 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 45% chance of occurrence in any given year. This probability is based on the 29 events over 67 years reported in the NCDC Storm Events Database and other historical records (local knowledge and news sources). Based on historical analysis, Wharton County unincorporated area can expect an event every 3-4 years year and has the same frequency and probability for future events. The City of El Camp, East Bernard, and Wharton can expect an event every 10 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 Wharton County and participating communities, the magnitude/severity of flooding is severe. The 100-Year HAZUS-MH flood scenario estimates more than 12,928 residents will be displaced and will seek temporary lodging in public shelters. Overall significance is considered severe.

The intensity and magnitude of a flood event are also determined by the depth of floodwaters. 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 mean sea level.

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 extends well into the floodplain, destroying property, equipment, and livestock.

The range of flood intensity that Wharton 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 and San Bernard River can experience flooding past the flood stage with over 40 feet as shown in Figures 12-3 and 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 12-12 shows the flood depths for the area.

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

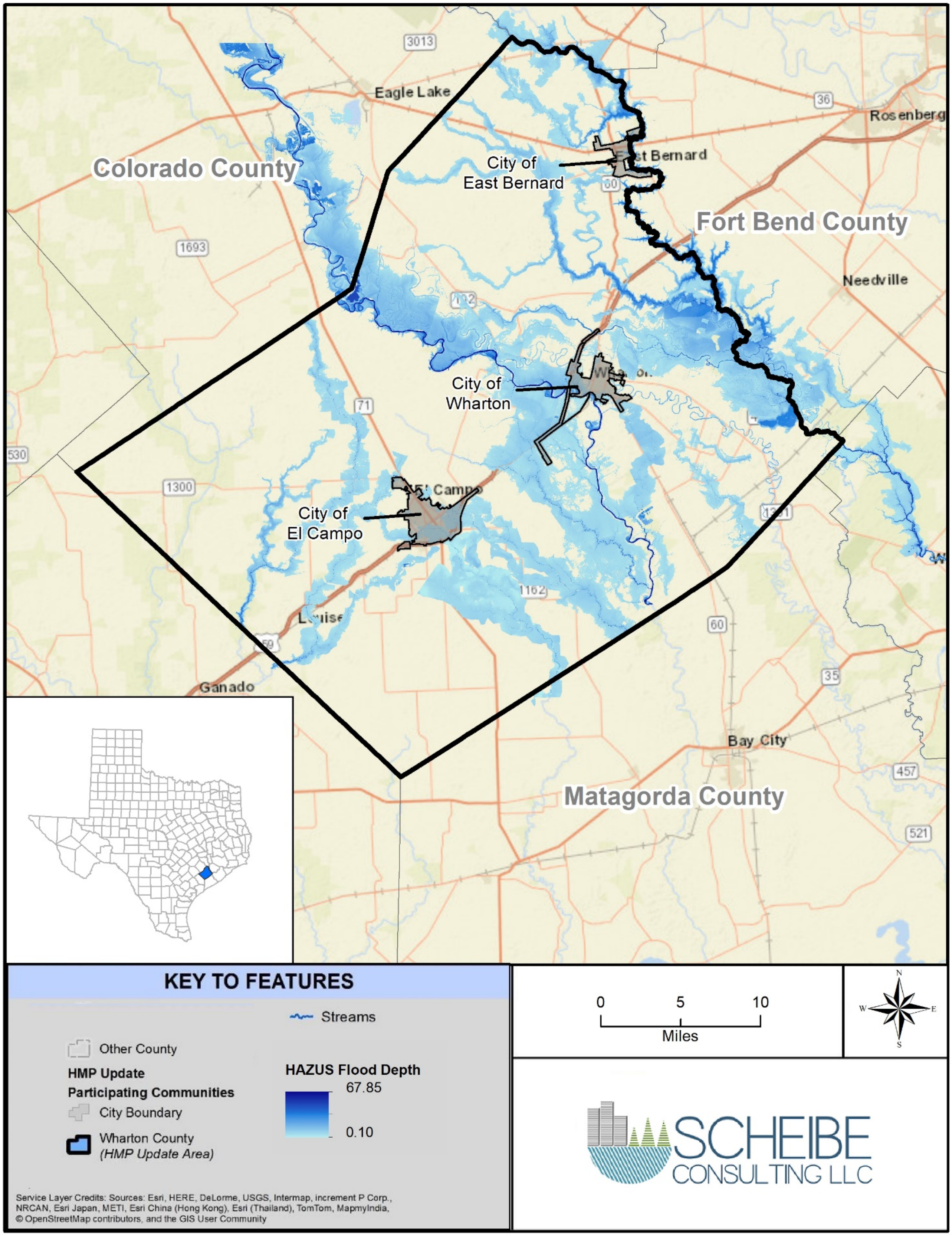


Figure 12-10. Flood Depths in the City of East Bernard

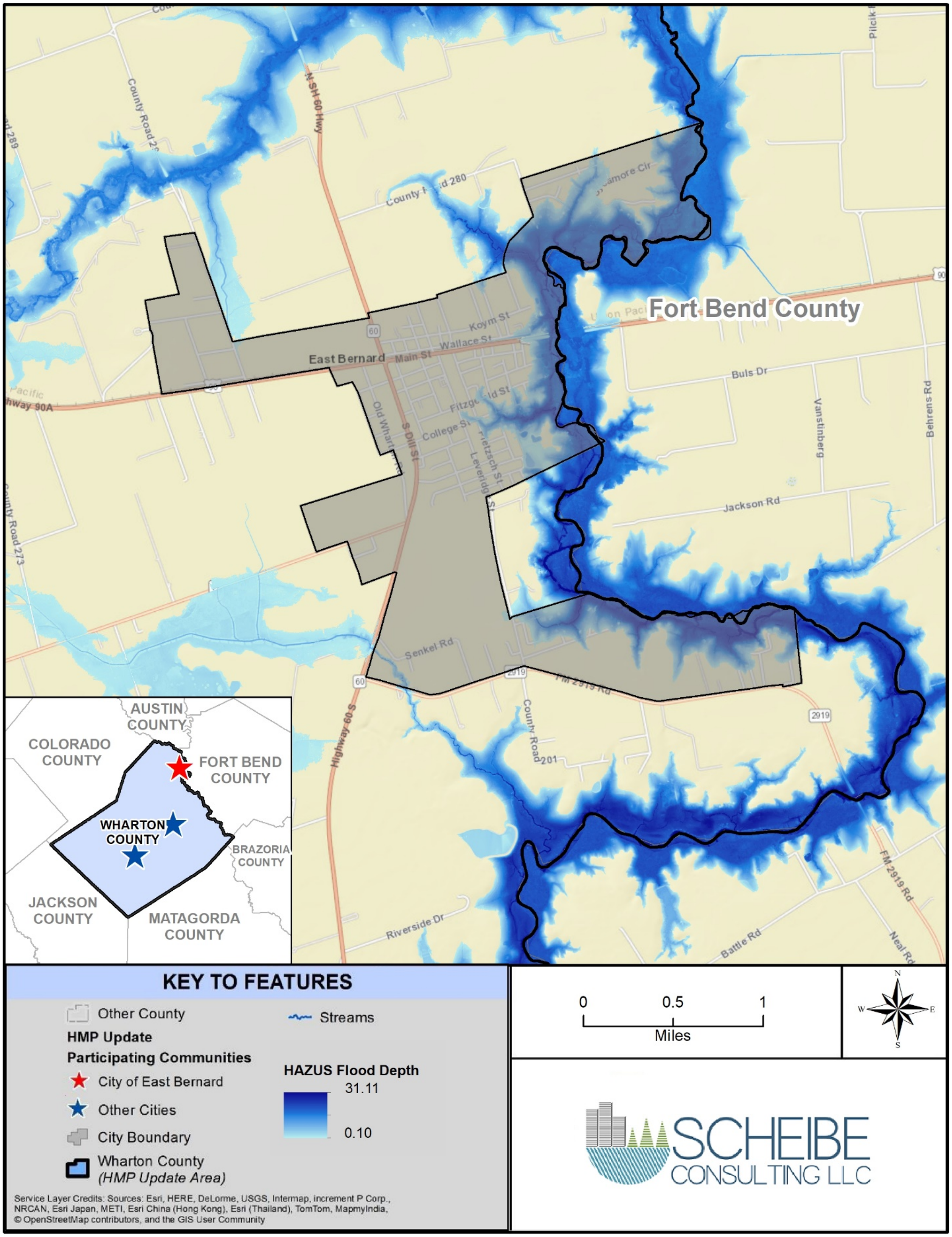


Figure 12-11. Flood Depths in the City of El Campo

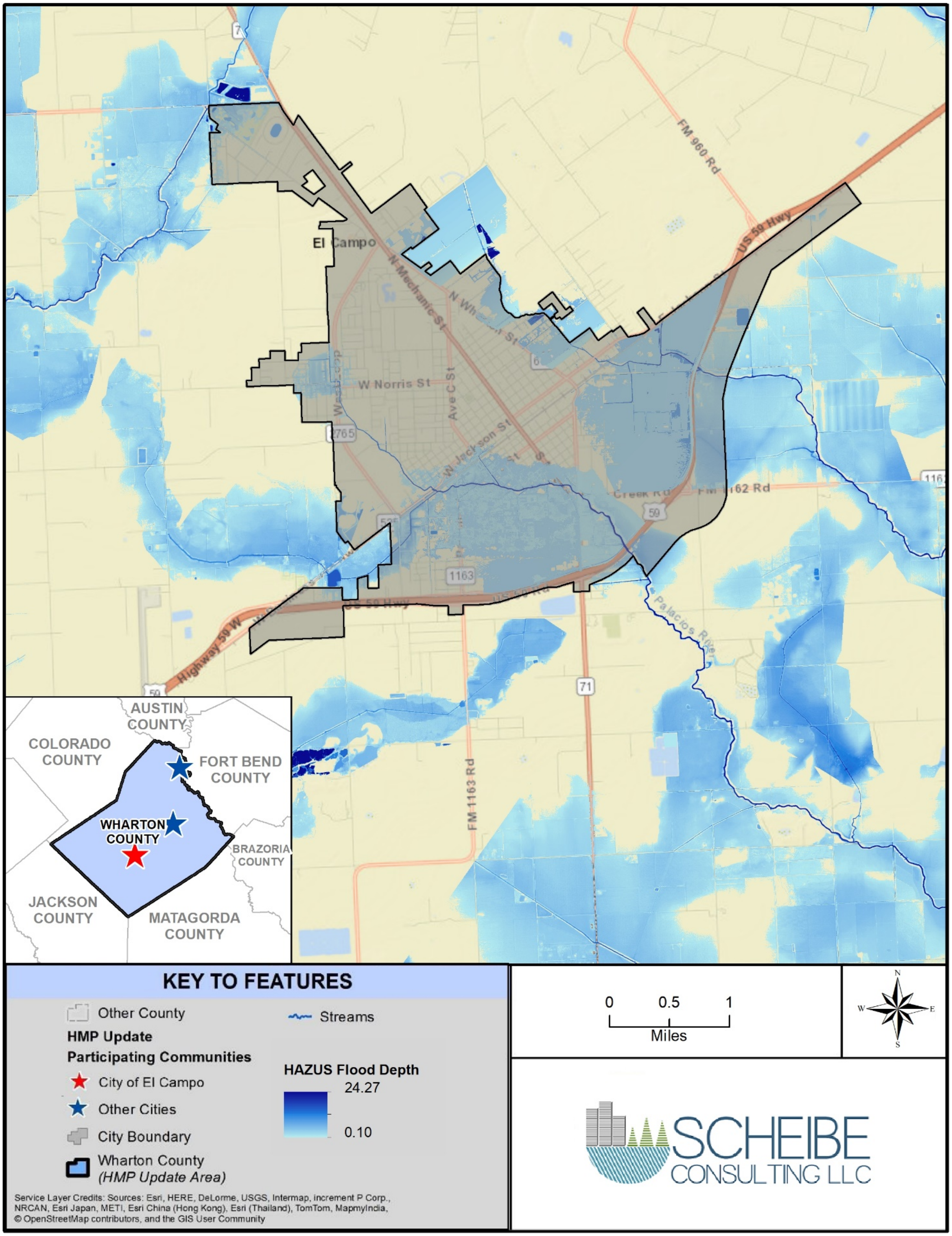
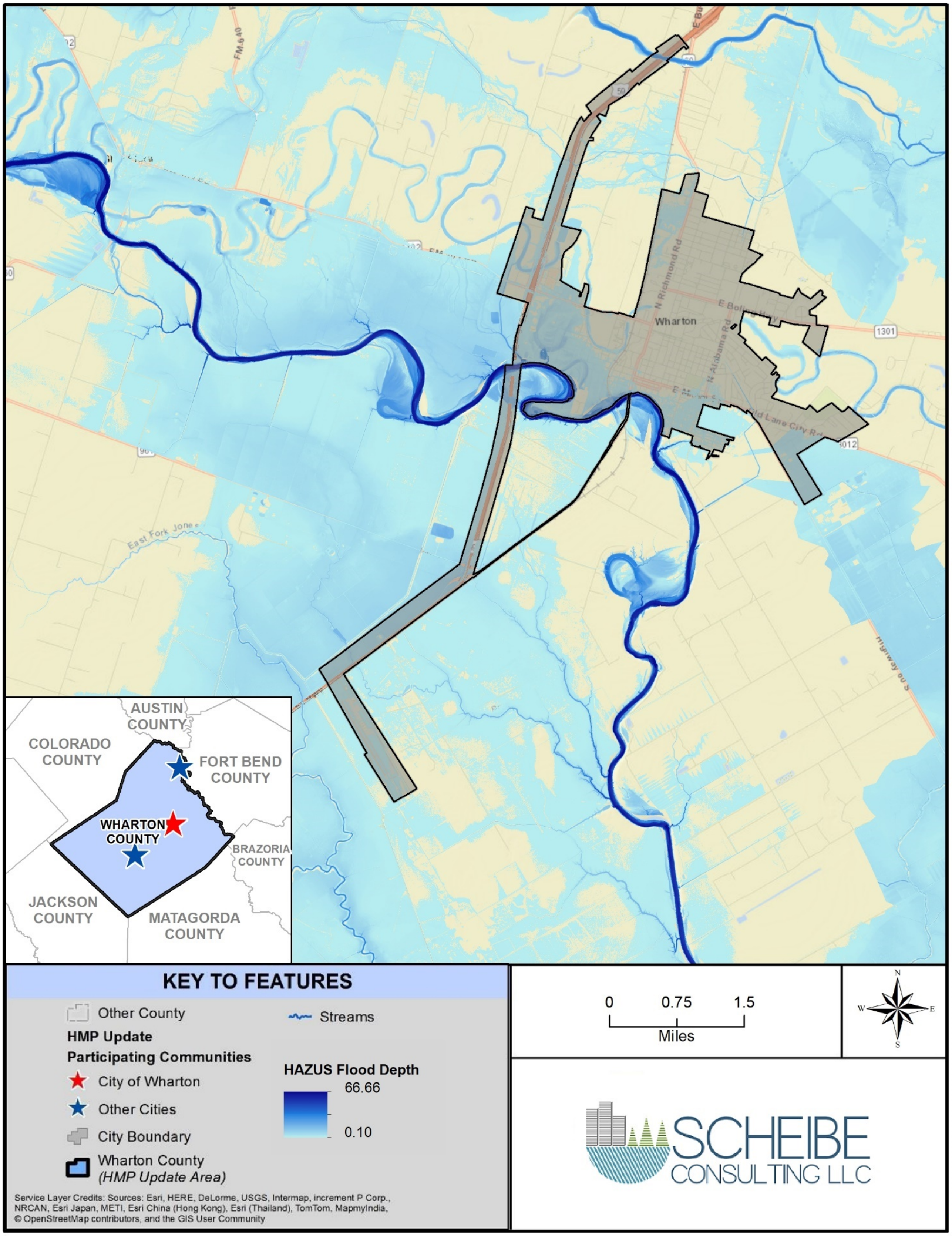


Figure 12-12. Flood Depths in the City of Wharton



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. It should be noted however that during very extreme flooding improved flood warning is needed. This was realized during Hurricane Harvey, as the overflows from the Colorado River at Glenn Flora were not expected at the volume that they occurred. This unexpected volume resulted in a flash flood risk along the upper watersheds of Peach Creek, Baughman Slough, and Caney Creek. High-velocity flow occurred and inundated the City of Wharton and numerous rural residential neighborhoods in the County. Improved flood warning is needed along the Colorado River and the San Bernard River as very large floods can make these watersheds behave in less predictable ways.

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. Significant channel geomorphology/erosive forces were observed post Hurricane Harvey, primarily along the Colorado River. Significant bank erosion from this event resulted in the loss of cropland and degradation of the highly sandy soils along the Colorado River.

12.4 CLIMATE CHANGE IMPACTS

The 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 the 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 the ever-changing climate must be adopted. Climate change has always been occurring, to varying degrees, and it has a direct impact on water resources, and resource managers have observed the following:

Historical hydrologic patterns should not be solely relied upon to forecast the future. A false sense of confidence had been developed over the years based on the primase the natural forces are a constant, but observations of the data clearly illustrate that these natural forces are constantly changing and records are only a snapshot as to what could likely happen but are by no means a solid source for future predictions.

Precipitation and runoff patterns continue to change, highlight uncertainty for water supply and quality, flood management, and ecosystem functions.

Due to the current warming patterns observed (and assuming they continue in an upward trajectory), it is safe to assume that more extreme climatic events will become more frequent. This assumption is based on the fact that warmer summers near the equator will produce more and likely larger tropic depressions that will in turn produce more and likely larger hurricanes. Until a global cooling cycle begins again, these more extreme weather patterns should be expected.

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 U.S. 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-MH default inventory (updated with 2010 U.S. Census data and 2018 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 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, coupled with population centroids, and overlayed this 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 12,632 (30.6% of the total county population). In the 500-year floodplain, it is estimated that 17,820 people countywide live within the mapped non-SFHA areas (43.2% 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 6,125 structures within the 100-year floodplain and 8,462 structures within the 500-year floodplain. In the 100-year floodplain, 38% of these structures are in unincorporated areas and 96% are residential.

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

Present Use Classification	Area (acres)					
	City of East Bernard	City of El Campo	City of Wharton	Unincorporated Area	**Wharton County Total**	**% of Total**
Barren Land (Rock/Sand/Clay)	0	3	12	722	**737**	**0.3**
Cultivated Crops	4	417	436	81,607	**82,464**	**36.9**
Deciduous Forest	79	32	189	18,577	**18,877**	**8.4**
Developed High Intensity	0	62	83	20	**165**	**0.1**
Developed, Low Intensity	18	345	512	726	**1,601**	**0.7**
Developed, Medium Intensity	3	178	229	129	**539**	**0.2**
Developed, Open Space	67	908	894	7,761	**9,630**	**4.3**
Evergreen Forest	2	0	5	1,498	**1,505**	**0.7**
Emergent Wetlands	35	0	16	6,120	**6,171**	**2.8**
Grassland/Herbaceous	10	97	84	1,890	**2,081**	**0.9**
Mixed Forest	30	0	6	3,593	**3,629**	**1.6**
Open Water	0	0	33	2,973	**3,006**	**1.3**
Pasture/Hay	105	177	252	55,513	**56,047**	**25.1**
Shrub/Scrub	23	94	109	12,461	**12,687**	**5.7**
Woody Wetlands	286	2	27	24,244	**24,559**	**11.0**
Wharton County Total	**662**	**2,315**	**2,887**	**217,834**	**223,698**	**100**

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

Present Use Classification	Area (acres)					% of Total
	City of East Bernard	City of El Campo	City of Wharton	Unincorporated Area	**Wharton County Total**	
Barren Land (Rock/Sand/Clay)	0	3	12	752	**767**	**0.3**
Cultivated Crops	98	418	539	99,092	**100,147**	**38.5**
Deciduous Forest	96	32	202	20,285	**20,615**	**7.9**
Developed High Intensity	6	70	155	31	**262**	**0.1**
Developed, Low Intensity	55	387	799	883	**2,124**	**0.8**
Developed, Medium Intensity	19	194	406	167	**786**	**0.3**
Developed, Open Space	144	971	1,310	9,490	**11,915**	**4.6**
Evergreen Forest	2	0	7	1,646	**1,655**	**0.6**
Emergent Wetlands	58	0	16	7,129	**7,203**	**2.8**
Grassland/Herbaceous	14	101	120	2,155	**2,390**	**0.9**
Mixed Forest	33	0	6	3,947	**3,986**	**1.5**
Open Water	0	0	35	3,075	**3,110**	**1.2**
Pasture/Hay	228	181	353	64,368	**65,130**	**25.0**
Shrub/Scrub	48	103	134	13,954	**14,239**	**5.5**
Woody Wetlands	287	2	39	25,422	**25,750**	**9.9**
Wharton County Total	**1,088**	**2,462**	**4,133**	**252,396**	**260,080**	**100**

TABLE 12-6. STRUCTURES AND POPULATION IN THE 100-YEAR FLOODPLAIN					
	Residential	Commercial	Other*	**Total Structures Affected****	**Total Population Affected**
City of East Bernard	48	0	5	**52**	**286**
City of El Campo	1,445	34	95	**1,574**	**2,971**
City of Wharton	2,006	17	144	**2,167**	**4,562**
Unincorporated Area	2,227	18	86	**2,331**	**5,109**
Wharton County Total	**5,726**	**69**	**330**	**6,125**	**12,928**

Notes:
*Other includes industrial, agricultural, religious, governmental, and educational classifications.
**Total Structures were obtained from the TNRIS address point database, which was used to ratio HAZUS-MH results.

TABLE 12-7. STRUCTURES AND POPULATION IN THE 500-YEAR FLOODPLAIN					
	Residential	Commercial	Other*	**Total Structures Affected**	**Total Population Affected**
City of East Bernard	231	7	7	**245**	**635**
City of El Campo	1,622	113	23	**1,757**	**3,547**
City of Wharton	3,331	252	72	**3,655**	**7,002**
Unincorporated Area	2,677	93	34	**2,805**	**5,869**
Wharton County Total	**7,861**	**466**	**136**	**8,462**	**17,053**

Note: *Other includes industrial, agricultural, religious, governmental, and education classifications.

Exposed Value

Table 12-8 and Table 12-9 summarize the estimated value of exposed buildings in the planning area in the 100-year and 500-year floodplains. The updated HAZUS-MH model inventory data estimated $2.0 billion worth of building and contents exposure to the 100-year flood. This represents 31% of the total assessed value of the planning area. Approximately $2.8 billion worth of building-and-contents exposure was estimated to be exposed to the 500-year flood. This represents 44% of the total assessed value of the planning area.

TABLE 12-8. VALUE OF STRUCTURES IN THE 100-YEAR FLOODPLAIN					
	Value Exposed ($)				
Jurisdiction	Structure	Contents	**Total**	Total Assessed Value ($)	% of Total Assessed Value
City of East Bernard	13,301,489	3,275,557	**16,577,046**	429,246,000	4
City of El Campo	383,802,678	278,394,738	**662,197,416**	2,269,332,000	29
City of Wharton	408,373,186	252,532,095	**660,905,280**	1,535,539,000	43
Unincorporated Area	414,288,194	243,281,751	**657,569,945**	2,204,334,000	30
Wharton County Total	**1,219,765,547**	**777,484,140**	**1,997,249,687**	**6,438,451,000**	**31**

TABLE 12-9. VALUE OF STRUCTURES IN THE 500-YEAR FLOODPLAIN					
	Value Exposed ($)				
Jurisdiction	Structure	Contents	**Total**	Total Assessed Value ($)	% of Total Assessed Value
City of East Bernard	53,262,488	25,333,643	**78,596,131**	429,246,000	18
City of El Campo	401,939,340	283,960,947	**685,900,287**	2,269,332,000	30
City of Wharton	800,430,202	499,594,782	**1,300,024,984**	1,535,539,000	85
Unincorporated Area	486,185,767	280,847,837	**767,033,603**	2,204,334,000	35
Wharton County Total	**1,741,817,797**	**1,062,027,202**	**2,831,555,006**	**6,438,451,000**	**44**

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 floodplains of the planning area. Details are provided in the following sections.

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

	City of East Bernard	City of El Campo	City of Wharton	Unincorporated Area	**Wharton County Total**
Medical and Health	0	0	0	0	**0**
Government Functions	0	0	1	0	**1**
Police/Fire Station	0	0	1	1	**2**
Schools	0	0	2	0	**2**
Hazardous Materials	0	5	3	0	**8**
Bridges	0	17	18	226	**261**
Water Storage	1	1	0	0	**2**
Wastewater	1	1	0	3	**5**
Power	0	0	0	0	**0**
Communications	0	0	0	2	**2**
Transportation	0	1	1	0	**2**
Dams	0	0	0	5	**5**
Airports	0	0	1	0	1

TABLE 12-11. CRITICAL FACILITIES AND INFRASTRUCTURE IN THE 500-YEAR FLOODPLAIN					
	City of East Bernard	City of El Campo	City of Wharton	Unincorporated Area	**Wharton County Total**
Medical and Health	0	0	0	0	**0**
Government Functions	0	0	3	0	**3**
Police/Fire Station	0	0	2	2	**4**
Schools	0	0	4	1	**5**
Hazardous Materials	1	5	5	0	**11**
Bridges	0	17	23	234	**274**
Water Storage	1	1	0	0	**2**
Wastewater	1	1	0	3	**5**
Power	0	0	0	2	**2**
Communications	0	0	0	2	**2**
Transportation	0	1	1	0	**2**
Dams	0	0	0	6	**6**
Airports	0	0	1	0	**1**

Utilities and Infrastructure

It is important to identify who may be at risk if infrastructures are 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.

*Road*s

The major roads in the planning area that pass through the 100-year floodplain and thus are exposed to flooding are U.S. Highway 59 and State Highways 60 and 71. In severe flood events, these roads can be blocked or damaged, preventing access to some areas. This was experienced recently post Hurricane Harvey, where large portions of US 59 and Hwy 60 were flooded for days and were impassable. This prevented the moving of goods and also greatly inhibited emergency access throughout Wharton County and the Cities within.

Bridges

Flooding events can significantly impact road bridges. These are important because often they provide the only ingress and egress to some neighborhoods. Countywide, 261 bridges 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 centered over the centroid of each census block. To mitigate this, Texas Natural Resources Information System (TNRIS) 911 address points for specific structures were utilized to provide a more accurate estimate of actual building locations relative to the floodplain. These 911 structure counts were used to provide a weighted adjustment relative to the census block centroid structure counts to help provide a more accurate estimate of flood risk.

12.6.1 Population

A geographic analysis of demographics (countywide) 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 10.4% 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 13.7% of the population in the 100-year floodplain are over 65 years old.
- Population under 16 Years Old—It is estimated that approximately 27.5% of the population in the 100-year floodplain are under 16 years of age.

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

- During a 100-year flood event
    - Displaced population = 2,742
    - Persons requiring short-term shelter = 5,976
- During a 500-year flood event
    - Displaced population = 2,875
    - Persons requiring short-term shelter = 6,250

12.6.2 Property

HAZUS-MH calculates direct losses to structures from flooding by looking at the depth of flooding and the type of structure. Using historical flood insurance claim data, HAZUS-MH estimates the percentage of direct damage to structures and their contents by applying established damage functions to an inventory. Other losses often coincide with direct losses but for purposes of this analysis, these indirect losses are not accounted for. 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 $177 million in total direct flood loss from a 100- year flood event in the planning area. This represents 8.9% of the total exposure to the 100-year flood for the county. Losses are estimated to be $291 million in total direct flood losses from a 500- year flood event, representing 10.3% of the exposure to the 500-year event for the county (Table 12-13).

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

Jurisdiction	Loss ($)			Exposed Value ($)	% of Total Exposed Value
	Structure	Contents	**Total**		
City of East Bernard	9,014,000	5,952,000	**14,966,000**	16,577,046	90.3
City of El Campo	14,793,000	14,642,000	**29,435,000**	662,197,416	4.4
City of Wharton	16,589,000	15,098,000	**31,687,000**	660,905,280	4.8
Unincorporated Area	58,779,000	42,233,000	**101,012,000**	657,569,945	15.4
Wharton County Total	**99,175,000**	**77,925,000**	**177,100,000**	**1,997,249,687**	**8.9**

TABLE 12-13. LOSS ESTIMATES FOR THE 500 YEAR FLOOD EVENT					
Jurisdiction	Loss ($)			Exposed Value ($)	% of Total Exposed Value
	Structure	Contents	**Total**		
City of East Bernard	15,990,000	11,335,000	**27,352,000**	78,596,131	34.8
City of El Campo	41,358,000	44,440,000	**85,798,000**	685,900,287	12.5
City of Wharton	24,427,000	23,955,000	**48,382,000**	1,300,024,984	3.7
Unincorporated Area	75,255,000	54,586,000	**129,841,000**	767,033,603	16.9
Wharton County Total	**157,030,000**	**134,316,000**	**291,346,000**	**2,831,555,006**	**10.3**

National Flood Insurance Program

Table 12-14 lists flood insurance statistics (from 1979 to May 2017) that help identify vulnerability in the planning area. Wharton County and the Cities of East Bernard, El Campo, and Wharton participate in the NFIP.

TABLE 12-14. NATIONAL FLOOD INSURANCE PROGRAM STATISTICS			
Jurisdiction	Initial FIRM Effective Date	Claims	Value of Claims Paid
City of East Bernard	4/5/2006	106	$9,191,473
City of El Campo	6/4/1980	215	$4,039,874
City of Wharton	9/19/1982	620	$29,872,224
Unincorporated Area	4/18/1983	122	$5,065,400
Wharton County Total	**04/05/2006 ***	**1063**	**$48,168,970**

Notes:
FIRM Flood Insurance Rate Map
*Effective date of initial countywide Flood Insurance Study
From FEMA Flood Loss Statistics

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 Flood Hazard Boundary Map (FHBM) for the City of El Campo was available in 1974, the City of Wharton in 1976, and Wharton County in 1974.

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 paid in Wharton County (1978 to June 2015) is approximately $17,515, well below the national average

Wharton County's continued NFIP compliance is detailed in their floodplain management program and the Flood Prevention Order, (2001 as amended) that is enforced by the County's Permitting and Inspection Department. The Floodplain Administrator is a Certified Floodplain Manager (CFM). The County has instituted the following higher floodplain management standards: 1) Detention ponds are required in new subdivisions, 2) Elevation certificate is required prior to pouring the lowest floor and when the structure is complete, 3) Floodplain permits are cross-referenced to 911 Addresses, and 4) One foot of freeboard is required above existing base flood elevation (BFE). The County has several mitigation actions such as improve drainage infrastructure throughout the county; update and adopt new Flood Insurance Study and FIRM; adopt a higher standard for riverine flood damage ordinances; join the CRS program; implement a Wharton County Flood Warning/Monitoring System; drainage master plan as listed in Table 22-2. 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 East Bernard's** floodplain management program is detailed in the Standard for Floodplain Management and it is enforced by the City Secretary. The City has contracted with Wharton County to manage its floodplain management. The City requires one foot of freeboard above existing the BFE for construction in the 100-year floodplain. The City plans to initiate mitigation actions such as adopt a stormwater drainage plan and ordinance and improve drainage throughout the City as listed in Table 22-2.

The **City of El Campo's** floodplain management program is part of Chapter 10 of the City of El Campo Design Manual, Buildings and Building Regulations, this is enforced by the Public Works Department. The Floodplain Administrator is a CFM. The City has instituted the following higher floodplain management standards: 1) In Zone X, new development must be 18 inches above the natural grade or 12 inches above the crown of the nearest street, 2) Elevation certificate is required before framing/pouring the lowest floor and after construction is complete, and prior to the certificate of occupancy, and 3) No development is permitted in the floodway. The mitigation actions in Table 22-2 states that the City intends to improve drainage infrastructure throughout the city, adopt a new freeboard ordinance to reduce the flood risk to structures, and update the drainage master plan.

The **City of Wharton's** floodplain management program is the Standard for Floodplain Management and is enforced by the Code Enforcement Department. The Floodplain Administrator is a CFM. The City has instituted the following higher floodplain management standards: 1) In Zone X, new construction must be one foot above the curb or adjacent grade whichever is higher, 2) Detention is required to mitigate fill/development, 3) Drainage plan is required for new development that meets Wharton County Drainage Criteria, and. 4) Elevation certificate is required prior to forming, when construction is complete, and prior to the certificate of occupancy. The mitigation actions in Table 22-2 states that the City intends to clean and repair storm drains, increase freeboard requirements for permitting structures in the floodplain, implement a watershed ordinance for new development, minimize the impact of flooding by installing berms and levees where appropriate, develop flood-reduction / stream restoration/channelization projects to ensure adequate drainage/diversion of stormwater, conduct an acquisition and relocation, elevation and "demo-rebuild" of flood-prone structures, update/implement Drainage Master Plan, and improve drainage infrastructure throughout the city.

All the municipal planning partners are informed of the training schedule for their Floodplain Administrators through the Texas Colorado River Floodplain Coalition (TCRFC) and the TWDB and attend continuing education seminars and classes on a yearly basis.

Repetitive Loss

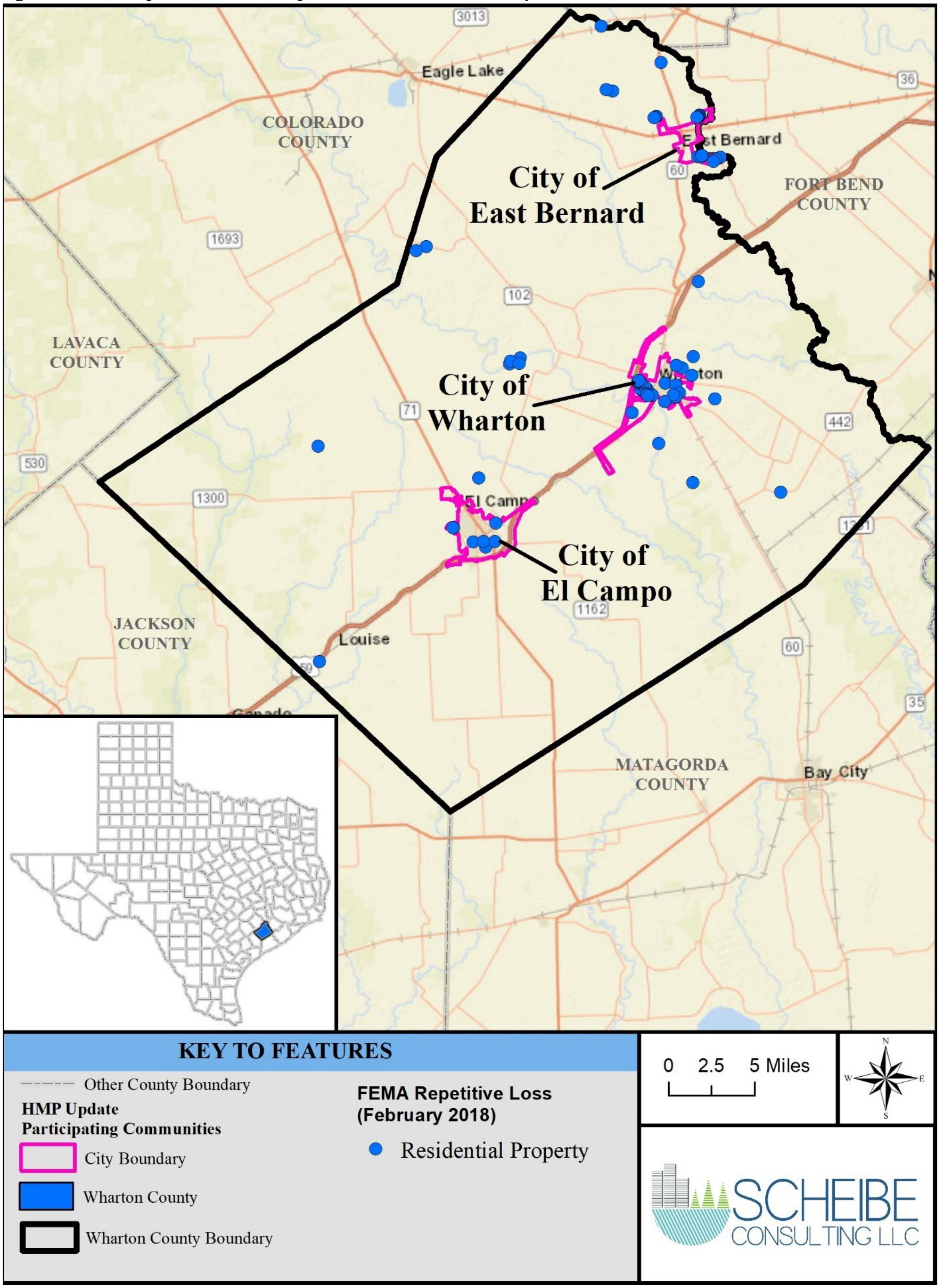
A repetitive loss property is defined by FEMA as an NFIP-insured property that has experienced two or more claims of more than $1,000 were paid by the NFIP within any rolling 10-year period since 1978. A sever repetitive loss property are properties that have had at least four NFIP payments of $5,000 each, or at least two or more claims payments which the cumulative amount exceeds the market value of the home since 1978. For both severe repetitive loss cases, two of the claims must have been within a rolling 10-year period.

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 12-13 shoes the location of repetitive loss properties in Wharton County and the participating communities.

As of February 2018, Wharton County has a total of 71 residential repetitive loss properties. The City of East Bernard has 15 residential repetitive loss properties. The City of El Campo has 6 residential repetitive loss properties. The City of Wharton has 33 residential repetitive loss properties. Wharton County unincorporated area has 14 residential repetitive loss properties.

Figure 12-13. Repetitive Loss Properties in Wharton 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-MH critical facility analysis found that, on average, critical facilities would receive some damage to structure and contents during a 100-year or 500-year flood event. Countywide, both the 100-year and 500-year flood scenarios would result in moderate damage (10 to 50%) to one police station, one hospital, and two schools. Significant functionality would be lost during these events.

12.6.4 Environment

The environment vulnerable to flood hazards is the same as the environment exposed to the hazard. Loss estimation platforms such as HAZUS-MH are not currently equipped to measure the environmental impacts of flood hazards. The best gauge of the 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

Wharton 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 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 22-2.

Urban flooding issues that contribute to flash floods are also a concern in more highly developed areas in Wharton 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 meets 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 a 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	
Wharton County	High
City of East Bernard	High
City of El Campo	High
City of Wharton	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

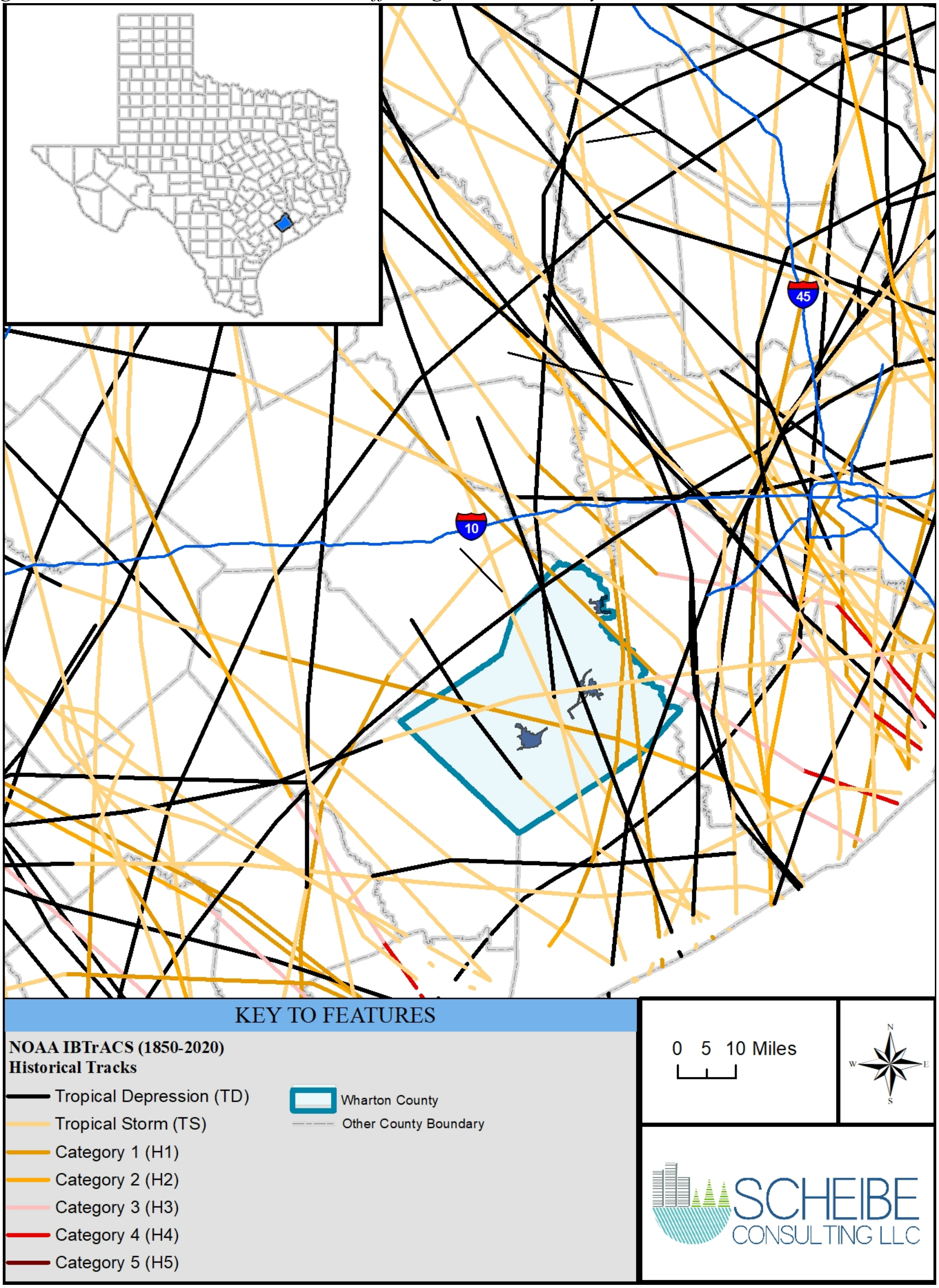
13.1.1 Hurricanes and Tropical Storms

Tropical cyclones are classified into three main categories (per intensity): hurricanes, tropical storms, and tropical depressions. Tropical cyclones that affect Texas form in the Gulf of Mexico or the Atlantic Ocean. Hurricanes are any closed circulation developed around a low-pressure center in which the winds rotate. Winds rotate counter-clockwise in the Northern Hemisphere and clockwise in the Southern Hemisphere. 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, the rotational force from the spinning of the earth, and the absence of wind shear in the lowest 50,000 feet of the atmosphere. Such storms can have diameters that span thousands of miles and sustain winds that approach 200 miles an hour.

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 must reach 74 miles per hour (mph) or more. Hurricanes are classified 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, resembling a hurricane. Figure 13-1 illustrates historical hurricane tracks affecting the entire study area.

Figure 13-1. Historical Hurricane Paths Affecting Wharton County



Notes: From NOAA IBTrACS Version 4

13.1.2 Hurricane and Tropical Storm Classifications

Hurricanes are classified according to the Saffir-Simpson Hurricane Wind Scale from 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 roofs, 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.

Notes:
Other non-hurricane classifications are tropical storms (39-73 miles per hour) and tropical depressions (0-38 miles per hour)
From NOAA – National Hurricane Center and Central Pacific Hurricane Center

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

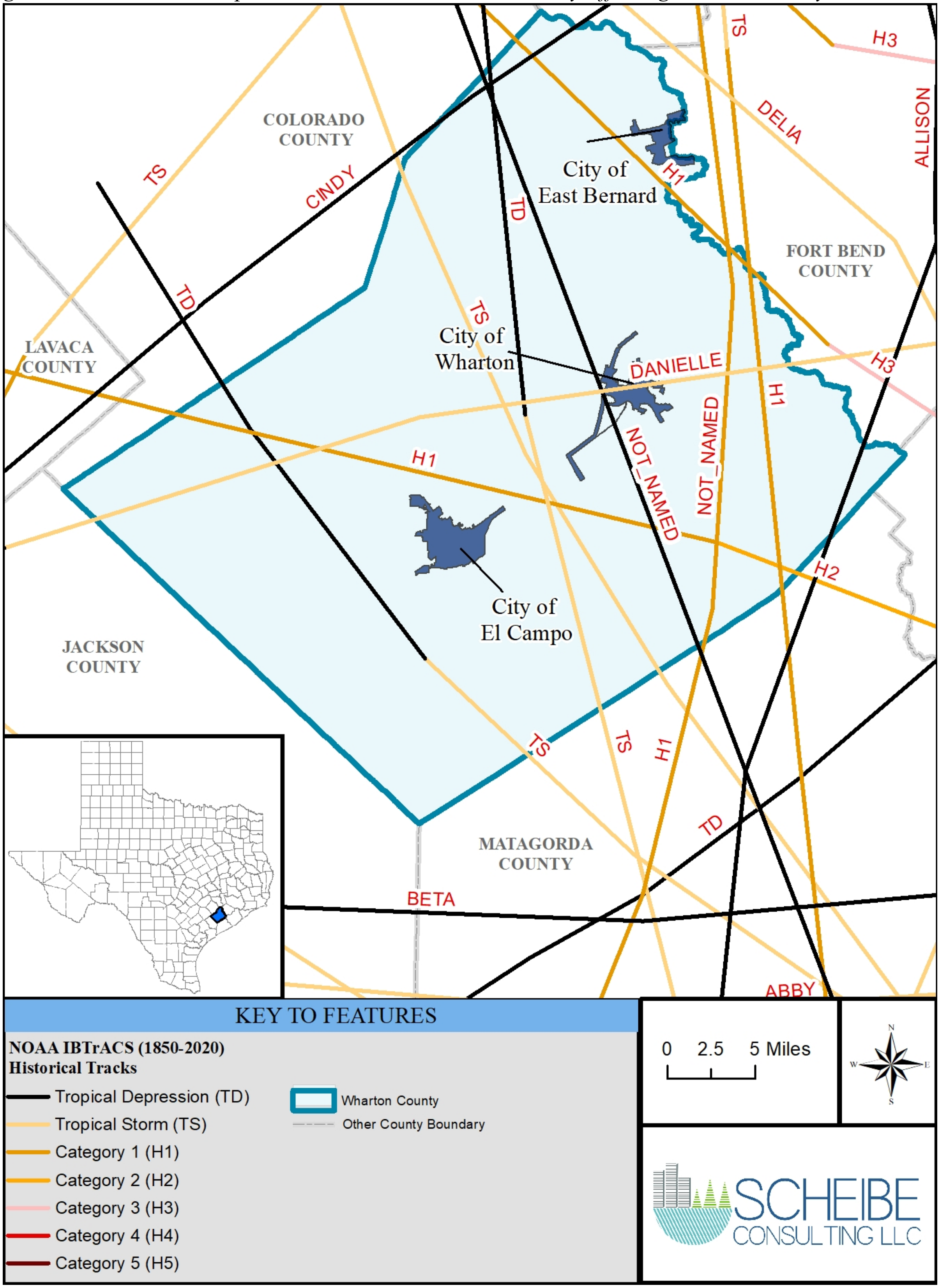
Due to Wharton County and participating communities' interior location (approximately 60 miles inland), it is not exposed directly to hurricanes. The hurricanes usually fade and downgrade to tropical storms or tropical depressions as they move away from the coast. According to NOAA, Wharton County and participating communities have been in the direct track of at least 13 tropical cyclones ranging from tropical depressions to hurricanes. A record count of the seven different hurricane categories within this time period shows four measured Category 1 hurricane conditions, one Category 2 hurricane condition, one Category 4 hurricane condition, five tropical depression conditions, and eight tropical storm conditions. Events whose tracks do not make landfall in Wharton County and participating communities can still have catastrophic consequences on the study area. Notable hurricane, tropical storm, and depression landfalls and other tropical cyclones with serious effects on the study area documented by NOAA between 1851 and 2020 for Wharton County are described below:

- September 19, 1854 (Unnamed Category 1 Hurricane) – Maximum wind speeds were approximately 80 mph.
- June 24, 1880 (Unnamed Tropical Storm) – Maximum wind speeds were approximately 46 mph.
- October 17, 1938 (Unnamed Tropical Storm) – Maximum wind speeds were approximately 40 mph.
- September 19, 1963 (Hurricane Cindy) – Maximum wind speeds were approximately 29 mph. Hurricane Cindy impacted Wharton County as a tropical depression.
- September 6, 1973 (Tropical Storm Delia) – Maximum wind speeds were approximately 46 mph.
- September 6, 1980 (Tropical Storm Danielle) – Maximum wind speeds were approximately 46 mph.
- June 16 to 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 for Wharton County. Approximately 11.59 inches of rain was recorded in areas west of El Campo. Approximately 10 to 15 inches of rain fell in 24 hours in several areas of the county. Several flooding problems were reported.
- August 24 to 29, 2017 (Hurricane Harvey) – Hurricane Harvey made landfall along the Texas coast near Port Aransas on August 25 as category 4. Harvey maintained tropical intensity the entire time while inland over the Texas coastal bend and southeast Texas. Flooding from Harvey caused serious damage to Wharton County. Four days after Harvey the Colorado and San Bernard rivers overflowed. The water stayed high for days, cresting at 50.5 feet on the Colorado River, and flooded more than one in three homes in the county.

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 affecting Wharton County and participating communities. Most of these hurricane events become tropical depressions or tropical storms by the time they reach the participating communities. Some however make landfall as major hurricanes.

Figure 13-2. Historical Tropical Storms and Hurricanes Directly Affecting Wharton County



Note: From NOAA IBTrACS Version 4

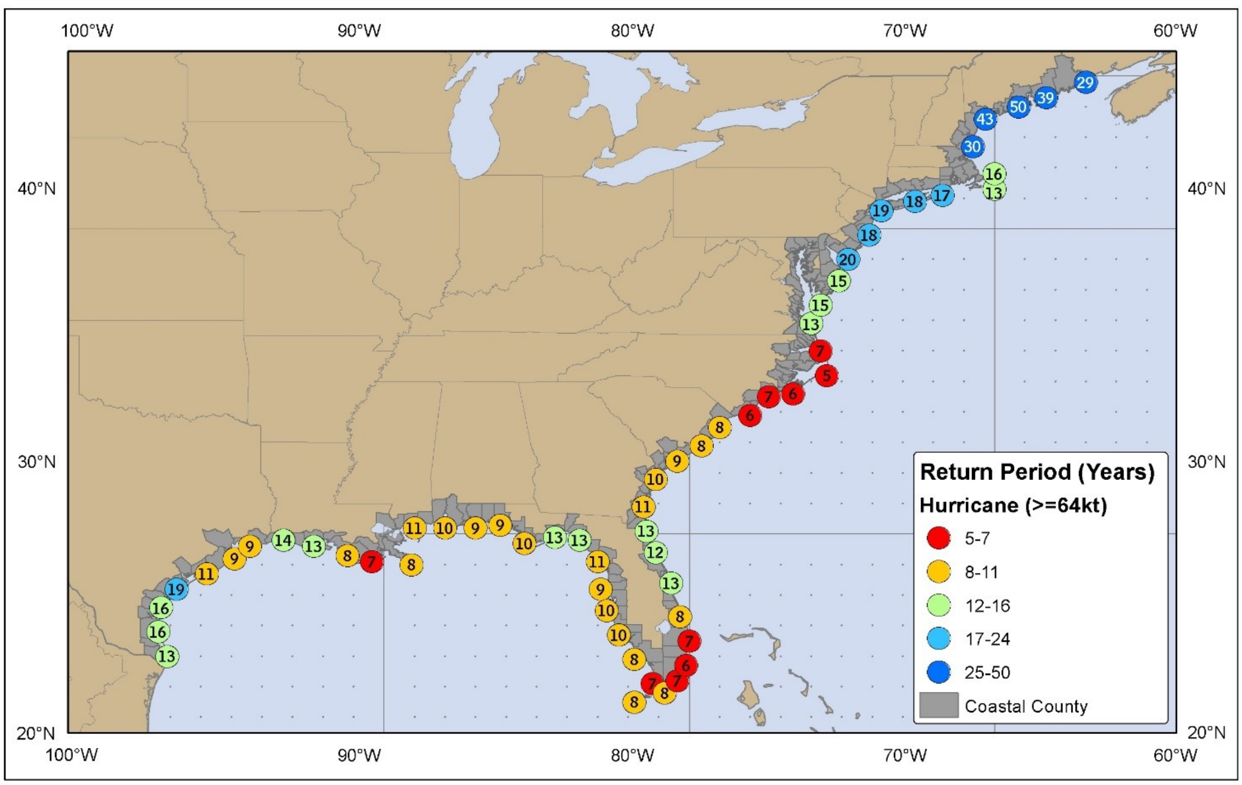
13.2.3 Frequency

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 seven 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 return period in years for hurricanes passing within 50 nautical miles of various locations, where damage can still occur from high-intensity events. Wharton and participating communities have had 59 tropical events between 1851 to 2020.

Future Probability

Thirteen tropical events followed a path through Wharton County. An event with a track through the community is unlikely. However, Wharton and participating communities experienced the effects of 59 tropical events. A tropical event that could affect the community occurs approximately every three years.

Figure 13-3: Estimated Return Period in Years for Hurricanes Passing Within 50 Nautical Miles of Various Locations



Note: From National Hurricane Center and Central Pacific Hurricane Center – Tropical Cyclone Climatology

13.2.4 Severity

Historic events indicate that a hurricane will affect Wharton County and participating communities as a lower category 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. People generally rely on weather forecasts from the City of Wharton.

13.3 SECONDARY EVENTS

Secondary events associated with a hurricane reaching Wharton 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 Wharton 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 Wharton County and participating communities may impact tourism; for example, damage may impact the Polka Festival hosted by the City of El Campo each year.

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 hurricane speeds to increase by up to 10% and precipitation to increase by 10 to 15%. In the past 10 years, the average Atlantic hurricane season has had an increased probability of named storms and hurricanes with an average of two more named storms and one more hurricane.

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 Wharton 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 from 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
City of East Bernard	909	62	43	**1,014**	**2,272**
City of El Campo	4,465	352	200	**5,017**	**11,602**
City of Wharton	3,299	321	138	**3,758**	**8,832**
Unincorporated Area	6,799	210	181	**7,190**	**18,574**
Wharton County Total	**15,472**	**945**	**562**	**16,979**	**41,280**

Note: *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 U.S. 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. The HAZUS-MH default data (updated with 2010 Census data and 2018 RS Means Square Foot Costs) were used.

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 tracks for Category 3, 4, and 5 landfalling hurricanes from 1900 to 2018. For this analysis, a probabilistic HAZUS-MH hurricane scenario was selected for the County. Since HAZUS does not allow for a hurricane analysis specific to a city limit, thus the loss estimates for each city were weighted based on the flood loss estimates presented in Chapter 12 of this report. 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 99 mph to 116 mph (Figure 13-4). Approximately 10% of the buildings (mostly residential) are expected to sustain moderate damages for this scenario. The annualized economic loss estimated for this probabilistic hurricane scenario (for Wharton County) is approximately $10.5 million.

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
City of East Bernard	638	28.07	342	15.05	129	5.68
City of El Campo	3402	29.33	1648	14.21	992	8.55
City of Wharton	2317	26.23	1288	14.58	1251	14.17
Unincorporated Area	4,715	25.39	2,741	14.76	1,537	8.28
Wharton County Total	**11,072**	**26.82**	**6,019**	**14.58**	**3,910**	**9.47**

TABLE 13-4. LOSS ESTIMATES FOR HURRICANE EVENT					
	Annualized Loss ($)			Exposed Value* ($)	% of Total Exposed Value
	Structure	Contents	**Total**		
City of East Bernard	675,219	187,178	**862,178**	429,246,000	0.2
City of El Campo	1,746,449	584,169	**2,330,618**	2,269,332,000	0.1
City of Wharton	1,031,494	345,024	**1,376,517**	1,535,539,000	0.1
Unincorporated Area	3,177,838	1,101,629	**4,279,467**	2,204,334,000	0.2
Wharton County Total	**6,631,000**	**2,218,000**	**8,849,000**	**6,438,451,000**	**0.14**

Note: *Exposed Value is equal to the total Assessed Value in each community.

Vulnerability Narrative

All participating communities are equally at risk to hurricanes, tropical storms, and tropical depressions. The extent of a hurricane event for each jurisdiction is described below.

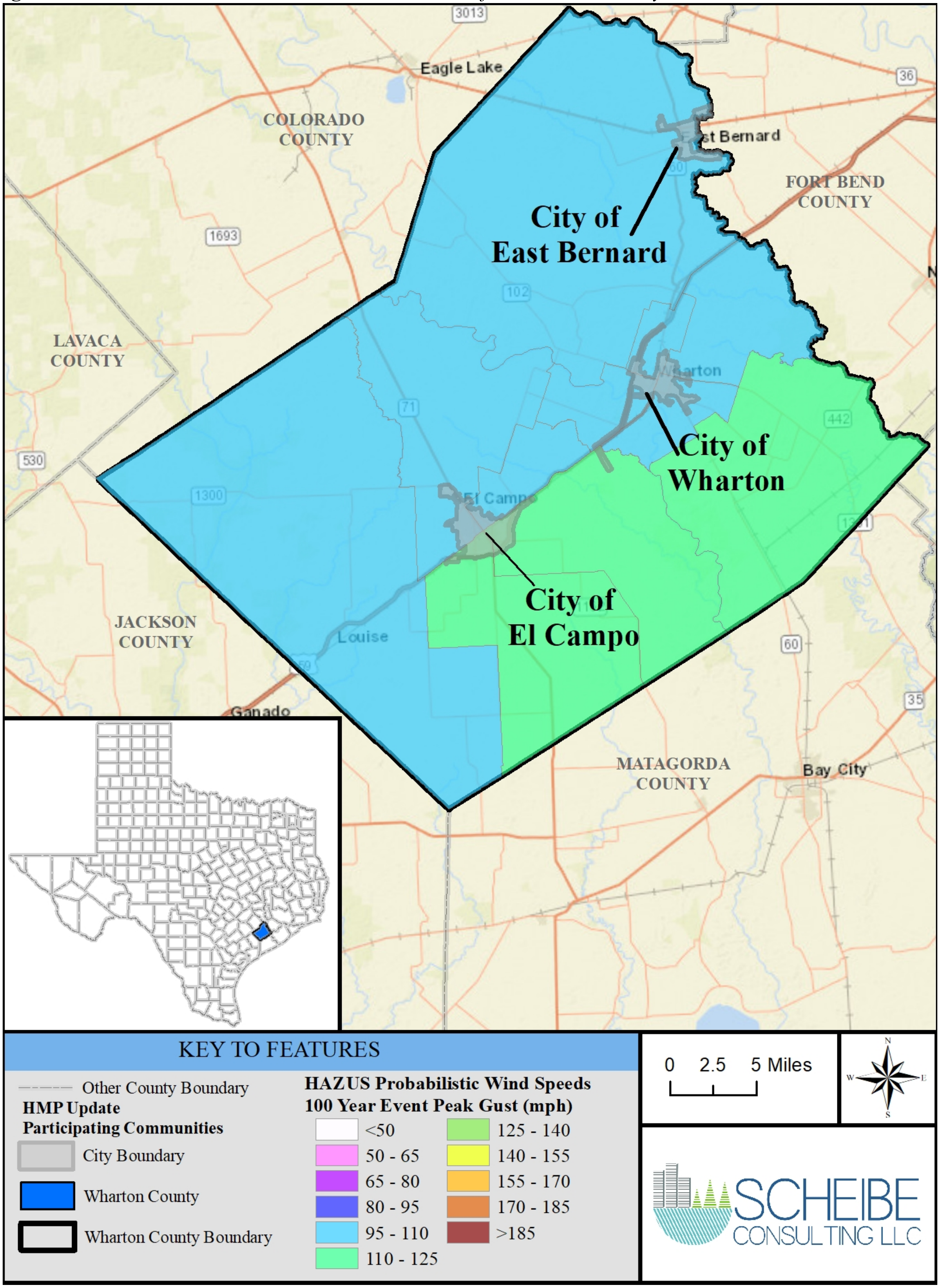
- **City of East Bernard** - Probabilistic Peak Wind Gusts for the City of East Bernard are approximately 99–116 mph. Approximately 6.5% of the City of East Bernard's housing is manufactured homes. These are more vulnerable to high winds from an event. Property along drainage areas that have not been cleaned out are more prone to flooding. Communities that do not implement Emergency Response Plans or identify and educate vulnerable areas increase their risk. Residents unaware of their risk or the hazards associated with hurricanes are less able to effectively prepare or respond.

- **City of El Campo -** Probabilistic Peak Wind Gusts for the City of El Campo are approximately 99–116 mph. Approximately 6.1% of the City of El Campo'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. Residents unable to receive notification, those in communities without emergency alert systems, are more at risk. Structures built without the benefit of building requirements designed to minimize the risk of property damage are more vulnerable as well.
- **City of Wharton -** Probabilistic Peak Wind Gusts for the City of Wharton are approximately 99– 116 mph. Approximately 8.9% of the City of Wharton'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. Property along drainage areas that have not been cleaned out are more prone to flooding. Communities that do not have mitigation measures and funding sources in place increase their risk as well.
- **Wharton County (Unincorporated Area) -** Probabilistic Peak Wind Gusts for Wharton County Unincorporated Areas range between approximately 99-116 mph. Approximately 19.9% of the County's 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 that do not provide shelters for vulnerable residents increase their risk. Critical facilities such as emergency response and medical facilities could be impacted by an event increasing response times. These response times would be longer for rural residents, especially if major thoroughfares such as US 59 were impacted. Communities that do not monitor and implement improvements needed to roadways increase their vulnerability to these impacts.

Community Perception of Vulnerability

See the front page of the current chapter for a summary of hazard rankings for Wharton County and participating communities in this HMP update. Chapter 21 gives a detailed description of these rankings and Chapter 22 addresses mitigations actions for this hazard vulnerability.

Figure 13-4. 100-Year Probabilistic Peak Wind Gusts for Wharton 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 future trends are difficult to predict. Colorado State University released their 2021 hurricane season outlook predicted that an above-average hurricane season is likely. This outlook calls for 17 named storms, 8 hurricanes, and 3 major hurricanes. However, Global Weather Oscillations Inc., a leading hurricane cycle prediction company, predicts 17 named storms, 9 hurricanes, 5 major hurricanes. Therefore, communities and community leaders need 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 move inland through Wharton County. Such a powerful storm at landfall would have significant impacts in Wharton 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 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 Wharton County and the participating communities include the following:

- The 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.
- The redundancy of the 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, & WIND

LIGHTNING, HAIL, AND WIND RANKING			
	Lightning	**Hail**	**Wind**
Wharton County	Low	Medium	Low
City of East Bernard	Medium	Medium	Medium
City of El Campo	Medium	Medium	High
City of Wharton	Low	Low	Low

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 the wind.

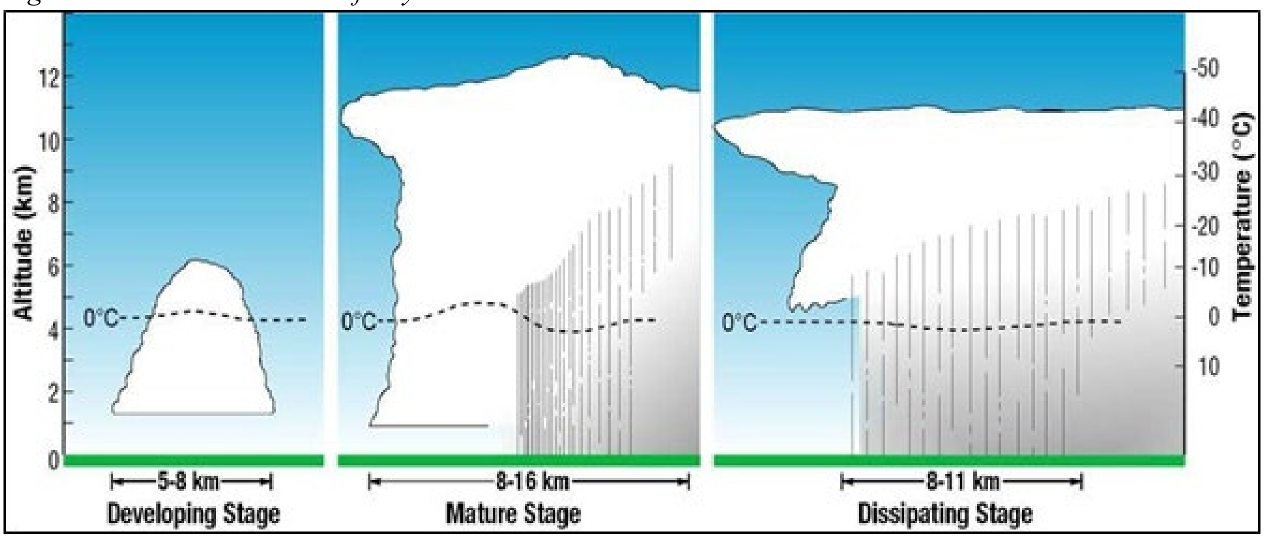
14.1 GENERAL BACKGROUND

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 one inch or greater, winds gusting in excess of 50 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, are not a Texas State Hazard per the Texas State Mitigation Plan Update 2018. ‘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.

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**. On 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 the 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.

14.1.1 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.

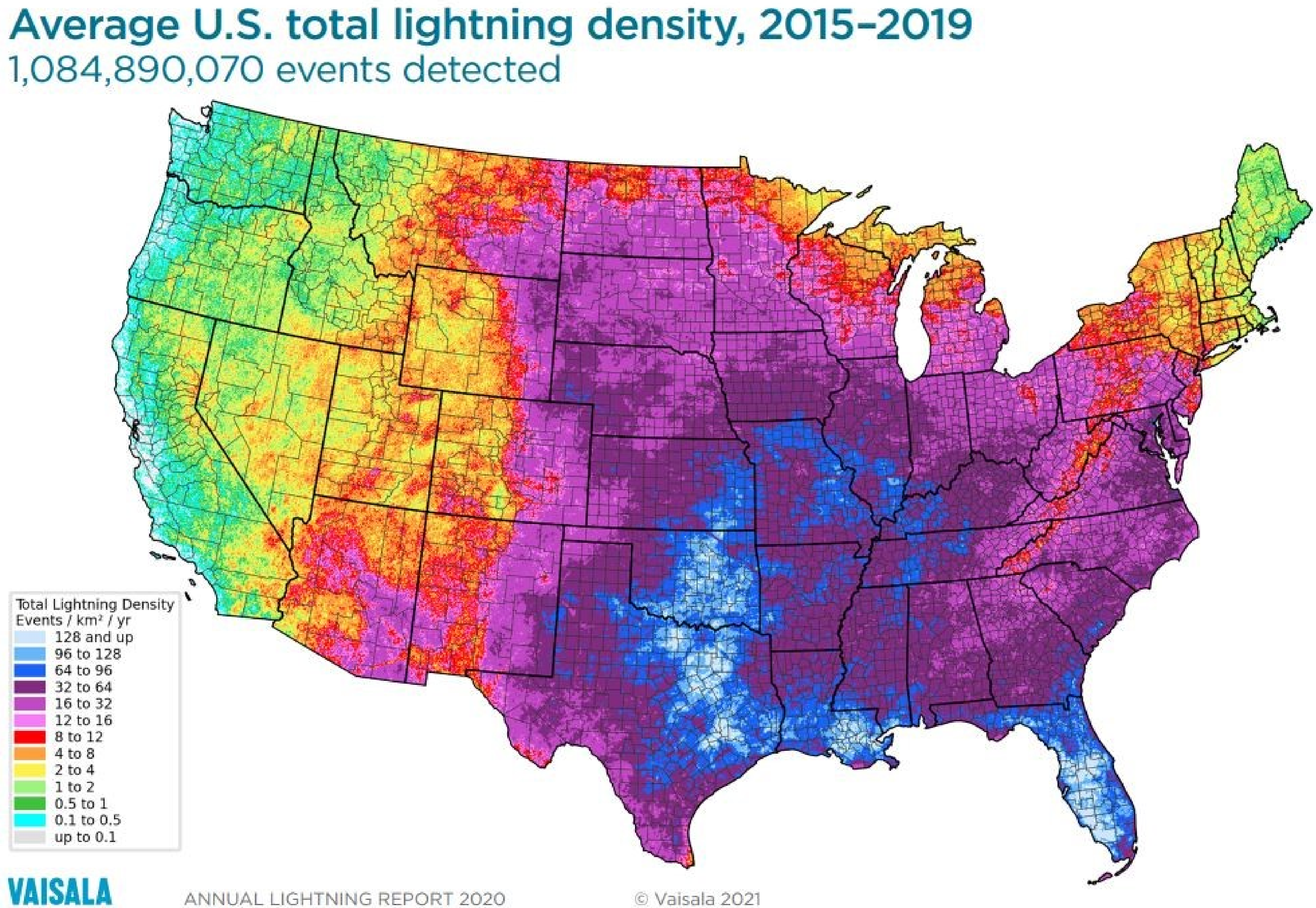
Lightning is one of the more dangerous and unpredictable weather hazards in the United States and Texas. Each year, lightning is responsible for deaths, injuries, and millions of dollars in property damage, including damage to buildings, communications systems, power lines, and electrical systems. Lightning also causes forest and brush fires as well as deaths and injuries to livestock and other animals. According to the NOAA, lightning strikes the U.S about 25 million times and on average kills 49 people and injures hundreds more each year. The latest data available from the National Fire Protection Association (NFPA) show that were an average of 22,600 fires between 2007 and 2011. These fires caused an average of nine civilian deaths and $451 million in direct property damage per year, according to the NFPA. The impact of lightning 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 a negative charge to the earth. However, a minority of flashes carry a 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 lighting 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 2006 and 2019 indicate that most lightning incidents occur during the summer months of June, July, and August.

Figure 14-2. Average Annual National Lightning Density



Note: From Vaisala-National Lightning Detecting Network

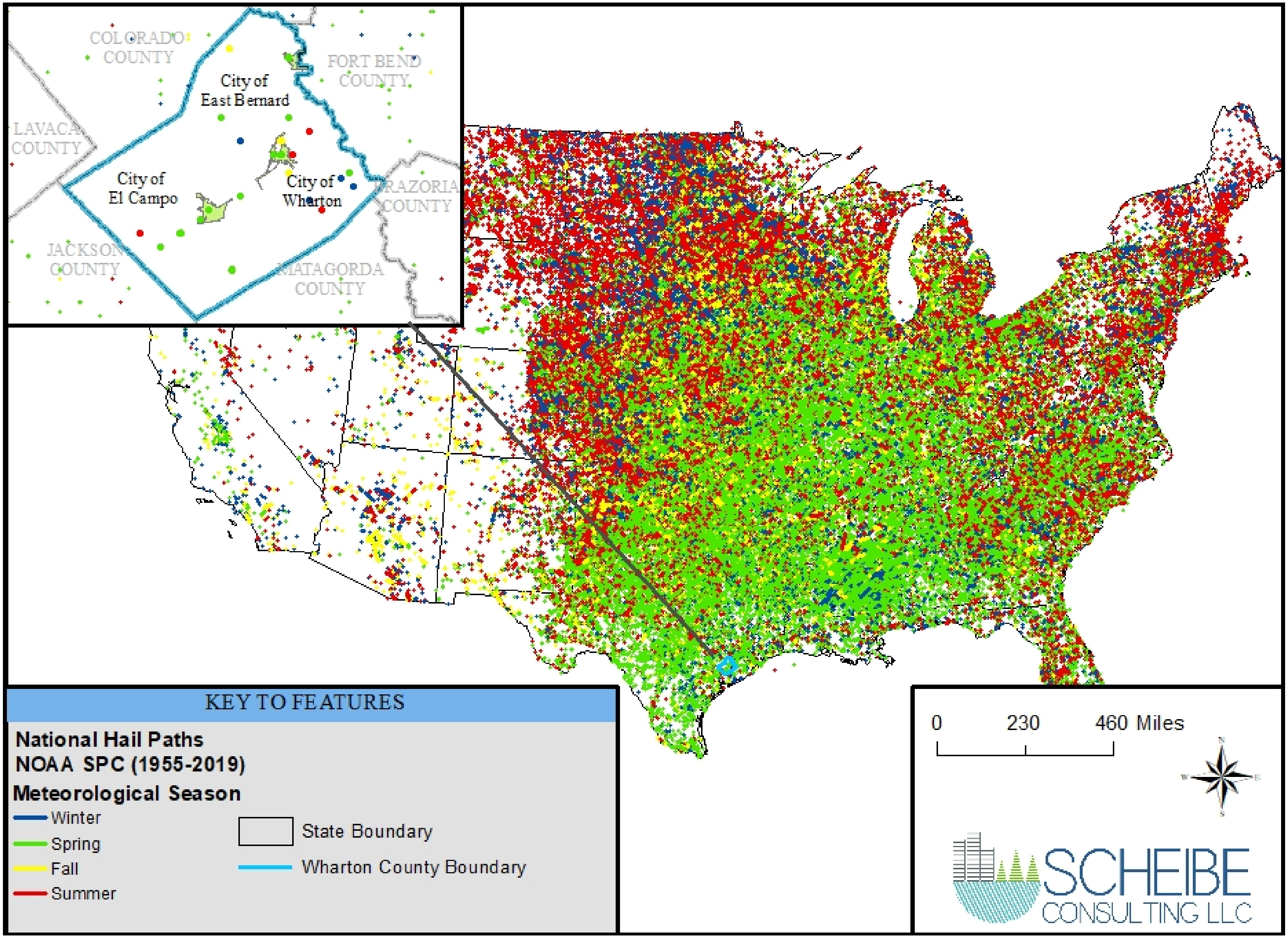
14.1.2 Hail

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. 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.

Figure 14-3. National Hail Paths



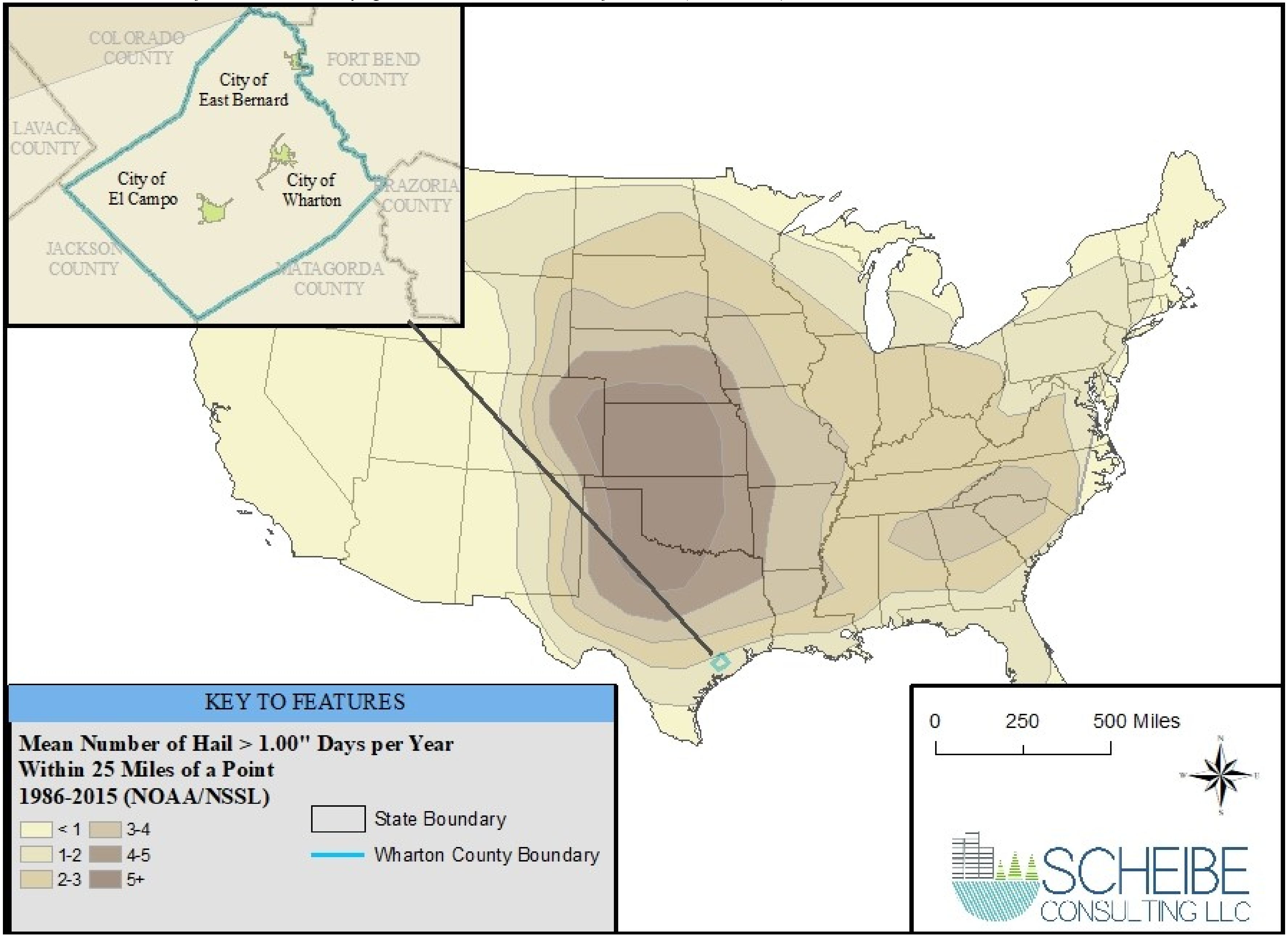
Note: From NOAA/NWS Storm Prediction Center

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. Mean Number of Hail > 1.00" Days per Year Within 25 miles of a Point (1986-2015)



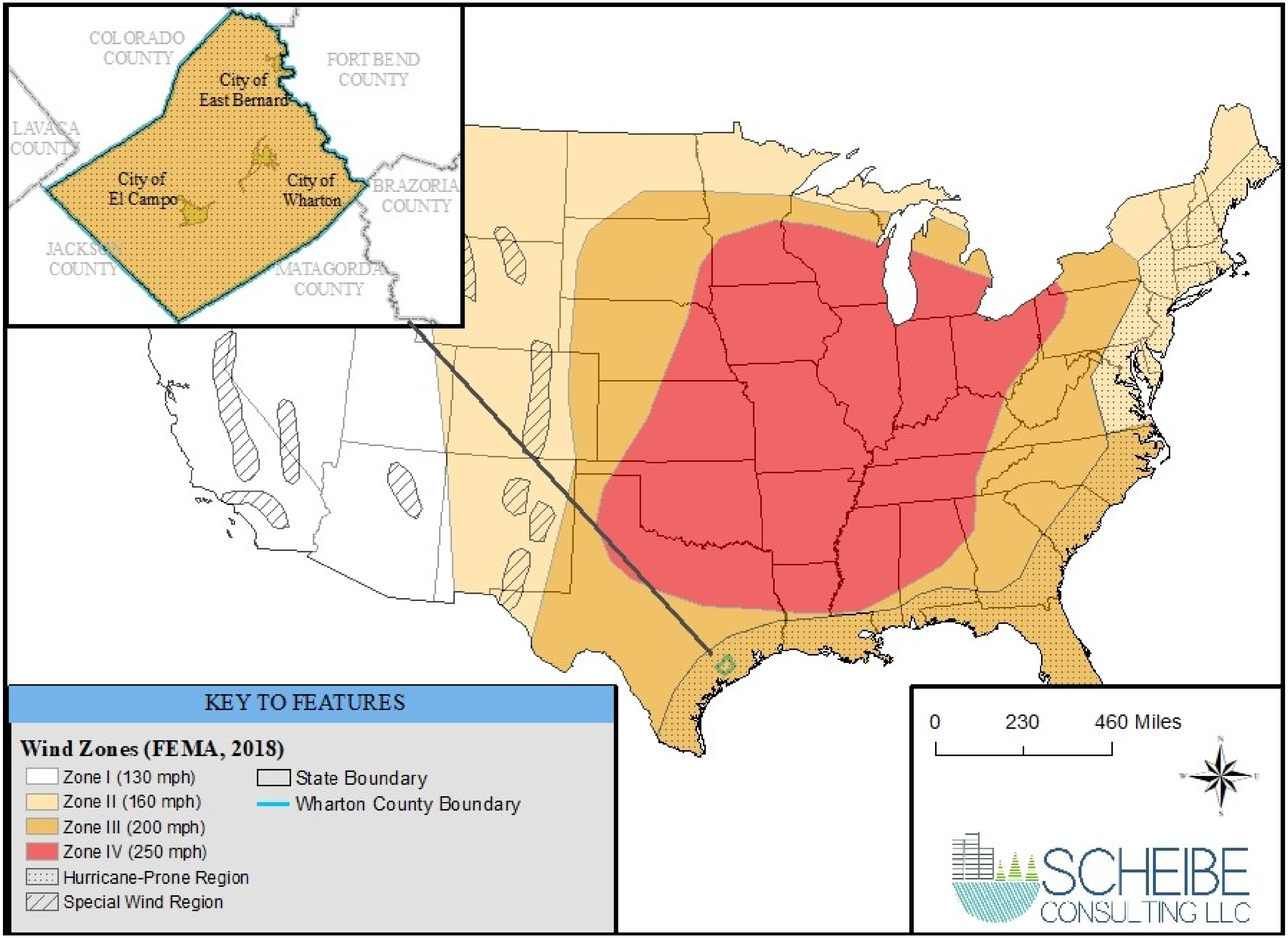
Note: From NOAA/NWS Storm Prediction Center WCM

14.1.3 Wind

Damaging winds are classified as those exceeding 60 mph. Figure 14-5 shows the wind zones in the nation. NOAA's Storm Events Database has a strong wind inventory from 1955 to 2020. Figure 14-6 shows the thunderstorm wind paths from 1955 to 2019. According to NOAA's National Severe Strom Laboratory (NSSL), 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:

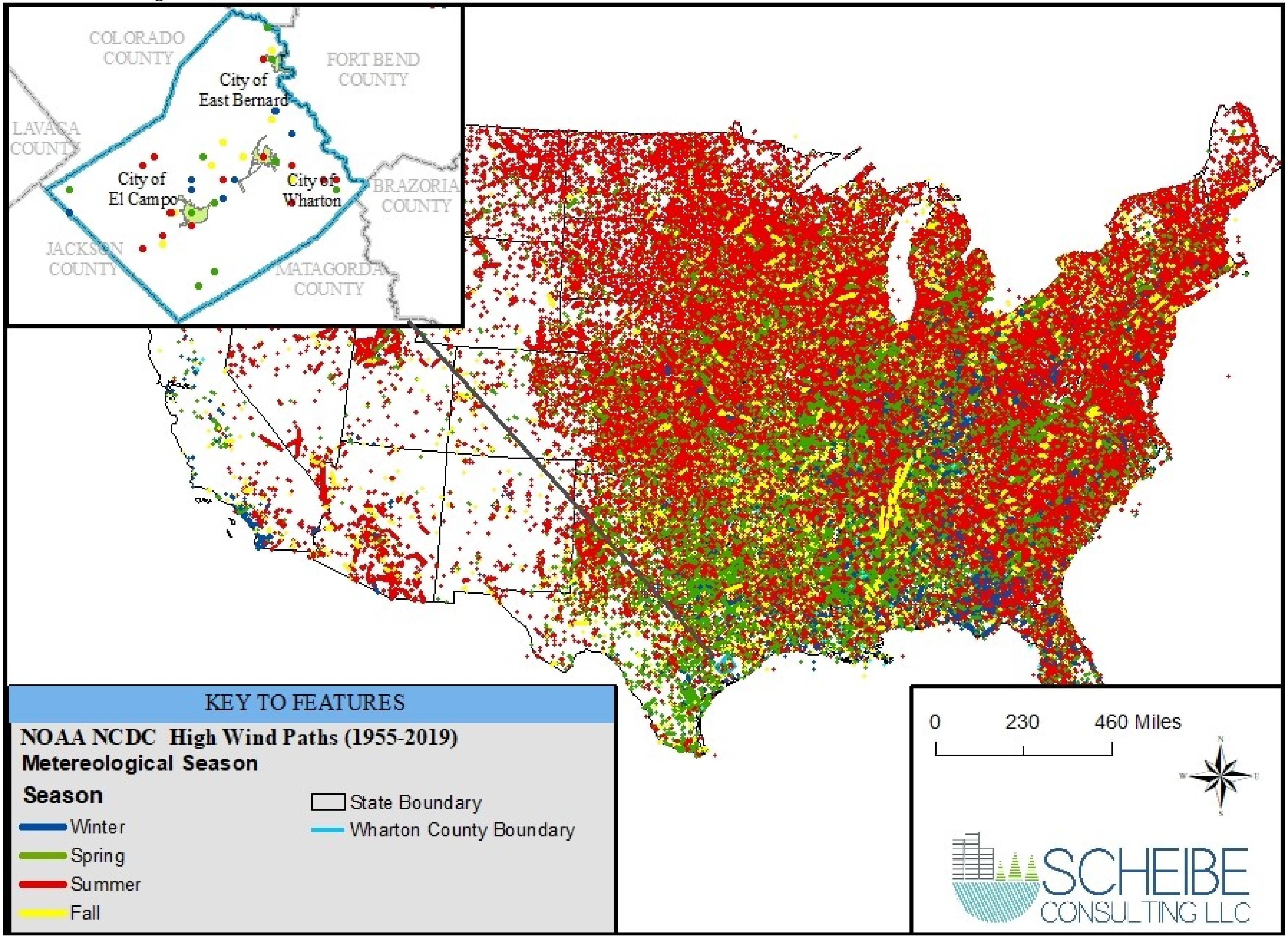
- **Straight-line winds**—Any thunderstorm wind that is not associated with rotation; this term is used mainly to differentiate from tornado winds. Most thunderstorms produce some straight-line winds as a result of outflow generated by the thunderstorm downdraft.
- **Downdrafts**—A small-scale column 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 the 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 NSSL 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 winds 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



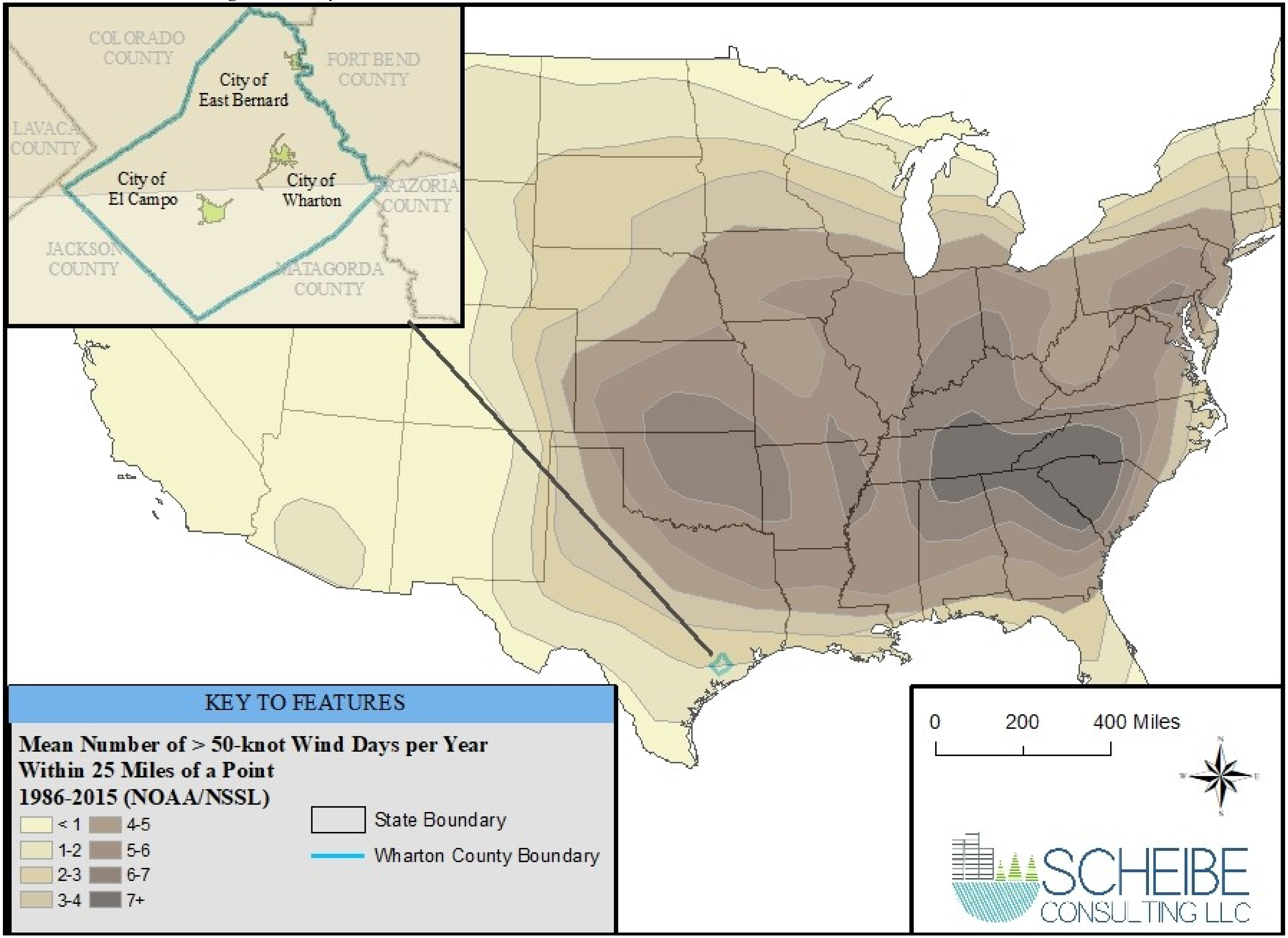
Note: From FEMA - Taking Shelter from The Storm

Figure 14-6. National High Wind Paths



Note: Note: From NOAA/NWS Storm Prediction Center

Figure 14-7. National Annual High Wind Days



Note: From NOAA/NWS Storm Prediction Center

14.2 HAZARD PROFILE

14.2.1 Past Events

Lightning

Data from the National Lightning Detection Network ranked Texas first in the nation (excluding Alaska and Hawaii) with respect to the number of cloud-to-ground lightning flashes in 2020. In 2020 Texas recorded 33,816,168 cloud-to-ground lightning strikes. The majority of lightning events occur in the Eastern part of the state with the highest total lightning density occurring in the central plains. In 2020 there were a total of 385,629 lightning strikes in Wharton County. The 5-year average for lightning events in Wharton County was 6 to 8 flashes per km^2 per year as shown in Figure 14-2.

Figure 14-8 shows state-by-state lightning deaths between 1959 and 2020. Texas ranks second for the number of deaths at 234. Texas has a 0.25 death rate per million people from lightning strikes according to 1959 to 2017 data published by NWS.

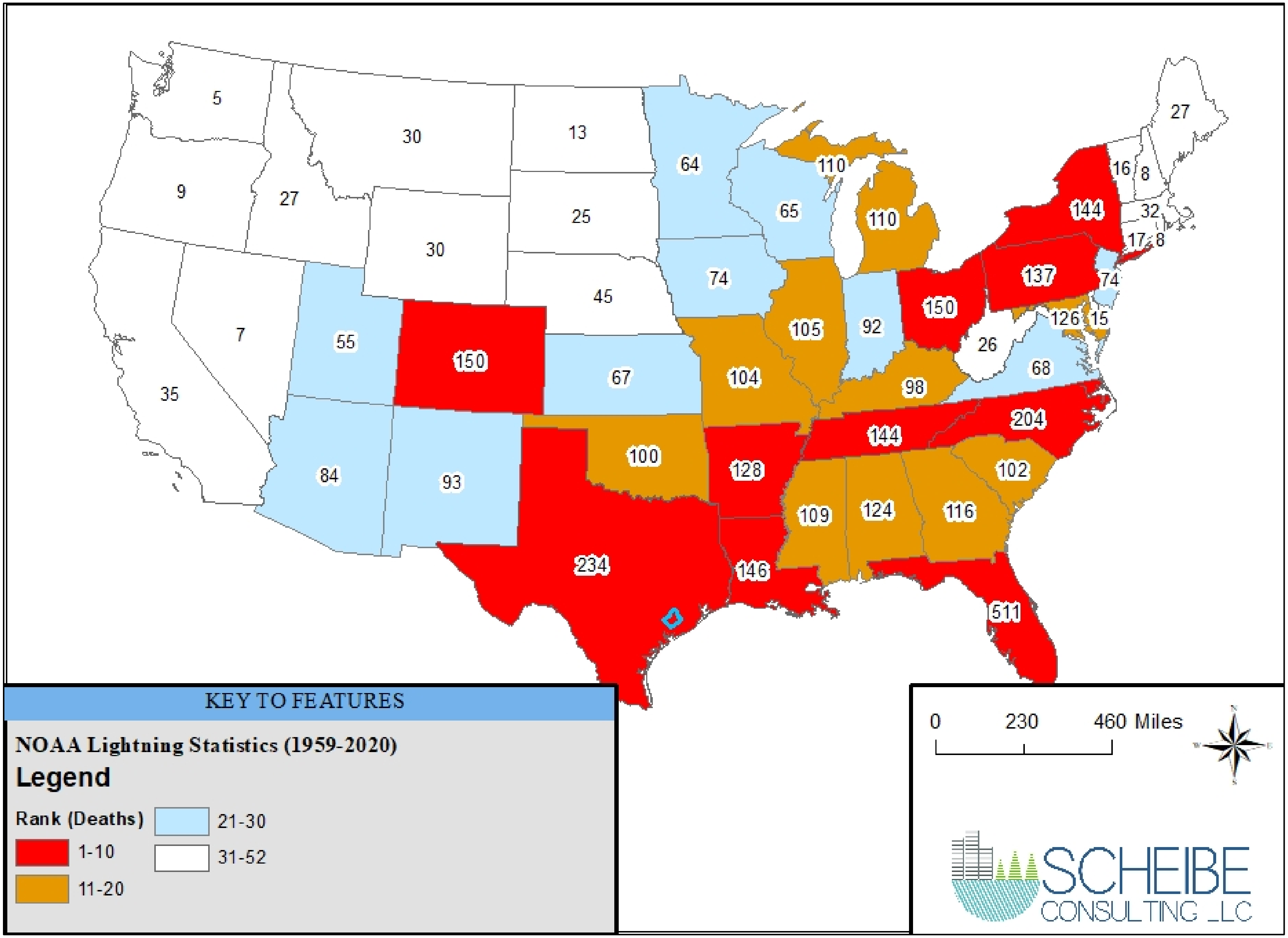
Table 14-2 lists the documented lightning events for Wharton County and participating communities as documented by the National Climatic Data Center Storm Events Database as well as locally available data. There were no reported injuries or fatalities from lightning in Wharton County between 1996 and 2020.

TABLE 14-2.
HISTORIC LIGHTNING EVENTS IN WHARTON COUNTY (1996-2020)

Location	Date	Estimated Damage Cost	
		Property	Crops
East Bernard	05/10/2006	$20,000	$0
East Bernard	05/10/2006	$25,000	$0
El Campo	05/27/2009	$15,000	$0

Note: From http://www.ncdc.noaa.gov/stormevents

Figure 14-8. Lightning Fatalities in the U.S. (1959-2020)



Note: From NOAA/NWS Storm Prediction Center

Hail

The National Centers for Environmental Information Storm Events Database lists 80 hail events in Wharton County and participating communities between 1955 and 2020. Severe hail events (hail size > 1.00") are noted in Table 14-3. None of these events resulted in injuries or deaths. Events listed as Wharton County, Wharton, Countywide, or County in Table 14-3 affected large portions of the HMP update area. Large systems may have affected additional jurisdictions. These are also included in Table 14-3. Specific events for the participating communities are described below.

Event Descriptions

City of East Bernard – The City of East Bernard had 6 events from 1955 to 2020. Three significant events are described below.

- On April 2, 2000, quarter-sized hail was reported in East Bernard and at Spanish Camp.
- On April 2, 2013, a severe thunderstorm produced quarter to golf ball-sized hail.
- On May 3, 2019, a severe thunderstorm produced quarter-sized hail along with some wind gusts and tornado damage.

City of El Campo – The City of El Campo had 9 events from 1955 to 2020. Three significant events are described below.

- On March 30, 2002, Emergency Management and Sheriff witnessed baseball-sized hail at State Highway 59 and FM 1163, with one-inch hail covering the ground.
- On December 12, 2002, there was 0.75-inch hail reported in the El Campo area.
- On April 11, 2004, golf ball-size hail was reported by residents in El Campo.

City of Wharton – The City of Wharton had 20 events from 1955 to 2020. Three significant events are described below.

- On September 9, 1997, severe roof and car damage was reported from 1.25-inch hail.
- On April 11, 2004, quarter-size hail in Wharton was reported.
- On June 13, 2006, golf ball-size hail was reported on County Road 120.

Wharton County (Unincorporated Areas) - Wharton County Unincorporated Areas had 44 significant events from 1955 to 2020. Three significant events are described below.

- On February 10, 1985 thunderstorm winds blew over a trailer in Mackay, located near Wharton. ¾ inch hail fell also.
- On April 15, 2015, a passing southwestern shortwave disturbance produced quarter-sized hail which damaged an agricultural field in Danevang near the intersection of CR 407 and CR 414.
- On December 5, 2016, a late-night severe thunderstorm produced quarter-sized to golf ball-sized hail in Dinsmore near County Roads 123 and 154.

TABLE 14-3.
HISTORIC HAIL EVENTS IN WHARTON COUNTY AND PARTICIPATING COMMUNITIES
(1955-2020)

Location	Date	Hail Size	Estimated Damage Cost		Injuries	Deaths
			Property	Crops		
WHARTON CO.	06/25/1962	1.75	$0	$0	0	0
WHARTON CO.	10/30/1969	2	$0	$0	0	0
WHARTON CO.	05/09/1981	1.75	$0	$0	0	0
WHARTON CO.	06/07/1985	1.75	$0	$0	0	0
WHARTON CO.	07/23/1989	1	$0	$0	0	0
East Bernard	04/22/1995	1	$1,000	$0	0	0
WHARTON	05/11/1996	1.75	$5,000	$0	0	0
EGYPT	06/20/1996	4.5	$5,000,000	$5,000,000	0	0
WHARTON	04/25/1997	1.75	$10,000	$0	0	0
HUNGERFORD	04/25/1997	1.75	$10,000	$0	0	0
WHARTON	09/09/1997	1	$3,000	$0	0	0
WHARTON	09/09/1997	1.25	$15,000	$0	0	0
EL CAMPO	06/05/1998	1.75	$10,000	$0	0	0
LOUISE	06/05/1998	2	$10,000	$0	0	0
LOUISE	05/02/1999	1.75	$40,000	$0	0	0
DANEVANG	05/02/1999	1.75	$40,000	$0	0	0
EAST BERNARD	04/02/2000	1	$15,000	$0	0	0
EAST BERNARD	08/02/2000	1	$25,000	$0	0	0
HILLJE	03/30/2002	1	$10,000	$0	0	0
LOUISE	03/30/2002	1.75	$20,000	$0	0	0
EL CAMPO	03/30/2002	2.75	$50,000	$0	0	0
WHARTON	03/13/2003	1	$6,000	$0	0	0
WHARTON	03/13/2003	1	$6,000	$0	0	0

TABLE 14-3.
HISTORIC HAIL EVENTS IN WHARTON COUNTY AND PARTICIPATING COMMUNITIES
(1955-2020)

Location	Date	Hail Size	Estimated Damage Cost		Injuries	Deaths
			Property	Crops		
WHARTON	03/13/2003	1.75	$9,000	$0	0	0
EAST BERNARD	04/07/2003	1.75	$4,000	$0	0	0
PIERCE	04/11/2004	1	$5,000	$0	0	0
EL CAMPO	04/11/2004	1.75	$20,000	$0	0	0
WHARTON	04/11/2004	1.75	$20,000	$0	0	0
BOLING	05/14/2006	1.75	$20,000	$0	0	0
WHARTON	06/13/2006	1.75	$15,000	$0	0	0
WHARTON	03/06/2008	1.75	$3,000	$0	0	0
WHARTON	06/19/2008	1	$9,000	$0	0	0
BOLING	06/21/2008	1.75	$0	$0	0	0
EAST BERNARD	01/09/2012	1.5	$0	$0	0	0
WHARTON	04/02/2013	1	$0	$0	0	0
WHARTON	04/02/2013	1.5	$0	$0	0	0
DINSMORE	04/02/2013	1.5	$0	$0	0	0
DON TOL	04/02/2013	1.75	$0	$0	0	0
DANEVANG	04/16/2015	1	$0	$0	0	0
DINSMORE	12/05/2016	1.75	$0	$0	0	0
NEW TAITON	02/26/2019	1	$0	$0	0	0
EAST BERNARD	05/03/2019	1	$0	$0	0	0

Notes:
The 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.
From NOAA Storm Events Database

Winds

High winds occur year-round in Wharton 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 phenomenon in Southern Texas. These winds develop in well-defined areas and can be quite strong with resulting drastic drops 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 buildings 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 14-4 identifies the mean wind power density and speed associated with each classification. Figure 14-9 shows the wind power class potential density for Wharton County and participating communities classified as "Poor." Significant wind events for Wharton County and participating communities are highlighted below. They are also listed in Table 14-5. None of these events resulted in injuries or deaths.

Event Descriptions

City of East Bernard – The City of East Bernard had 8 events from 1955 to 2020. Three significant events are described below.

- June 5, 2011, Law enforcement reported severe thunderstorm winds at over 59 mph in the City of East Bernard. Three injuries were reported.
- On April 16, 2015 trees were downed and there was damage to a barn on the east end of CR 272 near the San Bernard River.
- On June 6, 2019 houses were damaged in the East Bernard area close to Highway 60.

City of El Campo – The City of El Campo had 14 events from 1955 to 2020. Three significant events are described below.

- On April 18, 2009, trees and power lines were blown down near the community of New Taiton.
- On February 14, 2017 power lines were downed near the intersection of West Norris Street and West Loop Street.
- On April 7, 2019 thunderstorm winds downed two trees with two of them blocking roadways and cause $2,000 worth of crop damage.

City of Wharton – The City of Wharton had 24 significant events from 1955 to 2020. Three significant events are described below.

- On February 1, 2011, downed trees blocked roadways at the intersection of Avenue A and Texas, Cornell and Elm, and in the 800 block of North Alabama in the City of Wharton.

- On April 26, 2015, a late afternoon severe thunderstorm developed and produced damaging wind gusts and hail. The Thunderstorm wind gust was near the intersection of FM 961 and Highway 71.
- On January 19, 2019, a strong cold front wind caused damage to a barn and a shed.

Wharton County (Unincorporated Areas) - Wharton County Unincorporated Areas had 39 significant events from 1955 to 2014. Three significant events are described below.

- On August 26, 2009, a severe thunderstorm produced strong winds that blew down a billboard on Business 59 near Louise.
- On April 26, 2015, a severe thunderstorm wind in Iago tore off a part of a mobile home roof on FM 1301.
- On June 6, 2019, there was trailer damage, trees were uprooted, 2x4's were wedged into the ground and there was debris on power lines near Spanish Camp.

TABLE 14-4.
WIND POWER CLASS AND SPEED

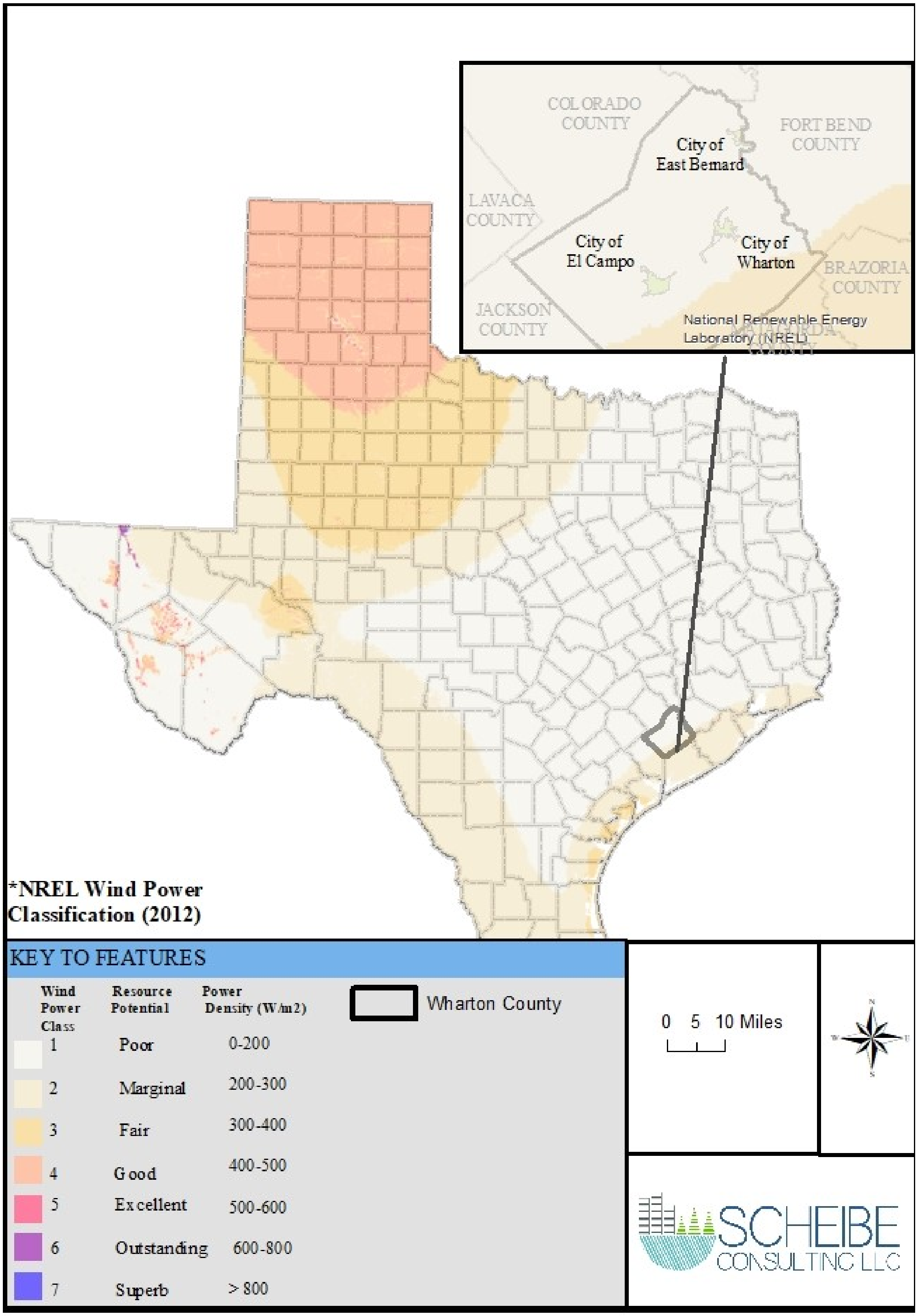
Rank	Wind Power Class	Wind Power Density at 50 meters (W/m^2)	Wind Speed at 50 meters (mph)
Poor	1	0-200	0-12.5
Marginal	2	200-300	12.5-14.3
Fair	3	300-400	14.3-15.7
Good	4	400-500	15.7-16.8
Excellent	5	500-600	16.8-17.9
Outstanding	6	600-800	17.9-19.7
Superb	7	800-2000	19.7-26.6

Note:
Mph Miles per hour
W/m^2 Watts per square meter
From National Renewable Energy Laboratory

Historical severe weather data from the NCDC Storm Events Database lists thunderstorm wind events in Wharton County and participating communities between 1955 and December 2020, as shown in Table 14-5. This table was supplemented with local knowledge and news articles of events affecting the participating communities.

The NCDC database as well as locally available datasets list no dust devil or dust storm events for the participating communities. There were several documented tornadoes in Wharton County and participating communities in the 1950 to 2020 time period. These tornadoes are discussed in Chapter 15. Events listed as Wharton County, Wharton, Countywide, or County in Table 14-5 affected large portions of the HMP update area. Large systems may have affected additional jurisdictions.

Figure 14-9. Texas Wind Power



Note: From NREL National Wind Technology Center

TABLE 14-5. HISTORIC WIND-RELATED EVENTS IN WHARTON COUNTY AND PARTICIPATING COMMUNITIES (1955-2020)						
Location	Date	Peak Wind Speed (knots)	Estimated Damage Cost		Injuries	Deaths
			Property	Crops		
Wharton County	04/20/1985	52	$0	$0	0	0
Wharton County	05/04/1991	91	$0	$0	0	0
Wharton County	02/22/1992	52	$0	$0	0	0
Wharton County	09/03/1992	70	$0	$0	0	0
Wharton County	06/11/1995	52	$400,000	$10,000	0	0
Pierce	04/11/1997	55	$5,000	$0	0	0
Pierce	12/23/1997	50	$3,000	$0	0	0
El Campo	08/31/1999	65	$0	$0	0	0
Hungerford	03/30/2002	60	$3,000	$0	0	0
Wharton	12/23/2002	52	$35,000	$0	0	0
Wharton	12/23/2002	52	$35,000	$0	0	0
El Campo	12/30/2002	60	$10,000	$0	0	0
Wharton	12/30/2002	60	$12,000	$0	0	0
El Campo	07/24/2003	52	$0	$0	1	0
Boling	06/23/2004	50	$75,000	$0	0	0
Wharton	08/11/2004	50	$10,000	$0	0	0
Glen Flora	11/23/2004	65	$15,000	$0	0	0
Wharton	03/19/2005	52	$8,000	$0	0	0
Countywide	05/08/2005	64	$200,000	$0	0	0
Wharton	04/21/2006	55	$3,000	$0	0	0
Hungerford	10/12/2006	50	$1,000	$0	0	0
Wharton	10/16/2006	58	$2,000	$0	0	0
El Campo	03/12/2007	50	$8,000	$0	0	0
Danevang	03/12/2007	50	$3,000	$0	0	0
Wharton	03/31/2007	52	$5,000	$0	0	0
Wharton	06/03/2007	65	$0	$0	0	0
Louise	02/11/2008	56	$5,000	$0	1	0
El Campo South	04/18/2008	56	$10,000	$0	0	0
Wharton	06/19/2008	55	$2,000	$0	0	0
East Bernard	06/29/2008	51	$9,000	$0	0	0

TABLE 14-5. HISTORIC WIND-RELATED EVENTS IN WHARTON COUNTY AND PARTICIPATING COMMUNITIES (1955-2020)						
Location	Date	Peak Wind Speed (knots)	Estimated Damage Cost		Injuries	Deaths
			Property	Crops		
Hungerford	06/29/2008	51	$5,000	$0	0	0
El Campo Airport	04/18/2009	52	$2,000	$0	0	0
New Taiton	06/25/2009	60	$35,000	$10,000	0	0
Newgulf	08/12/2009	52	$1,000	$0	0	0
Louise	08/26/2009	55	$6,000	$0	0	0
Wharton	06/08/2010	52	$10,000	$0	0	0
Wharton	02/01/2011	56	$5,000	$0	0	0
Wharton	05/12/2011	50	$15,000	$0	0	0
East Bernard	06/05/2011	52	$0	$0	3	0
East Bernard	09/29/2011	50	$3,000	$0	0	0
Hungerford	04/02/2012	61	$30,000	$0	0	0
Hungerford	06/07/2012	52	$5,000	$0	0	0
Magnet	05/10/2013	60	$5,000	$0	0	0
Hungerford	05/26/2014	61	$0	$0	0	0
East Bernard	04/16/2015	52	$0	$0	0	0
El Campo	04/17/2015	52	$0	$0	0	0
Wharton	04/26/2015	61	$0	$0	0	0
Iago	04/26/2015	56	$0	$0	0	0
Hungerford	05/26/2015	60	$0	$0	0	0
El Campo	02/14/2017	52	$0	$0	0	0
Lane City	02/25/2018	50	$0	$0	0	0
Wharton	01/19/2019	50	$3,000	$0	0	0
El Campo	04/07/2019	57	$0	$2,000	0	0
Spanish Camp	06/06/2019	53	$17,000	0	0	0
East Bernard	06/06/2019	52	$11,000	0	0	0

Notes:
The 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.
From NCDC

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.

Lightning

The entire extent of Wharton County and participating communities are exposed to some degree of lightning hazard, though exposed points of high elevation have a 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 were three lightning damage events recorded by the NOAA Storm Events Database from 1996 to 2020 in the HMP update area. These events were located near the Cities of East Bernard and El Campo (Figure 14-10). The City of Wharton did not have any lightning events recorded by the NOAA Storm Events Database during this period. There were no new lightning-related data from local sources for the 1996 to 2020 time period. The events are described below:

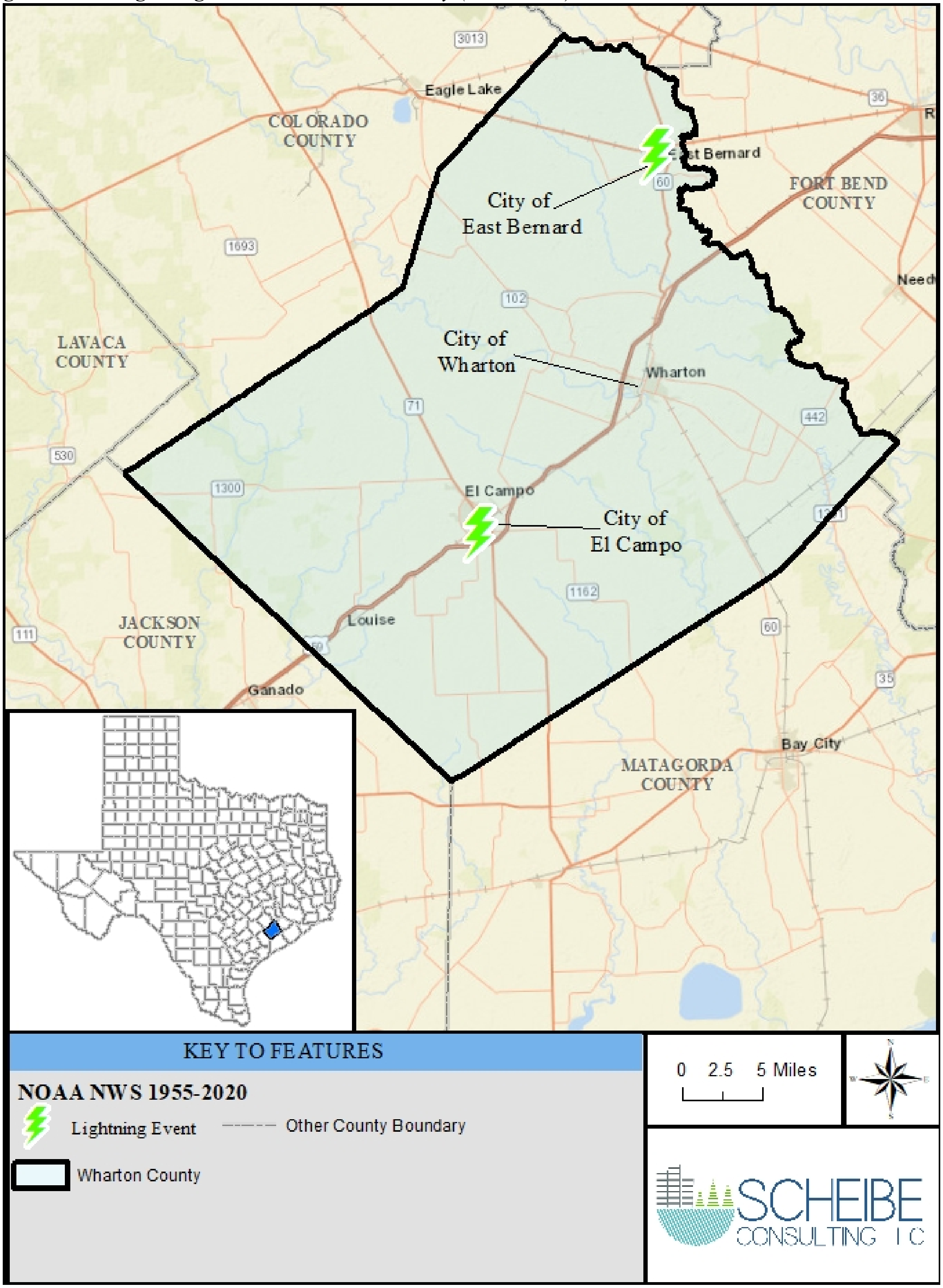
Hail

The entire extent of Wharton 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 14-3 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

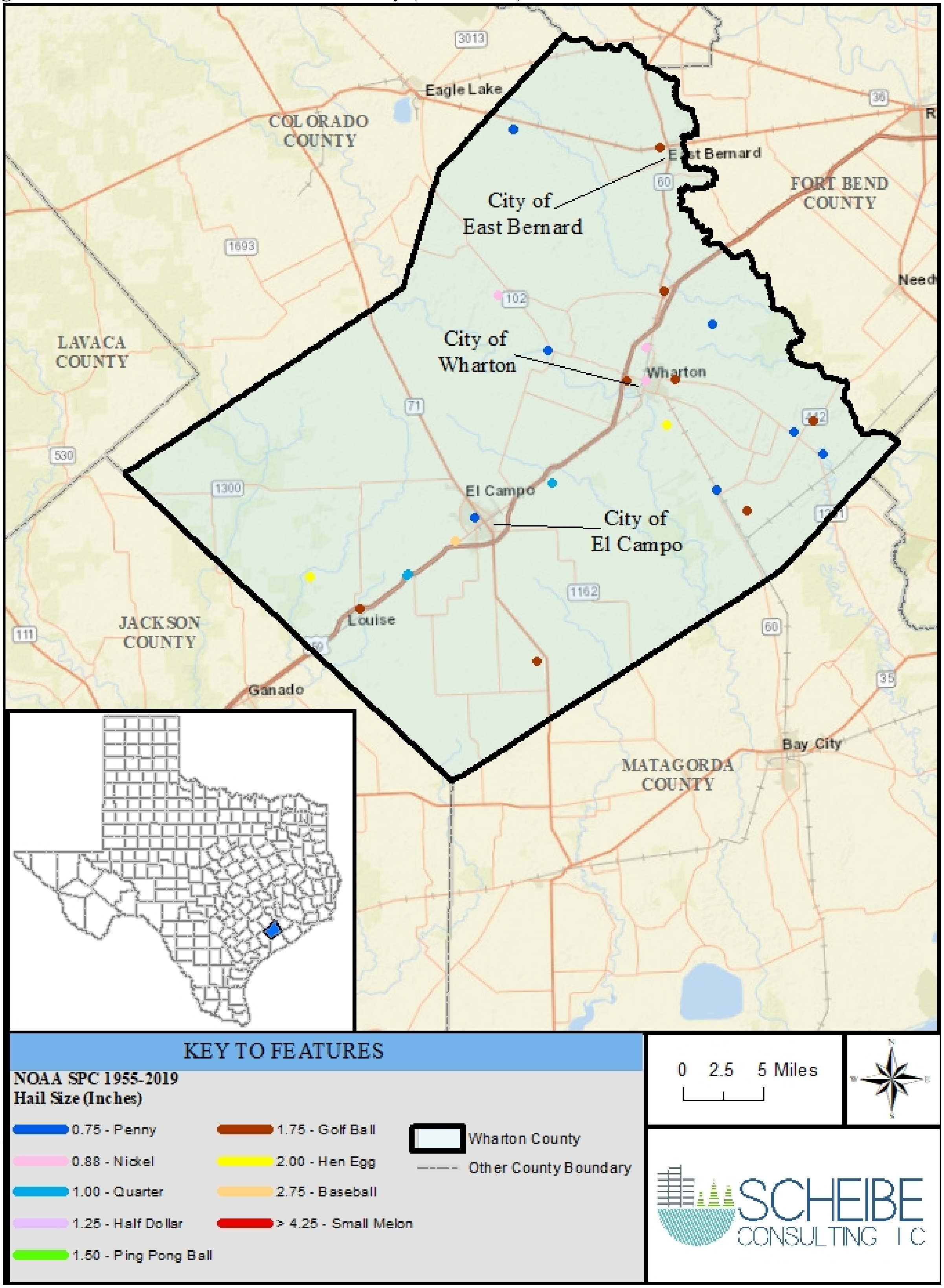
The entire extent of Wharton County and participating communities are exposed to high winds. Storms have the ability to cause damage over 100 miles from the center of storm activity. Wind events are most damaging to heavily wooded areas. Winds impacting walls, doors, windows, and roofs, may cause structural components to fail. Previous occurrences of damaging high winds and the locations that they occurred are shown in Figure 14-12. 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 14-5 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 Wharton County (1955-2020)



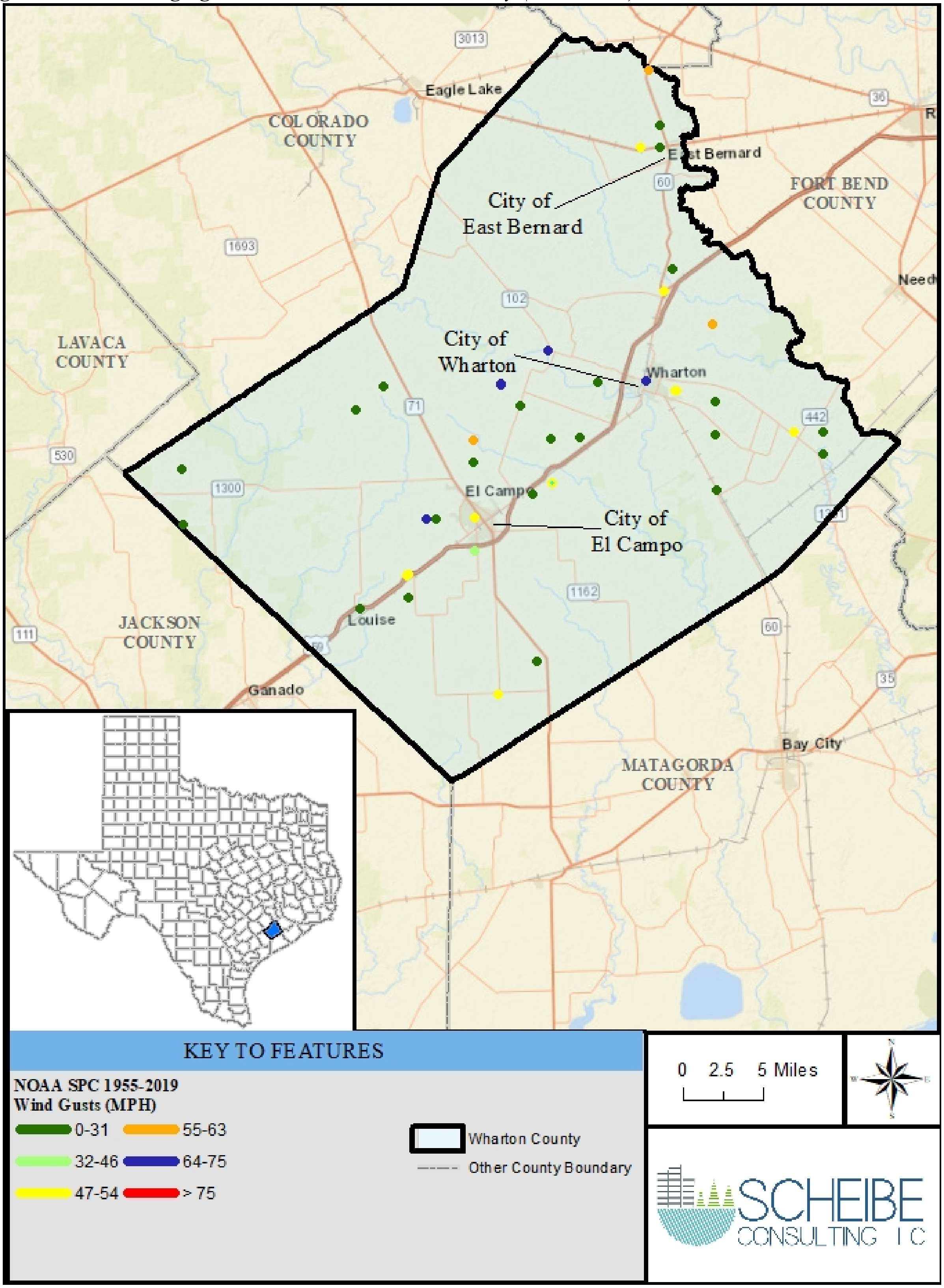
Note: From NOAA/NWS Storm Prediction Center

Figure 14-11. Hail Events in Wharton County (1955-2019)



Note: From NOAA/NWS Storm Prediction Center

Figure 14-12. Damaging Wind Events in Wharton County (1955-2019)



Note: From NOAA/NWS Storm Prediction Center

14.2.3 Frequency

Lightning

To date, there have been three reported lightning strikes resulting in property damage in Wharton County and participating communities. Texas ranks as second of the highest in lightning fatalities in the nation. Wharton County and all participating communities have approximately 25 to 37 lightning flashes per square mile per year and a thunderstorm lightning event is considered “High”. This frequency statistics applies to all Wharton County and participating communities.

Hail

Based on a record of 42 hailstorm events over a 65-year period, significant hail (>1”) occurs approximately every other year on average and is considered likely. 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 1 to two years). Based on historical records, the City of East Bernard can expect future events to have hail up to 1.75” in diameter hail. Based on historical records, the City of El Campo can expect future events up to 2.75” in diameter hail. Based on historical records, the City of Wharton can expect future events up to 1.75” in diameter hail. Based on historical records, Wharton County Unincorporated area can expect hail up to 2” in diameter. All participating jurisdictions can expect an event every 1 to 2 years in the future.

Winds

Based on 36 events in 65 years, a damaging high-wind (> 50 MPH) event occurs approximately every other year on average in Wharton County and participating communities 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 (once every one to two years).

14.2.4 Severity

Lightning

Based on the information in this hazard profile, the risk of a damaging lightning event in Wharton County and participating communities is likely, but the magnitude/severity of thunderstorms is limited. 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 the United States hail related insured losses between 2000 and 2019 averaged between $8 billion and $14 billion a year, according to Aon. Within Texas, over the last 55 years, there’s been $1.8 billion damage to property and crops. Between 2017-2019 there were a total of 192,988 hail loss claims. The property damage can be as minimal as a few broken shingles to the total destruction of buildings.

The top five states generating hail damage claims were Texas (637,977 claims); Colorado (380,066 claims); Nebraska (161,374 claims); Minnesota (150,673 claims) and Illinois (150,416 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.

A significant hail event occurred on June 20, 1996, in Egypt (an unincorporated community in northern Wharton County). Grapefruit-sized hail fell in Egypt, significantly damaging the roofs and windows of 30 to 40% of homes. Trees snapped and many cars were considered total losses. The event resulted in a significant agricultural loss (1,000 acres of sorghum, 2,000 acres of corn, and 1,000 acres of soybeans were destroyed) and caused over $10 million in property and crop damages.

Based on the information in this hazard profile, the severity of hail storms is moderate and the overall significance is medium. Wharton County and participating communities have an overall limited to medium risk to this hazard: The economy of Wharton 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. The overall significance is considered medium: moderate potential impact.

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 Wharton County 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 Wharton 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.

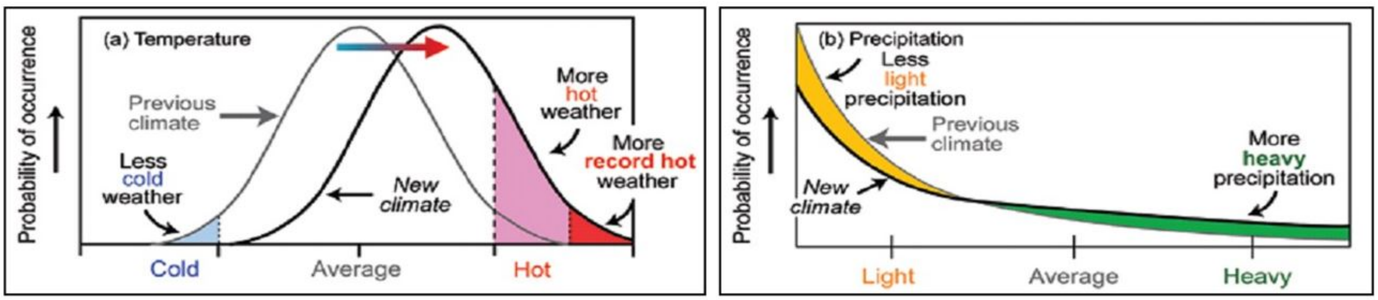
14.3 SECONDARY HAZARDS

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 a 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. 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 of 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-MH inventory data (updated with 2010 Census Data and 2018 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 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 blackout, 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 HAZUS-MH inventory data (updated with 2010 U.S. Census data and 2018 RS Means Square Foot Costs), there are 16,979 buildings within the census blocks that define the planning area with an asset replaceable value of $3.9 billion (excluding contents). About 91% of these buildings (and 75% of the building value) are associated with residential housing. Other types of buildings in this report include agricultural, education, religious, and governmental structures. See Table 14-6 below.

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 lightning, wind, and hail hazards, but structures in poor condition or 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 14-6
EXPOSED STRUCTURES AND POPULATION

Jurisdiction	Residential	Commercial	Other *	**Total Structures**	**Total Population**
City of East Bernard	909	62	43	**1,014**	**2,272**
City of El Campo	4,465	352	200	**5,017**	**11,602**
City of Wharton	3,299	321	138	**3,758**	**8,832**
Unincorporated Area	6,799	210	181	**7,190**	**18,574**
Wharton County Total	**15,472**	**945**	**562**	**16,979**	**41,280**

Note: *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 the 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-MH, 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 thunderstorms, wind, lightning, 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 14-7 shows vulnerable populations per participating jurisdiction.

TABLE 14-7
MOST VULNERABLE POPULATION

Jurisdiction	Youth Population (< 16)	% of Total Population	Elderly Population (> 65)	% of Total Population	Economically Disadvantage (Income< $20,000)	% of Total Population
City of East Bernard	638	28.07	342	15.05	129	5.68
City of El Campo	3402	29.33	1648	14.21	992	8.55
City of Wharton	2317	26.23	1288	14.58	1251	14.17
Unincorporated Area	4,715	25.39	2,741	14.76	1,537	8.28
Wharton County Total	**11,072**	**26.82**	**6,019**	**14.58**	**3,910**	**9.47**

14.6.2 Property

All property is vulnerable during thunderstorms, lightning, wind, and hail events, but properties in poor condition or 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 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 counties and communities reported damages and exposed values to create an annualized Table 14-8 through Table 14-10 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 14-8.
LOSS ESTIMATES FOR HAIL EVENTS IN WHARTON COUNTY AND PARTICIPATING COMMUNITIES

Jurisdiction	Exposed Value	Annualized Loss	Annualized Loss Percentage
City of East Bernard	$262,048,000	$692	<0.01
City of El Campo	$1,343,990,000	$1,908	<0.01
City of Wharton	$915,074,000	$1,569	<0.01
Unincorporated Area	$1,371,697,000	$157,723	<0.01
Wharton County Total	**$3,892,809,000**	**$161,892**	**<0.01**

TABLE 14-9.
LOSS ESTIMATES FOR LIGHTNING EVENTS IN WHARTON COUNTY AND PARTICIPATING COMMUNITIES

Jurisdiction	Exposed Value	Annualized Loss	Annualized Loss Percentage
City of East Bernard	$262,048,000	Negligible	<0.01
City of El Campo	$1,343,990,000	Negligible	<0.01
City of Wharton	$915,074,000	Negligible	<0.01
Unincorporated Area	$1,371,697,000	Negligible	<0.01
Wharton County Total	**$3,892,809,000**	**Negligible**	**<0.01**

TABLE 14-10.
LOSS ESTIMATES FOR WIND EVENTS IN WHARTON COUNTY AND PARTICIPATING COMMUNITIES

Jurisdiction	Exposed Value	Annualized Loss	Annualized Loss Percentage
City of East Bernard	$262,048,000	$2,431	<0.01
City of El Campo	$1,343,990,000	$1,800	<0.01
City of Wharton	$915,074,000	$1,923	<0.01
Unincorporated Area	$1,371,697,000	$9,508	<0.01
Wharton County Total	**$3,892,809,000**	**$15,508**	**<0.01**

Vulnerability Narrative

All participating communities are equally at risk of lightning, hail, and wind events. Table 14-7 lists the vulnerable population per community. Table 14-8 to Table 14-10 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 East Bernard -

- *Lightning* – Properties with thick vegetation and large trees or those built under no or insufficient building codes are more susceptible to negative impacts of a lightning event. Residents unaware of the risks or hazards associated with lightning increase their vulnerability as well.
- *Hail* – The maximum hail size recorded for the City is 1.75 inches (golf ball-size hail) and can cause extensive damage to windows, glass roofs, as well as the bodywork of vehicles. Mobile homes and older residential areas are more prone to damages from an event. Residents uninformed on the hazards associated with hail will be more vulnerable to its impacts.
- *Wind* – Based on historical events, significant wind events have been recorded within The City at over 55-63 mph. Approximately 6.5% of the City of East Bernard's housing are 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. Recorded reports of these events were most prevalent around US 90.

Community Perception of Vulnerability in the City of East Bernard

See the front page of the current chapter for a summary of hazard rankings for the City of East Bernard. Chapter 21 gives a detailed description of these rankings and Chapter 22 addresses mitigations actions for this hazard vulnerability.

City of El Campo -

- *Lightning* – Properties built without sufficient building codes or with large trees or thick brush are more vulnerable to a damaging lightning event. Residents not aware or unable to afford preventive actions or corrective responses to a lightning event are more vulnerable as well.
- *Hail* – The maximum hail size recorded for El Campo was 2.75 inches (baseball-size hail) and can cause damage to roofing tiles, facades, metal cladding, window frames, and poses a risk of serious injury. 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 event recorded for the City of El Campo was between 55 -63. Approximately 6.1% of the City's housing are 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 of oncoming severe weather through a community alert system are more vulnerable as well.

Community Perception of Vulnerability in the City of El Campo

See the front page of the current chapter for a summary of hazard rankings for the City of El Campo. Chapter 21 gives a detailed description of these rankings and Chapter 22 addresses mitigations actions for this hazard vulnerability.

City of Wharton-

- *Lightning* – Properties with large trees or thick brush are more vulnerable to a damaging lightning event. Communities unaware of the areas of higher risk, such as structures built in the absence of sufficient codes, are more at risk.
- *Hail* – The maximum hail size recorded for Wharton was 1.75 inches (golf ball-size hail). This hail size can cause damage to glass windows and roofs as well as the bodywork of cars and aircraft. Manufactured homes are less resilient to natural disasters, such as hail, and are more vulnerable to feeling the effects of a damaging hail event.
- *Wind* – Based on historical events, the most significant wind events recorded for the City of Wharton were over 75 mph. Approximately 8.9% of the of the City of Wharton's housing are 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.

Community Perception of Vulnerability in the City of Wharton

See the front page of the current chapter for a summary of hazard rankings for the City of Wharton. Chapter 21 gives a detailed description of these rankings and Chapter 22 addresses mitigations actions for this hazard vulnerability.

Wharton County (Unincorporated Area) -

- *Lightning* – Emergency service facilities and infrastructures such as area schools, 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 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 Wharton County was 4.5 inches (grapefruit size hail) in Egypt which caused significant damage to roofs and windows. On average, severe hail events can cause extensive damage to windows, glass roofs, as well as the bodywork 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 Wharton County were over 75 mph. Approximately 19.9% of the of the HMP update area's housing are manufactured homes. Wharton 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 Wharton County Unincorporated Areas

See the front page of the current chapter for a summary of hazard rankings for Wharton County and participating communities in this HMP update. Chapter 21 gives a detailed description of these rankings and Chapter 22 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 on 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 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 severe weather in the planning area include the following:

The 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.

- The redundancy of the 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	
Wharton County	Medium
City of East Bernard	High
City of El Campo	Low
City of Wharton	Medium

DEFINITIONS

Tornado A violently rotating column of air touching the ground, usually attached to the base of a thunderstorm. Winds of a tornado may reach 300 miles per hour and damage paths can be in excess of 1 mile wide and 50 miles long. Most are on the ground for less than 15 minutes. They are measured using the Fujita Scale (ranging from F0 to F5), or the Enhanced Fujita Scale.

15.1 GENERAL BACKGROUND

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 and thunderstorms. 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 the 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 a 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 the 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 areas. Table 15-2 describes the EF-Scale ratings.

With a yearly average of 1,253 tornadoes, the U.S. experiences more tornadoes than any other country. 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 2000 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 NSSL 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

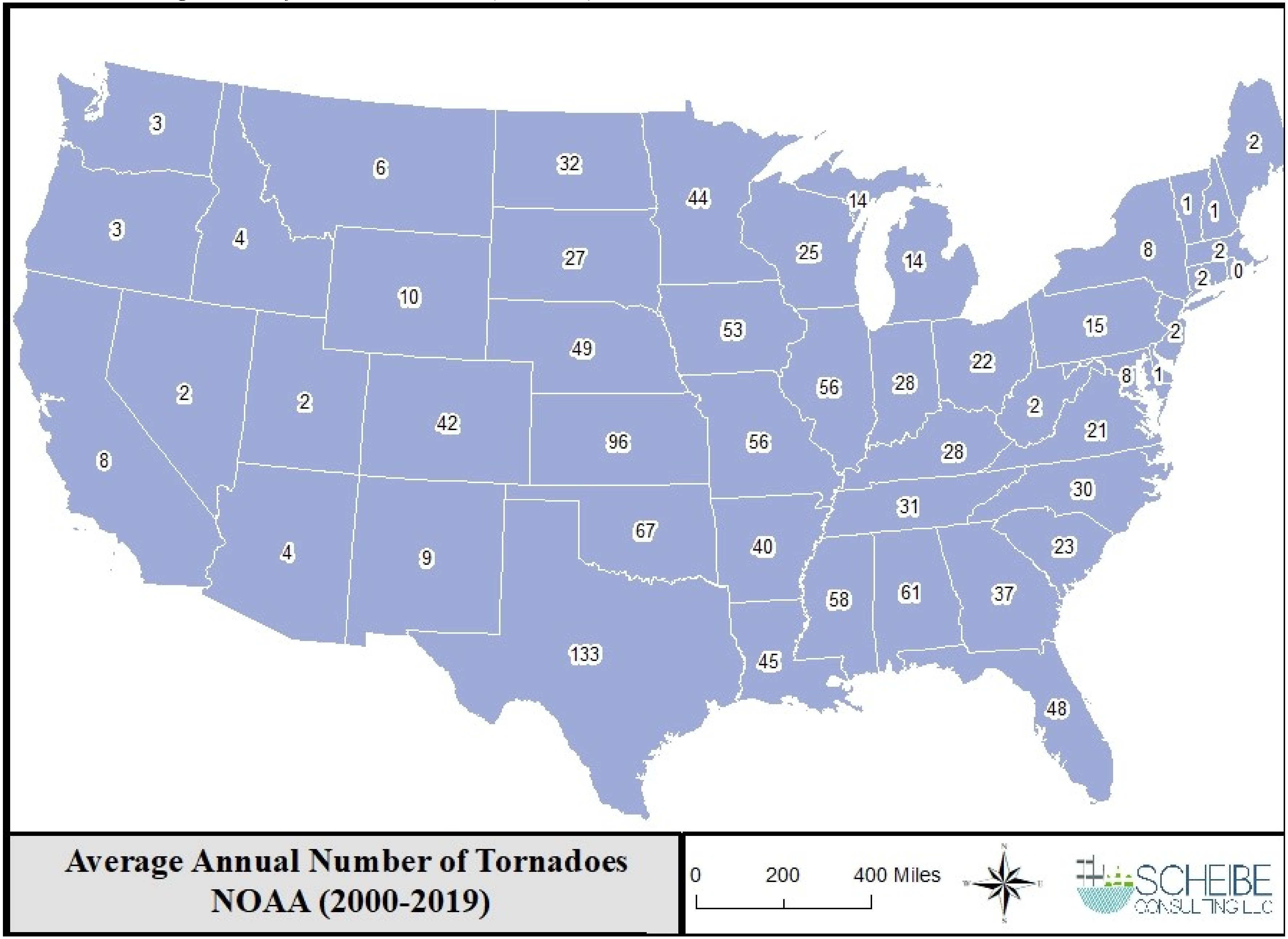
Note: From NOAA-NWS

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

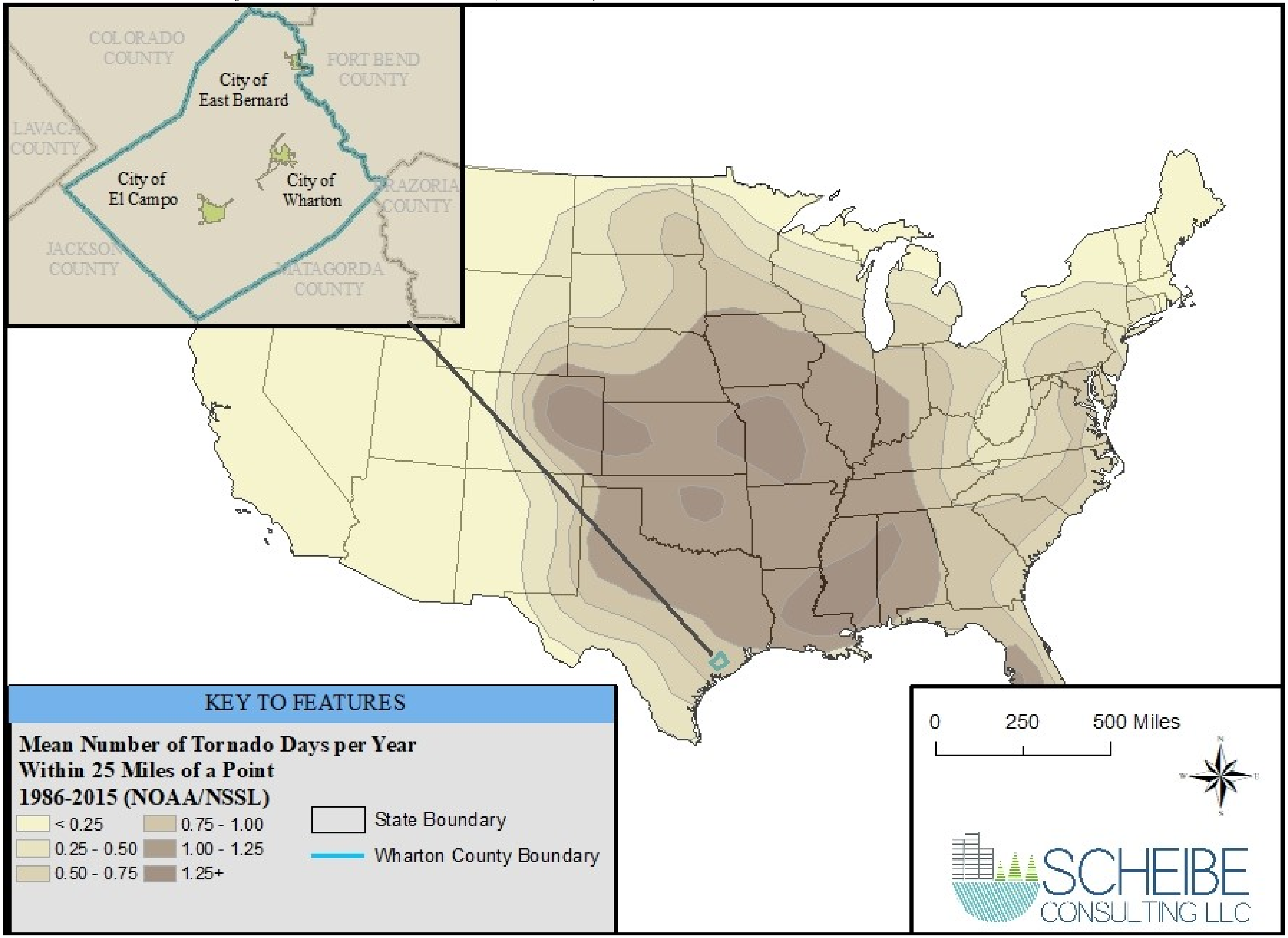
Note: From NOAA-NWS

Figure 15-1. Annual Average Number of Tornadoes in the U.S. (2000-2019)



Note: From NOAA/NWS Storm Events Database

Figure 15-2. Total Annual Threat of Tornado Events in the U.S. (1986-2015)



Note: From NOAA/NWS Storm Prediction Center WCM

15.2 HAZARD PROFILE

15.2.1 Past Events

Table 15-3 lists tornadoes in Wharton County recorded by the NOAA Storm Events Center from 1950 to 2020. Figure 15-3 shows the location of NOAA documented tornado paths between 1955 and 2019. 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 WHARTON COUNTY (1950-2020)

Location	Date	Category	Deaths	Injuries	Estimated Property Damage
Wharton County	12/2/1953	F2	0	0	$ 2,500.00
Wharton County	5/23/1955	F2	0	0	$ -
Wharton County	8/30/1955	F1	0	5	$ -
Wharton County	8/21/1959	F0	0	0	$ -
Wharton County	6/24/1960	F1	0	0	$ 2,500.00
Wharton County	11/22/1961	F3	0	1	$ -
Wharton County	6/15/1964	F2	0	0	$ 2,500.00
Wharton County	4/14/1966	F2	0	0	$ -
Wharton County	9/19/1967	F0	0	0	$ 2,500.00
Wharton County	9/20/1967		0	2	$ 25,000.00
Wharton County	9/20/1967	F1	0	0	$ 30.00
Wharton County	9/20/1967		1	1	$ 25,000.00
Wharton County	9/20/1967		0	1	$ 25,000.00
Wharton County	9/21/1967		0	0	$ 2,500.00
Wharton County	6/23/1968	F1	0	0	$ 250.00
Wharton County	6/23/1968	F1	0	0	$ 250.00
Wharton County	6/23/1968	F1	0	0	$ 250.00
Wharton County	10/23/1970	F0	0	0	$ 25,000.00
Wharton County	10/23/1970	F2	0	0	$ 25,000.00
Wharton County	10/23/1970	F2	0	0	$ 25,000.00
Wharton County	3/20/1972	F2	0	0	$ 25,000.00
Wharton County	6/13/1973	F1	0	0	$ 2,500.00
Wharton County	7/14/1976		0	0	$ -
Wharton County	11/8/1977	F1	0	0	$ 2,500.00
Wharton County	12/13/1977	F1	0	1	$ 250,000.00
Wharton County	4/22/1978	F1	0	0	$ 2,500.00
Wharton County	1/20/1979	F1	0	0	$ 25,000.00
Wharton County	1/31/1983	F1	0	0	$ 250,000.00
Wharton County	8/18/1983	F0	0	0	$ 30.00

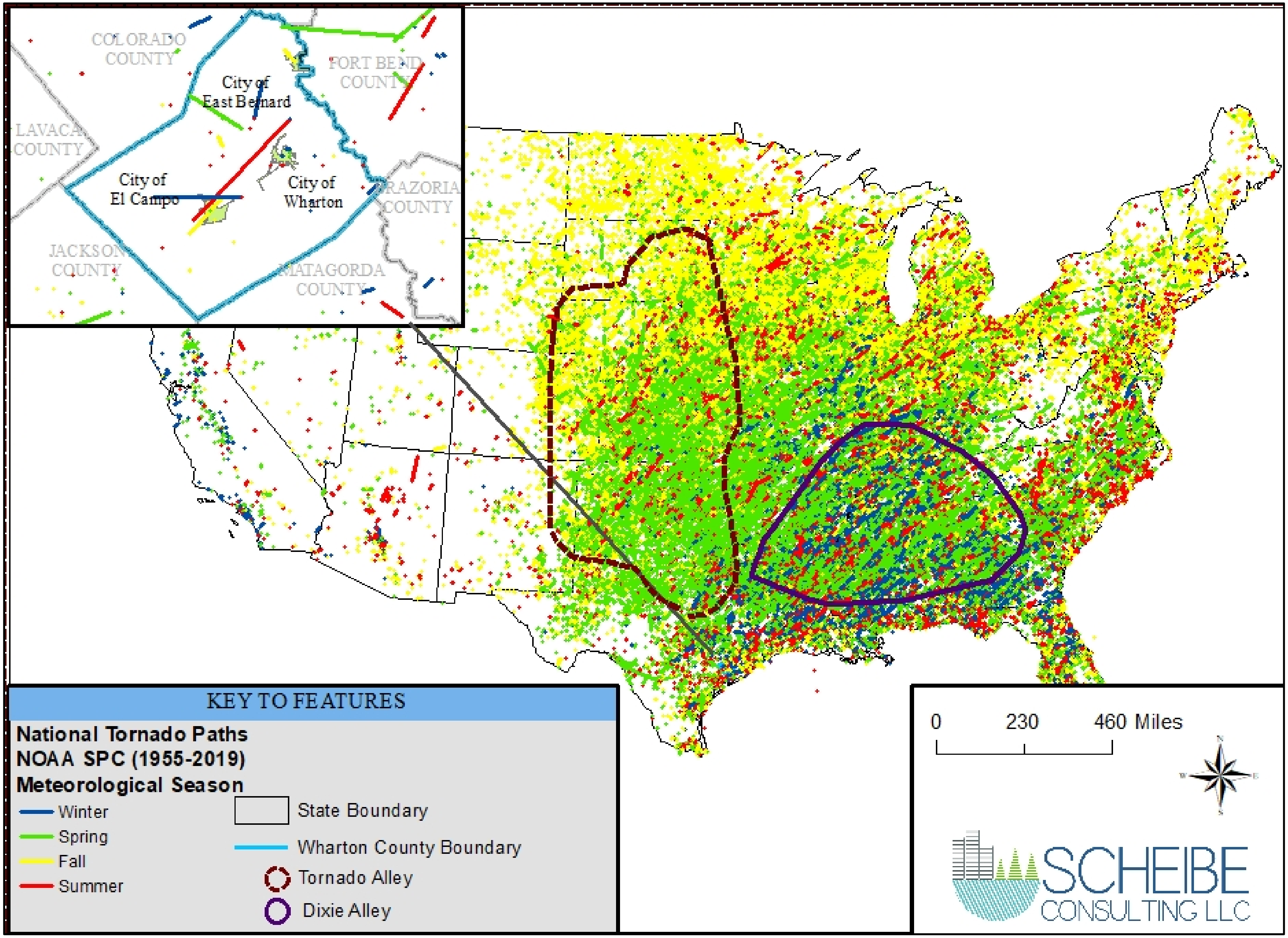
TABLE 15-3. HISTORIC TORNADO EVENTS IN WHARTON COUNTY (1950-2020)					
Location	**Date**	**Category**	**Deaths**	**Injuries**	**Estimated Property Damage**
Wharton County	1/14/1991	F1	0	0	$ 250,000.00
Wharton County	1/14/1991	F0	0	0	$ 2,500.00
Wharton County	1/14/1991	F0	0	0	$ 2,500.00
Wharton County	1/14/1991	F0	0	0	$ 2,500.00
Wharton County	5/4/1991	F1	0	0	$ 250,000.00
Wharton County	8/7/1991	F0	0	0	$ -
Wharton County	11/19/1992	F1	0	0	$ 2,500.00
Wharton County	11/19/1992	F1	0	0	$ 2,500.00
Wharton County	11/19/1992	F1	0	0	$ 2,500.00
Wharton County	11/21/1992	F1	0	0	$ 25,000.00
Wharton County	11/21/1992	F1	0	0	$ 250,000.00
Wharton County	11/21/1992	F1	0	0	$ 25,000.00
Egypt	4/7/1993	F2	0	0	$ 50,000.00
Egypt	3/13/1995	F1	0	0	$ 100,000.00
El Campo	8/12/1996	F0	0	0	$ 40,000.00
Wharton	4/11/1997	F0	0	0	$ 20,000.00
El Campo	6/21/1997	F0	0	0	$ 20,000.00
Hungerford	3/30/2002	F0	0	0	$ -
Wharton	3/30/2002	F0	0	0	$ 50,000.00
Boling	9/7/2002	F0	0	0	$ 75,000.00
Egypt	7/7/2003	F0	0	0	$ 18,000.00
Wharton	10/9/2003	F0	0	0	$ 15,000.00
El Campo	11/17/2003	F0	0	0	$ 1,000.00
El Campo	11/17/2003	F0	0	2	$ 8,000.00
Pierce	11/17/2003	F0	0	0	$ 2,000.00
Wharton	11/17/2003	F0	0	0	$ -
Boling	11/17/2003	F0	0	0	$ 20,000.00
Danevang	4/6/2004	F0	0	0	$ -
El Campo	4/6/2004	F0	0	0	$ -
Wharton	6/8/2004	F1	0	6	$ 300,000.00
Wharton	6/8/2004	F1	0	0	$ 100,000.00
Danevang	6/23/2004	F0	0	0	$ 55,000.00
Wharton	11/23/2004	F0	0	0	$ 25,000.00
Spanish Camp	6/28/2010	EF0	0	0	$ -
Newgulf	2/23/2016	EF0	0	0	$ -
Wharton JCT	2/14/2017	EF0	0	0	$ 10,000.00
Egypt	8/26/2017	EF0	0	0	$ -

TABLE 15-3. HISTORIC TORNADO EVENTS IN WHARTON COUNTY (1950-2020)					
Location	**Date**	**Category**	**Deaths**	**Injuries**	**Estimated Property Damage**
East Bernard	8/26/2017	EF0	0	0	$ 50,000.00
East Bernard	8/27/2017	EF1	0	0	$ 300,000.00

15.2.2 Location

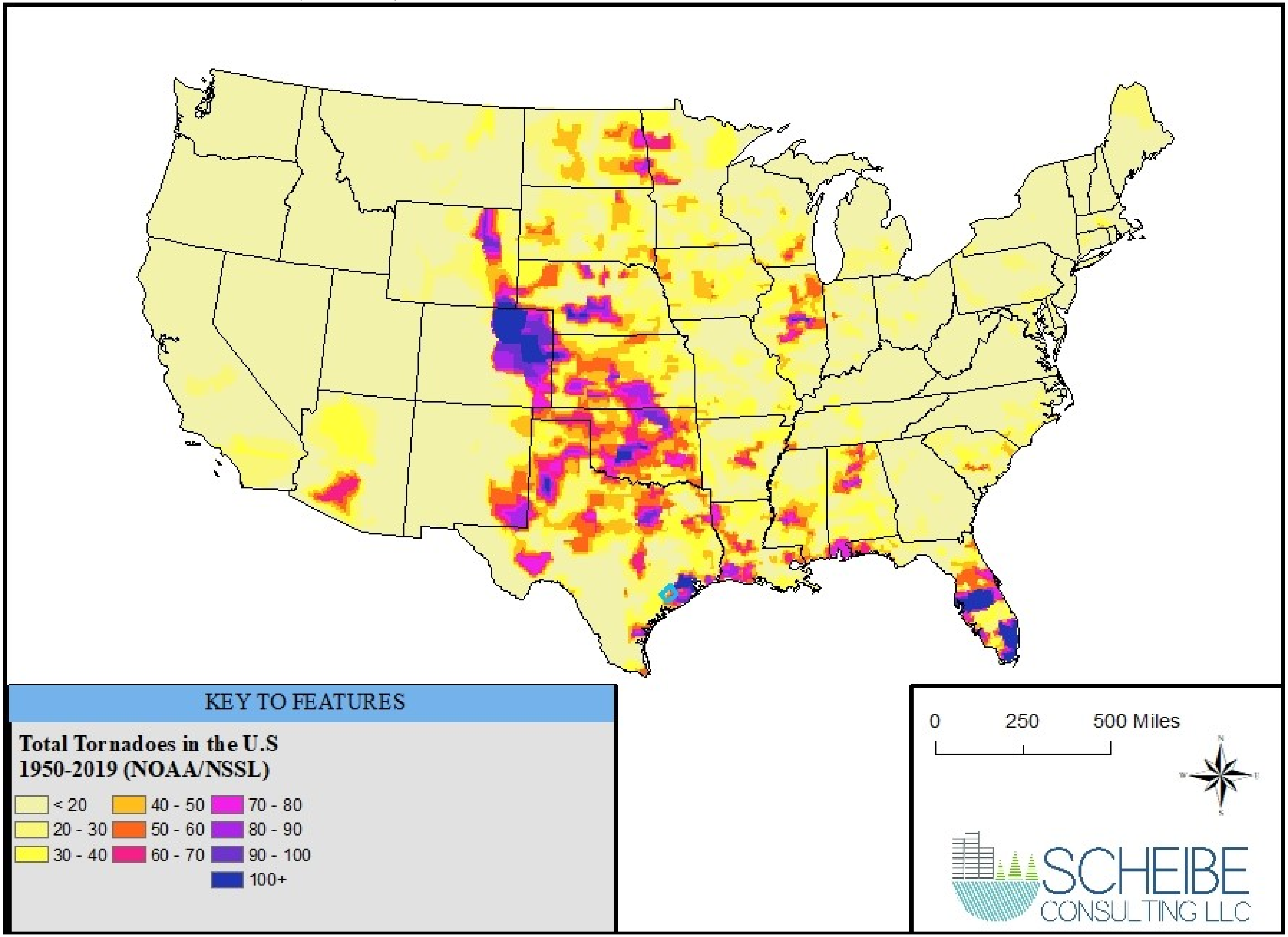
Recorded tornadoes in the planning area are typically average-sized and short-lived. They can occur anywhere in Wharton County and participating communities. Figure 15-4 shows tornado activity documented by NOAA from 1950-2019. Figure 15-5 shows the location of previous tornado events in Wharton County and participating communities from 1950 to 2019.

Figure 15-3. Tornado Paths in the U.S. (1955-2019)



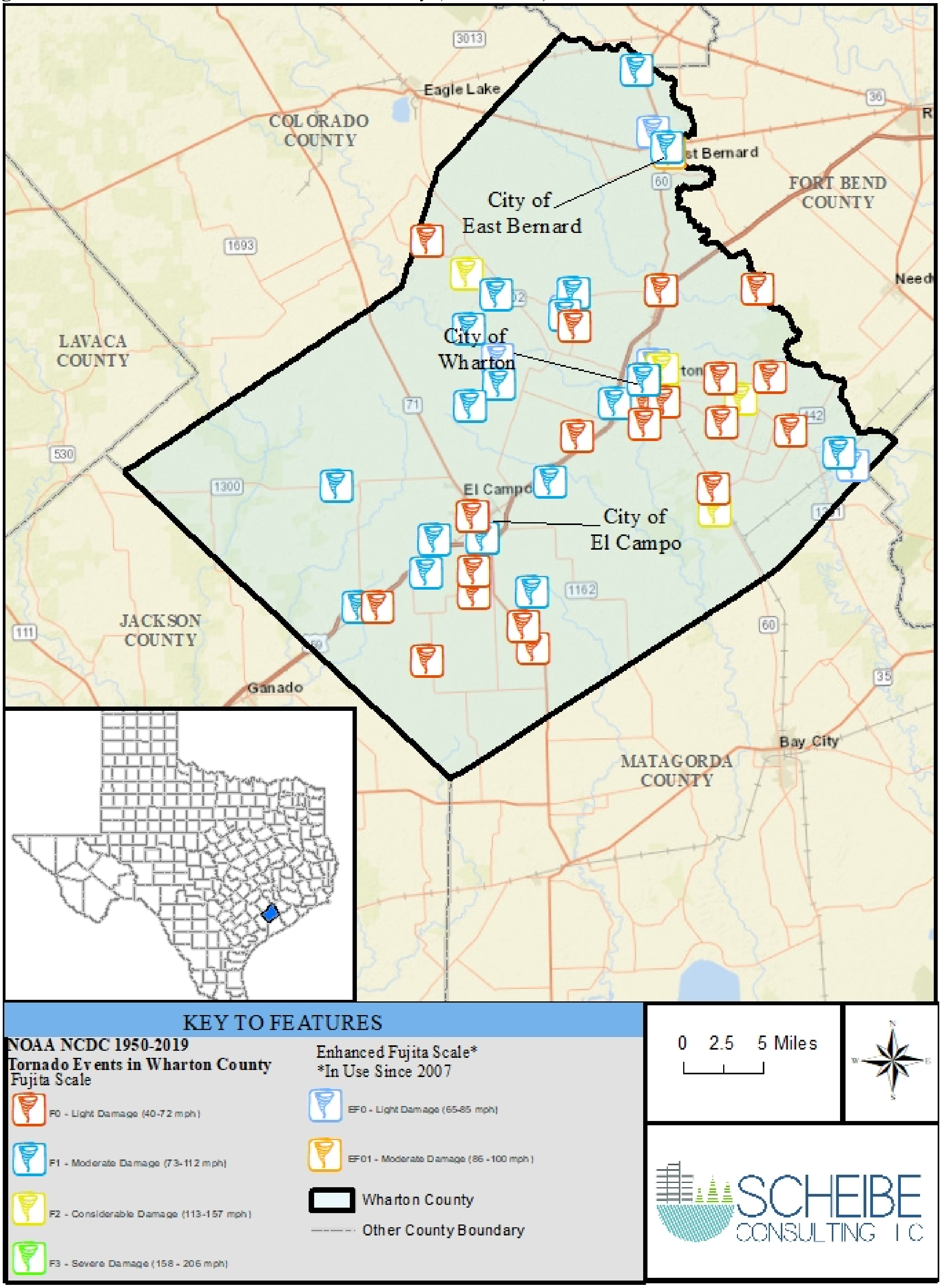
Note: From NOAA/NWS Storm Prediction Center

Figure 15-4. Total Tornadoes in the U.S (1950-2019)



Note: From NOAA/NWS Storm Events Database

Figure 15-5. Tornado Events in Wharton County (1950-2019)



Note: From NOAA/NWS Storm Prediction Center

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 4:00 pm and 8:00 pm. From 1951 to 2011, nearly 62.7% of all Texas tornadoes occurred within the three months of April, May, and June, with almost one-third of the total tornadoes occurring in May.

Table 15-3 lists 33 recorded tornadoes rated F1 or higher between 1950 and 2020. Therefore, on average, a significant tornado occurs in the HMP update area once every two years. 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 two years). Based on previous events, all participating jurisdictions can expect future tornado events up to a category EF4.

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 Wharton County and the participating communities, the 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, but sever tornados are possible. Based on previous events, all participating jurisdictions are at risk of future tornado events up to a category EF4, but stronger events are possible.

15.2.5 Warning Time

The NOAA Storm Prediction Center issues tornado watches and warnings for Wharton 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 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-MH, 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-MH inventory data (updated with 2010 U.S. Census data and 2018 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 HAZUS-MH inventory data (updated with 2010 U.S. Census data and 2018 RS Means Square Foot Costs), there are 16,979 buildings within the census blocks that define the planning area with an asset replaceable value of $3.9 billion (excluding contents). About 91% of these buildings (and 75% of the building value) are associated with residential housing. 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
City of East Bernard	909	62	43	**1,014**	**2,272**
City of El Campo	4,465	352	200	**5,017**	**11,602**
City of Wharton	3,299	321	138	**3,758**	**8,832**
Unincorporated Area	6,799	210	181	**7,190**	**18,574**
Wharton County Total	**15,472**	**945**	**562**	**16,979**	**41,280**

Note: *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 loss. 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 the 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
City of East Bernard	638	28.07	342	15.05	129	5.68
City of El Campo	3402	29.33	1648	14.21	992	8.55
City of Wharton	2317	26.23	1288	14.58	1251	14.17
Unincorporated Area	4,715	25.39	2,741	14.76	1,537	8.28
Wharton County Total	**11,072**	**26.82**	**6,019**	**14.58**	**3,910**	**9.47**

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
City of East Bernard	$262,048,000	$5,000	<0.01
City of El Campo	$1,343,990,000	$7,429	<0.01
City of Wharton	$915,074,000	$986	<0.01
Unincorporated Area	$1,371,697,000	$26,512	0.03
Wharton County Total	**$3,892,809,000**	**$596,375**	**0.01**

Vulnerability Narrative

The vulnerability of tornado events per jurisdiction is described below.

- **City of East Bernard** - Approximately 6.5% of the City of East Bernard'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 area schools or government facilities, services could be greatly limited and residents would be negatively impacted. Facilities without an alternate power source increase their risk. Residents unaware of their risk or the hazards of tornadoes are less able to effectively protect themselves.
- **City of El Campo** - Approximately 6.1% of the City of El Campo's 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 195, emergency response times would be limited. Residents unaware of the threat of an event, such as with neighborhood alert systems, are more at risk as well.
- **City of Wharton** - Tornadoes can easily destroy poorly constructed buildings and mobile homes. Approximately 8.9% of the City of Wharton's housing is manufactured homes. Loose structures, non-secured objects, and debris, such as boats, dead trees, and thick underbrush, can become flying projectiles during an event. If an event were to damage major access roads such as US 90, emergency services would have limited accessibility. If a tornado were to impact critical facilities, such as police or fire departments, service to residents would be delayed. Communities who have not identified the areas of higher risk or who have implemented mitigation planning to incorporate measures to ensure the functionality of these facilities in the event of a tornado are more vulnerable as well.

- **Wharton County (Unincorporated Area)** - Approximately 19.9% of Wharton County's Unincorporated Area's housing is manufactured homes. Tornadoes can easily destroy poorly constructed buildings and mobile homes. Dead trees, branches, and non-secured structures can become flying projectiles during a tornado, placing people and property at a greater risk. Response times to rural communities and residents would be greater if major thoroughfares, such as US 59, and emergency response facilities, such as police and fire departments, were impacted by an event, especially in rural areas. Communities not identifying and implementing improvements to roadways and crossings in need of maintenance increase these risks.

Community Perception of Vulnerability

See the front page of the current chapter for a summary of hazard rankings for Wharton County and participating communities in this HMP update. Chapter 21 gives a detailed description of these rankings and Chapter 22 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 EF4 or higher tornado were to hit populated areas of the county, substantial damage to property and loss of life could result. The 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 of. 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:

- The 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.
- The redundancy of the 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.