Brazos County Hazard Mitigation Action Plan

2024-2029

"Maintaining a secure and sustainable future through the revision and development of targeted hazard mitigation actions to protect life, property, and the environment."

**Credit for Photos Used on Cover

Bluebonnets. Photo from Brazos Valley Museum of Natural History. 2024.

Jackrabbit Lane, Wixon Valley, TX. John Prell, Creekview Realty. 2024.

Notice - Change to Hazard Mitigation Action Plan

This document and its contents have been prepared and are intended solely as information for Brazos County, Texas, and its participating entities and use in relation to the Brazos County Hazard Mitigation Action Plan Update

Document History of Change

Document Title: *Brazos County Hazard Mitigation Action Plan Update*

Revision #	Purpose (Description)	Primary Author(s) of Change	Email	Date of Change

Table of Contents

Section 8 – Wildland Fire

Section 9 – Severe Winter Weather

Section 10 – Tornado

Section 11 – Hail

Section 12 – Thunderstorm and Wind

Section 13 – Dam Failure

Section 14 – Excessive and Extreme Heat

Section 15 – Infectious Diseases

Section 16 – Mitigation Actions

Section 17 – Plan Management

Appendices

List of Tables

Section 1

No tables in this section.

Section 2

Section 3

Section 4

Section 5

Section 6

Section 7

List of Figures

Section 1

No figures in this section.

Section 2

Section 3

Section 4

Section 5

Section 6

Section 7

Section 8

Section 9

Section 10

Section 11

Section 12

No figures in this section.

Section 13

No figures in the section.

Section 14

Section 15

Section 16

No figures in this section.

Section 17

No figures in this section.

Acronym Definitions

Acronym	Meaning
ACS	American Community Survey (5-year, Census Bureau)
ASDSO	Association of State Dam Safety Officials
AVHRR	Advanced Very High-Resolution Radiometer
BC	Brazos County
BCHD	Brazos County Health District
BTU	Bryan Texas Utilities
^{0}C	Degrees of Celsius
CDC	Center for Disease Control and Prevention
CFR	Unites Stated Code of Federal Regulations
cfs	Cubic Feet per Second
CIP	Capital Improvement Plan
COB	City of Bryan
COCS	City of College Station
CRS	Community Rating System (NFIP)
CSID	Central Station Identification Number
DFIRM	Digital Flood Insurance Rate Map
DMA	Disaster Mitigation Act of 2000
EF	Enhanced Fujita [Scale]
F	Fujita Storm Category Scale (replaced by EF scale in 2007)
^{0}F	Degrees of Fahrenheit
FEMA	Federal Emergency Management Agency
FIRM	Flood Insurance Rate Map
FMA	Flood Mitigation Assistance
FOIA	Freedom of Information Act of 1966
FT	Full Time
GIS	Geographic Information Systems
HMAP	Hazard Mitigation Action Plan
HMGP	Hazard Mitigation Grant Program
ISD	Independent School District
K	Kurten
KBDI	Keetch-Byram Drought Index
KM	Kilometers
M	Meters
MPH	Miles per Hour
N/A	Not Applicable
NCEI	National Center for Environmental Information
NDMC	National Drought Mitigation Center
NEXRAD	Next Generation Weather Radar
NFIA	National Flood Insurance Act of 1968
NFIP	National Flood Insurance Program
NHS	National Health Institute
NIH	National Institute of Health
NOAA	National Oceanic and Atmospheric Administration

NWS	National Weather Service
PRI	Priority Risk Index
PT	Part Time
RL	Repetitive Loss
RV	Recreational Vehicle
SBA	Small Business Administration
SCS	Security Communication Systems
SFHA	Special Flood Hazard Area
SFR	Single Family Home – Residential
STAPLE + (E)	Social, Technical, Administrative, Political, Legal, and Economic/Environmental
STP	Standard Training Protocol
SRL	Severe Repetitive Loss Grant Program (FEMA)
TAMU	Texas A&M University
TCEQ	Texas Commission on Environmental Quality
TDEM	Texas Division of Emergency Management
TWDB	Texas Water Development Board
UPRR	Union Pacific Railroad
US	United States
USACE	United States Army Corps of Engineers
USD	United States Dollar
USDA	United States Department of Agriculture
USGS	United States Geologic Survey
VFD	Volunteer Fire Department
VOAD	Voluntary Organization(s) Active in Disasters
WHO	World Health Organization
WS	Watershed
WV	Wixon Valley

This page intentionally left blank.

Executive Summary

Purpose and Process of Development

This updated document, "Mitigating Risk: Protecting Brazos County from All Hazards, 2024 – 2029," was prepared by the participating entities within Brazos County. The participating entities in the planning area of the Brazos County Hazard Mitigation Plan include Brazos County, the Cities of Bryan, College Station, Kurten, Wixon Valley and Texas A&M University. These will be referred to as "Brazos County and participating entities", "participating entities" or the "planning area".

This plan is a five-year blueprint for the future, aimed at making communities in Brazos County, to include all the planning area; disaster resistant by reducing or eliminating the long-term risk of loss of life and property from the range of natural disasters. It meets the requirements of the Disaster Mitigation Act of 2000 (P.L. 106-390); Section 44 of the Code of Federal Regulations, Part 201.6, and Part 206; and State of Texas Division of Emergency Management standards. An open public process was established to provide multiple opportunities for all sectors in Brazos County and participating entities to be involved in the planning process and provide input during its drafting stage.

Hazards Facing the Planning Area

The plan identifies and assesses the potential impact of ten natural hazards that threaten Brazos County and participating entities. Hazards were identified based on a review of historical records, national data sources, existing plans and reports, and discussions with local, regional, and national experts. The list of hazards that may threaten Brazos County and the participating entities are:

Hazards For Planning Area
Floods
Drought
Wildland Fires
Severe Winter Storms
Tornadoes
Hail
Thunderstorms and Wind
Dam Failures
Excessive and Extreme Heat
Infectious Diseases

Vision and Goals

Vision

The mitigation vision for Brazos County is to maintain a secure and sustainable future through the revision and development of targeted hazard mitigation actions and the protection of lives, property, animals, and the environment; by building sustainable and resilient communities and reducing or eliminating the long-term risk of loss of life or property from natural and man-made disasters through the following actions:

- Intergovernmental coordination and cooperation on mutual issues of concern related to hazard mitigation and disaster preparedness.
- The local governance and regional entities are capable of securing resources for investments from local, state, federal, and private sources for planning and project implementation for hazard mitigation.
- Having informed citizenry aware of the risks they may face and the measures that can be taken to protect their families, homes, workplaces, communities, and livelihoods from the impacts of disasters.
- Having a commitment to retrofitting existing structures and property as well as supporting future construction of structures that can withstand the hazards that threaten them.
- The integration of mitigation into routine budgetary decisions and planning for future growth and development in the planning areas, making disaster resistance an integral part of the livability and sustainability of Brazos County.

Goals

Goal 1: Increase awareness throughout the community about potential natural and man-made hazards and the need for community preparedness.

Goal 2: Increase coordination and cooperation among government entities, business leaders, and the community to ensure hazard mitigation is integrated with land use plans and promote resource-sharing to increase capabilities.

Goal 3: Mitigate damage and losses of new and existing real property.

Goal 4: Strengthen critical facilities, infrastructures, utilities, and services from hazard impacts to establish redundancy and reliability, and to prevent or minimize loss, and facilitate quicker recovery.

Goal 5: Improve and coordinate data collection efforts in the County to fully maximize the extent of the efforts; and improve the mitigation capabilities of the County participating entities.

This page intentionally left blank.

Section 1 – Introduction

Introduction

Hazard Mitigation /ˈhæz ərd ˌmɪt ɪˈgeɪ ʃən /

Noun

Any sustained actions taken to reduce or eliminate long-term risk to people and property from hazards and their effects.

Brazos County is located in between the Navasota and Brazos rivers in southeast central Texas, is bounded on the northwest by Robertson County, on the east by Madison and Grimes counties, on the south by Washington County, and on the southwest by Burleson County. The county seat is the City of Bryan.

Texas is prone to extremely heavy rains and flooding with half of the world record rainfall rates (48 hours or less). While flooding is a well-known risk, Brazos County is susceptible to a wide range of natural hazards, including but not limited to drought, extreme heat, hail, and winter storms. These life-threatening hazards can destroy property, disrupt the economy, and lower the overall quality of life for individuals.

While it is impossible to prevent an incident from occurring, the effect of many hazards to people and property can be lessened. This concept is known as hazard mitigation, which is defined by the Federal Emergency Management Agency (FEMA) as *sustained actions taken to reduce or eliminate long-term risk to people and property from hazards and their effects.* Communities participate in hazard mitigation by developing hazard mitigation plans. The Texas Division of Emergency Management (TDEM) is required to review the plan and FEMA has the authority to review and approve hazard mitigation plans through the Disaster Mitigation Act of 2000.

This plan, hereinafter titled: “Brazos County Hazard Mitigation Action Plan 2024” was developed specifically for Brazos County and is a multi-jurisdictional plan. The participating entities include Brazos County; the Cities of Bryan, College Station, Kurten, and Wixon Valley; and Texas A&M University. These entities provided valuable input into the planning process.

Hazard mitigation activities are an investment in a community’s safety and sustainability. It is widely accepted that the most effective hazard mitigation measures are implemented at the local government level, where decisions on the regulation and control of development are ultimately made. A comprehensive review of a hazard mitigation plan addresses hazard vulnerability that exists today and in the foreseeable future. Therefore, it is essential that a plan identify projected patterns of how future development will increase or decrease a community’s overall hazard vulnerability.

Scope

The focus of the plan is to identify activities to mitigate hazards classified as “high” or “moderate” risk, as determined through a detailed hazard risk assessment conducted for Brazos County and the participating entities. The hazard classification enables the participating entities

to prioritize mitigation actions based on hazards which can present the greatest risk to lives and property in the geographic scope.

Purpose

The plan was prepared by Brazos County and the participating entities. The purpose of the plan is to protect people, animals, structures, and the environment and to minimize the costs of disaster response and recovery. The overall arching goal of the plan is to minimize or eliminate long-term risks to human life and property from known hazards by identifying and implementing cost-effective hazard mitigation actions. The planning process is an opportunity for participating entities within Brazos County, stakeholders, and the public to evaluate and develop successful hazard mitigation actions to reduce future risk of loss of life and damage to property resulting from a disaster within the Brazos County planning area.

Mission Statement

The Mission Statement of the plan is, "*Maintaining a secure and sustainable future through the revision and development of targeted hazard mitigation actions to protect life, property, and the environment."*

Authority

The plan is tailored specifically for participating entities within Brazos County and plan participants including Planning Team members, stakeholders, and the public who participated in the plan development process.

The plan complies with all requirements promulgated by the Texas Division of Emergency Management (TDEM) and all applicable provisions of the Robert T. Stafford Disaster Relief and Emergency Assistance Act, Section 104 of the Disaster Mitigation Act of 2000 (DMA 2000) (P.L. 106-390), and the Bunning-Bereuter-Blumenauer Flood Insurance Reform Act of 2004 (P.L. 108–264), which amended the National Flood Insurance Act (NFIA) of 1968 (42 U.S.C. 4001, et al).

Additionally, the Plan complies with the Interim Final Rules for the Hazard Mitigation Planning and Hazard Mitigation Grant Program (44 CFR, Part 201), which specify the criteria for approval of mitigation plans required in Section 322 of the DMA 2000 and standards found in FEMA's "Local Mitigation Plan Review Guide" (October 2011), and the "Local Mitigation Planning Handbook" (May 2023).

Additionally, the plan is developed in accordance with FEMA's Community Rating System (CRS) Floodplain Management Plan standards and policies.

Mitigation Actions

Mitigation actions taken by Brazos County are to build sustainable communities with fewer losses, quicker recoveries, to minimize the disruptions to the communities following a disaster, to streamline disaster recovery by identifying actions that need to be taken before a disaster

strikes, identifying hazards to reduce or eliminate future damages, and to serve as a basis for future funding that may become available through grants and other programs offered by state and federal governments or through private donations.

Based on input such as historical data, public perception, and technical requirements, the following hazards have been identified, by priority:

1. Flooding
2. Thunderstorms and Wind
3. Drought
4. Wildland Fire
5. Dam Failure (except Wixon Valley and Kurten)
6. Hail
7. Extreme Heat
8. Severe Winter Storm
9. Tornado
10. Infectious Diseases

This page intentionally left blank.

Section 2 – County Profile

Overview

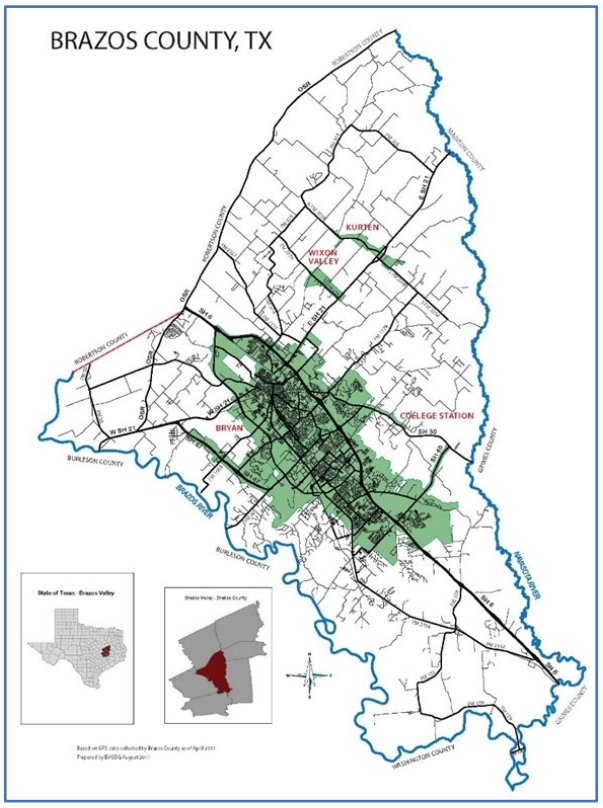
Brazos County has been the site of human habitation for more than 12,000 years. Evidence of Paleo-Indian inhabitants in the area has turned up in the form of spearpoints, and the remains of a butchered mammoth have been found at the Duewall-Newberry Site on the Brazos River. The territory that is now Brazos County was included in Stephen F. Austin's second colony and became part of Washington Municipality under the Mexican government[1].

During the twentieth century, Bryan and College Station played an increasingly important role in the life of the county. After its founding as a railroad town in 1866, Bryan slowly grew to a community of 3,589 in 1900, when approximately one-fifth of county residents lived there. The nearby community of College Station grew around Texas A&M University after its founding in the 1870s[1].

The urban population continued to grow into the rural population. In 1980 the 81,506 inhabitants of Bryan-College Station were 87 percent of the residents of Brazos County. Significant industries that developed in the two-city area in the late twentieth century included defense electronics and varied manufacturing[1].

In 1982, 67 percent of the land was in farms and ranches, with 18 percent of the farmland under cultivation and 20 percent irrigated. Primary crops were hay, cotton, sorghum, oats, and wheat, and primary livestock and products were cattle, hogs, and milk. The industries with the most employment were agribusiness, oil and gas extraction, and construction. In 1980 Brazos County was one of the most densely populated counties in the state[1].

In the early twenty-first century, Texas A&M University played a key role in the area's economy, and other local companies produced high-tech equipment and services, wine, and other goods; agribusiness was also important. In 2002 the county had 1,350 farms and ranches covering 308,814 acres, 51 percent of which were devoted to pasture, 38 percent to crops, and 9 percent to woodlands[2].



Today the Brazos County planning area covers an area of 586 square miles with a range of 200 to 350 feet above sea level. The following four incorporated cities are identified for planning purposes:

- Bryan
- College Station
- Kurten
- Wixon Valley

College Station and Bryan are the largest cities in the planning area with respective populations of 126,667 and 86,314, based on the US Census for 2022. Primary industries in the planning area include higher education, defense electronics, research, medical, agriculture, and manufacturing[2].

Since 1965, there have been ten (13) Presidential Disaster Declarations and eight (8) Small Business Administration (SBA) Declarations for the planning area[3]. (Table: 2.1)

Year	Disaster Number	Primary Incident	Presidential Declaration	SBA Declaration
1991-1992	930 DR	Flood	Yes	Yes
1993	3113 DR	Drought	Yes	No
1994	1041 DR	Flood	Yes	Yes
1998	1239 DR	Severe Storm	Yes	No
1999	3142 DR	Fire	Yes	No
2005	1606 DR	Hurricane	Yes	Yes
2005	3216 DR	Hurricane Evacuation	Yes	No
2006	1624 DR	Fire	Yes	Yes
2008	3284 DR	Fire	Yes	No
2008	1791 DR	Hurricane	Yes	Yes
2016	4272 DR	Flood/Tornado	Yes	Yes
2020	4485 DR	Pandemic	Yes	Yes
2021	3554 DR	Severe Ice Storm	Yes	Yes

Table: 2.1- Disaster Declarations by Year (Brazos County) Source: FEMA[3]

Population in the Planning Area

Demographics

As of July 1, 2022, the estimated population is 242,014[2]. Brazos County's population has increased each year since 2010 as is graphically represented below. (Figure: 2.1) Using official U.S. Census population counts, the estimate uses a formula based on new residential building permits and household size. It is simply an estimate and there are many variables involved in achieving an accurate estimation of people living in each area at a given time.

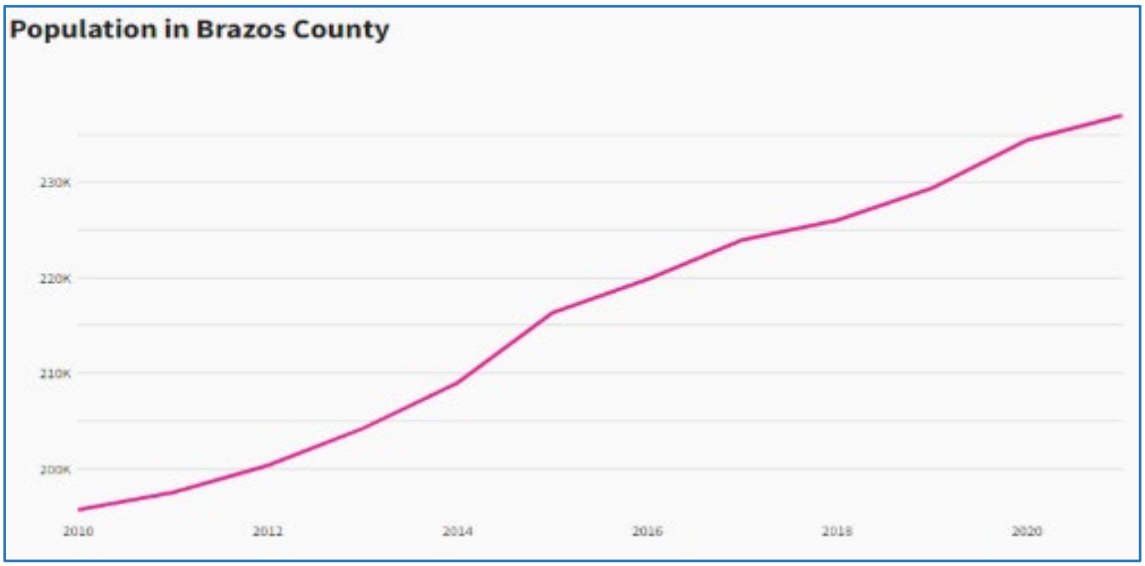


Figure: 2.1 – Population Growth in Brazos County (2010 to 2021) Source: Census Bureau[2]

Seasonal Population Growth

Texas A&M University[4] and Blinn College[5] have enrolled students, some of whom are only located in the planning area during part of the calendar year. Table: 2.2 – TAMU[4] and Blinn College[5] enrollment, identifies the Spring 2023 enrollment at each institution.

Institution	Location	Enrollment (Spring 2023)	Number Of Faculty *
Texas A&M University	College Station	64,215	4,062
Blinn College	Bryan**	5,462	512

Table: 2.2 – TAMU[4] and Blinn College[5] Enrollment (Spring 2023) Source: Office of Registrar – TAMU[4] and Blinn College[5]

*Faculty includes professors, associate professors, assistant professors, other faculty, and teaching assistants.

**Blinn's main campus location is in Brenham, TX (outside of the planning area).

Future Development

To better understand how future growth and development in the County might affect hazard vulnerability, it is useful to consider population growth, occupied and vacant land, the potential for future development in hazard areas, and current planning and growth management efforts. This section includes an analysis of the projected population change and economic impacts.

Population projections from 2010 to 2060 are listed in Figure: 2.2 – Projected Population Growth (2010-2060), as provided by the Office of the State Demographer[6], Texas State Data Center, and the Institute for Demographic and Socioeconomic Research. Population projections are based on a 0.5 scenario growth rate, which is 50 percent of the population growth rate that occurred during 2000-2010. This information is only available at the County level; however, the population

projection shows an increase in population density for the County, which would mean overall growth for the County[6].

The total resident population of all counties in the State for each year from 2020 through 2060, with the 2020 population equal to the 2020 census count for the State of Texas and all counties in Texas[6].

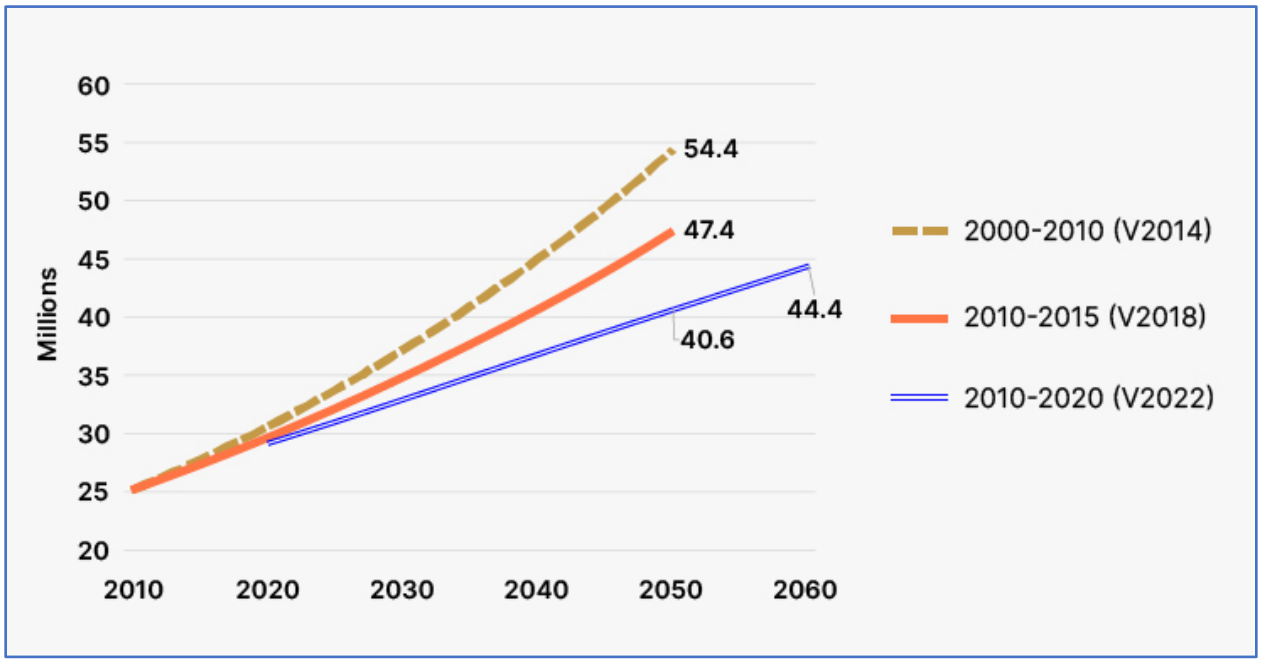


Figure: 2.2 – Projected Population Growth (2010-2060) Source: Texas Demographic Center[6]

Economic Impact

Building and maintaining infrastructure depends on the economy, and therefore, protecting infrastructure from risk due to natural hazards in the planning area is important to the participating entities within Brazos County. Whether it is expanding culverts under a road that washes out during flash flooding, shuttering a fire station, or flood-proofing a wastewater facility, infrastructure must be strengthened from natural hazards to continue providing essential utility and emergency response services in a fast-growing planning area. Major employers in the area are critical to the health of the economy, as well as effective transportation connectivity.

Existing and Future Land Use and Development

Comprehensive or Master Plans are part of a continuous process to provide an environment for the citizens and to consider the general desire of the community to conserve, preserve, and protect the natural environment. These plans are used to guide individuals in making decisions which affect the community with the understanding of the long-term effects.

Small and Impoverished Communities

The State of Texas requires that hazard mitigation plans identify any Small and Impoverished Communities. According to the established criteria, The term “small impoverished communities” is statutorily defined at 42 U.S.C. 5133(a) to mean a community of 3,000 or fewer individuals

that is economically disadvantaged, as determined by the state in which the community is located and based on criteria established by the President. As the term is statutorily defined, the maximum number of community members of 3,000 cannot be exceeded[3]. There are no communities that meet this designation in the planning area. However, Brazos County recognizes areas which meet the Low to Moderate Income standards as identified in the Tables below. (Figure: 2.3 – Household Income Distribution[7]) (Figure: 2.4 – Median Household Income by Race[7])

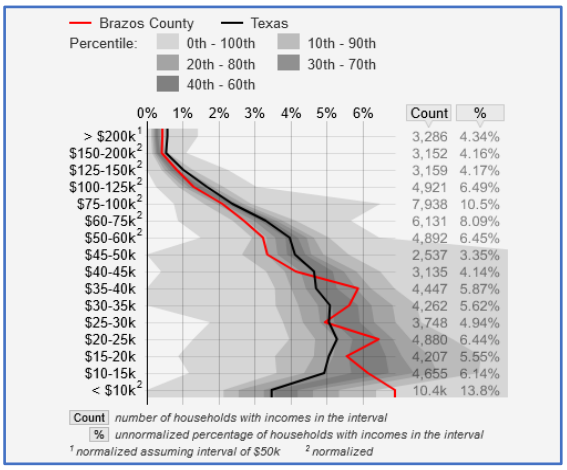


Figure: 2.3 – Household Income Distribution in Brazos County (2022) Source: Statistical Atlas[7]

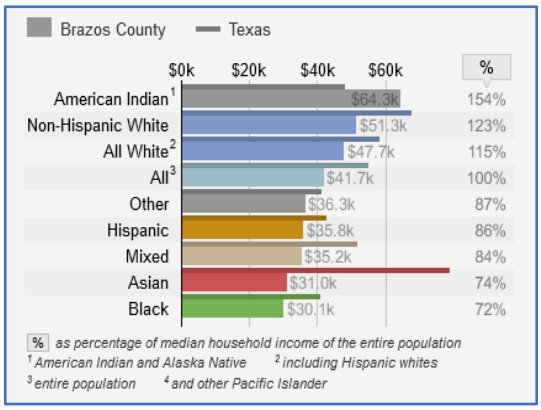


Figure: 2.4 Median Household Income by Race Source: Statistical Atlas[7]

Socially Vulnerable Populations

Table: 2.3 below, identifies socially vulnerable groups within the planning area, the number of persons who make up that category according to the 2020 census, and the percentage of the total population for that specific group[2].

Social Vulnerability Indicator	Number of Persons in Category	Percentage of Total Population
Under the age of 5	13,060	5.5%
65 years of age or older	24,414	10.3%
Non-white	48,118	20.3%
Persons in poverty*	53,569	22.6%
Persons over age 25 who have not completed high school or obtained a GED	26,785	11.3%
Single-parent households with children	11,551	15.24%
Persons living in mobile homes, RVs, boats, and other non-traditional housing**	7,707	9.23%
Vacant housing units**	5,408	6.48%

Table: 2.3 – Social Vulnerability (Brazos County) Source: US Census Bureau[2]

*Income-to-poverty threshold ratio is 0.99 and below.

**Percentage is based on the total number of housing units.

The number of persons under the age of 18 living in single parent households, as of Texas Kids Count's 2020 data, is 9,181. This is approximately 19.5% of the total number of children in the planning area. (Table: 2.4 – Poverty (ages 0-18))[11]

Location	Data Type	2016	2017	2018	2019	2020
Texas	Number	1,616,085	1,525,944	1,543,228	1,401,195	1,373,643
	Percent	22.4%	21.0%	21.1%	19.2%	18.8%
Brazos County	Number	10,040	9,339	9,297	9,181	9,181
	Percent	22.5%	20.5%	20.2%	19.4%	19.5%

Table: 2.4 – Poverty in Brazos County (ages 0-18) Source: Texas Kids Count[11]

Persistent Poverty

"Persistent Poverty Counties" means any county, including county equivalent areas in Puerto Rico, that has had 20% or more of its population living in poverty over the past 30 years, as measured by the 1990 and 2000 decennial censuses and the 2011–2015 5- year data series available from the American Community Survey of the Bureau of the Census or any other territory or possession of the United States that has had 20% or more of its population living in poverty over the past 30 years, as measured by the 1990, 2000 and 2010 Island Areas Decennial Censuses, or equivalent data, of the Bureau of the Census[2]. (See Table: 2.5 below)

County FIPS Code	County	State	1990 Poverty %	2000 Poverty %	2011-2015 Poverty %
48041	Brazos County	Texas	26.7	26.9	27.9

Table: 2.5 – Persistent Poverty County Percentages Source: US Census Bureau[2]

Critical Facilities

Brazos County has the following distribution of critical infrastructure and lifelines. (Table: 2.6)

Oil Pipe (Miles)	Gas Pipe (Miles)	Highway (Miles)	Railroad (Miles)
233.57	1,130.83	134.46	70.33

Table: 2.6 – Critical Infrastructure and lifelines Source: TXDOT[12]

A list of critical facilities by type[12] and entity are found in Table: 2.7 below.

	Brazos County	Bryan	College Station	Texas A&M University	Wixon Valley	Kurten
Airport		1		1		
Bus		2		1		
City Hall		1	1		1	
Communication		6	1	1		
Courthouse	1	1	2			
Electric		2	1	5		
Emergency Centers		1	2			
Emergency Operations	1	1	1	2	1	1
Fire Station	12	5	6			
Highway	5		2			
Post Office	1	1	1	1		1
Medical		14	15	1		
Police/Sheriff Station	1	3	1	1		
School	1	33	18			
Wastewater		6	21	2		
Assisted Living/Nursing Homes		10	4			
Community/Gathering Centers	2	4	8			

Table: 2.7 Critical Infrastructure by Type

Source: Brazos County HMAP (2019-2024)[10]

	Multiple Entities
Highway	14
Railway Bridge	2

Land Use and Development

Agricultural Land Use

Table 2.8 indicates vital statistics about the farmland use in Brazos County.

NUMBER OF FARMS	AVERAGE FARM SIZE (ACRES)	HARVESTED CROPLAND (ACRES)	IRRIGATED LAND (ACRES)
1,363	213	37,633	12,059

Table: 2.8 – Agricultural Land Use in Brazos County Source: U.S. Dept. of Agriculture[9]

Agricultural Products

Farms in the planning area produce a wide variety of agricultural products with cattle as the most common. Other agricultural products include poultry, cotton, hay, horses, and horticulture for an annual value of approximately $167.6 million[9].

Minerals

According to the United States Geologic Survey (USGS)[13], the primary minerals found in the planning area are alluvium, clay, limestone, gravel, sandstone, lignite, siltstone, tuff, mudstone, gypsum, halite, petroleum, quartz, natural gas, and sand[13].

Continuing Development

The building of new structures will continue throughout the planning area due to population growth. The Texas State Data Center projects continued moderate growth for the area while the Texas Water Development Board forecasts a much steeper climb in population. Local governments are working to develop the economic potential for the area and to bring high quality jobs including commercial research opportunities[13].

Agriculture and Infectious Disease

Diseases emerging from agriculture typically get high levels of attention. Many originate in wildlife and then spillover to people, often using livestock as bridges[14]. There is consensus that emerging zoonotic pathogens are best managed by One Health approaches in which human health, animal health and the environmental sectors work together. Recent epidemics and pandemics of emerging disease highlight the importance of good surveillance and rapid response[14].

The public health importance of foodborne disease is just starting to be recognized. The first global assessment of FBD, developed by the World Health Organization, suggested the health burden of FBD was comparable to that of malaria, HIV-AIDS, or tuberculosis[14]. There are several strategies for managing foodborne disease including good practices, technologies, and training[14].

Human infections that do not respond to treatment impose a large burden of illness and death as well as entailing enormous health care costs[14]. An unknown but potentially substantial amount of this burden is due to the use of antimicrobials in agriculture[14]. It is widely appreciated that

agriculture development contributes significantly to public health outcomes. Collaborations that bridge the structural divisions between the agriculture and health sectors provide an opportunity for better managing these important diseases[14].

References – Section 2

1. *Texas State Historical Association. 2020. Your Texas State History. https://www.tshaonline.org/home*
2. *United State Census Bureau.2022. Brazos County, Texas. https://www.census.gov/quickfacts/brazoscountytexas*
3. *Federal Emergency Management Agency. Disaster Declarations for States and Counties. https://www.fema.gov/data-visualization/disaster-declarations-states-and-counties*
4. *Texas A & M University. Office of the Registrar. https://registrar.tamu.edu/*
5. *Blinn College. Office of the Registrar. https://www.blinn.edu/admissions/index.html*
6. *Texas Demographic Center. Projected Population Growth. https://demographics.texas.gov/*
7. *Statistical Atlas. Overview of the United States. Texas. https://statisticalatlas.com/United-States/Overview*
8. *Texas County Profiles. Brazos County. https://txcip.org/tac/census/profile.php?FIPS=48041*
9. *US Department of Agriculture. Land Use, Land Value, & Tenure. https://www.ers.usda.gov/topics/farm-economy/land-use-land-value-tenure/*
10. *Brazos County HMAP (2019-2024). Main Page. https://bcdem.org/emergency/plans*
11. *Texas KIDS COUNT at Every Texan. Kids Count Data Center. https://datacenter.aecf.org/about/state-providers/details/44-texas-kids-count-at-every-texan*
12. *Texas Department of Transportation. Brazos County, Texas. https://www.txdot.gov/*
13. *US Geological Survey. Brazos County, Texas. https://www.usgs.gov/*
14. *Grace D. Infectious Diseases and Agriculture. Encyclopedia of Food Security and Sustainability. 2019:439–47. doi: 10.1016/B978-0-08-100596-5.21570-9. Epub 2018 Nov 16. PMCID: PMC7161382.*

This page intentionally left blank.

Section 3 – The Planning Process

Plan Preparation

Hazard mitigation planning involves coordination with various constituents and stakeholders to develop a more disaster-resistant community. This plan was prepared by the hazard mitigation planning team on behalf of the following participating entities that are all seeking approval for this plan; Brazos County; the Cities of Bryan, College Station, Kurten, and Wixon Valley; and Texas A&M University.

Figure: 3.1 – The Mitigation Planning Process Source: FEMA[1]

The process used to prepare the plan followed the major steps included Figure: 3.1. After the planning team was organized, a capability assessment was developed and distributed. Hazards were identified and assessed, and results associated with each of the hazards were provided at the risk assessment meeting. Based on Brazos County's identified vulnerabilities, specific mitigation strategies were discussed and developed at the mitigation strategy meeting. Finally, plan maintenance and implementation procedures were developed and are included in this section. The participation of planning team members, stakeholders, and the public at each of the meetings is documented in Appendices A, D, and E.

At the plan development meetings held throughout the planning process described herein, the following factors were taken into consideration[1]:

- The nature and magnitude of risks currently affecting the community.
- Hazard mitigation goals to address current and expected conditions.
- Whether current resources will be sufficient for implementing the plan.

- Implementation problems, such as technical, political, legal, and coordination issues, may hinder development.
- Anticipated outcomes.
- What participating entities within Brazos County, agencies, and partners will participate in implementing the plan.

Planning for the 2020-2022 years was halted due to the COVID-19 pandemic and the shifting of operations to support other local, state, and federal initiatives. In December 2022, Brazos' County resumed operations under emergency management and resumed planning efforts, but due to lack of funding and staffing, many hazard mitigation projects were incomplete (See Appendix G) for the planning area and will be rolled over into the 2024-2029 Hazard Mitigation Action Plan.

During resumption of activities, important discussions were held that resulted in the development of mitigation actions that are included in the plan that are designed to further mitigate risk from natural hazards in the future. The planning team developed hazard mitigation actions for mitigating risk from all the hazards including potential flooding, hail, and extreme heat. These actions include but are not limited to drainage improvement projects, strengthening critical facilities, installing generators, and educating citizens to practice hazard mitigation techniques.

Planning Team

A full roster of the hazard mitigation planning team showing names, agencies, and titles is available in Appendix A.

Mitigation Review and Development

The participating entities developed mitigation strategies for the plan and identified new goals and mitigation actions. Additionally, the participating entities were proactive in identifying mitigation actions that would lessen the risk of all the identified hazards included in the plan.

An inclusive and structured process was used to develop and prioritize new hazard mitigation actions for the plan. The prioritization method was based on FEMA's STAPLE+E (Social, technological, administrative, political, legal, and economic/environmental) criteria[1].

As a result, each planning team member was assigned an overall priority to each hazard mitigation action. The overall priority of each action is reflected in the hazard mitigation actions found in Section 16 – Mitigation Actions.

Planning team members then developed action plans identifying proposed actions, costs and benefits, the responsible organization(s), effects on new and existing buildings, implementation schedules, priorities, and potential funding sources[1].

Specifically, the process involved:

- Listing optional hazard mitigation actions based on information collected from previous plan reviews, studies, and interviews with federal, state, and local

officials. Workshop participants reviewed the optional mitigation actions and selected actions that were most applicable to their area of responsibility, cost-effective in reducing risk, easily implemented, and likely to receive institutional and community support.

- Meeting participants inventoried federal and state funding sources that could assist in implementing the proposed hazard mitigation actions. Information was collected (when available), including the program name, authority, purpose of the program, types of assistance and eligible projects, conditions on funding, types of hazards covered, matching requirements, application deadlines, and a point of contact.
- Planning team members considered the benefits that would result from implementing the hazard mitigation actions compared to the cost of those projects. Although detailed cost benefit analyses were beyond the scope of the plan, planning team members utilized economic evaluation as a determining factor between hazard mitigation actions.
- Planning team members then selected and prioritized mitigation actions.

Hazard mitigation actions identified in the process were made available to the Planning Team for review. The draft plan will be made available to the public for review on participating entities' websites, with the chance to comment via sending an email.

Review and Incorporation of Existing Plans

Background information utilized during the planning process included various studies, plans, reports, and technical information from sources such as FEMA, the United States Army Corps of Engineers (USACE), the U.S. Fire Administration, National Oceanic and Atmospheric Administration (NOAA), the Texas Water Development Board (TWDB), the Texas Commission on Environmental Quality (TCEQ), the Texas State Data Center, Texas Forest Service, the Texas Division of Emergency Management (TDEM), and local hazard assessments and plans.

The Risk Overview - Section 4 and the hazard-specific sections of the plan (Sections 5-15) summarize the relevant background information. Specific background documents, including those from FEMA[1], provided information on hazard risk, hazard mitigation actions currently being implemented, and potential mitigation actions. Previous hazard events, occurrences, and descriptions were identified through NOAA's National Centers for Environmental Information (NCEI). Results of past hazard events were found through searching the NCEI. The USACE studies were reviewed for their assessment of risk and potential projects in the region. State Data Center documents were used to obtain population projections. The State Demographer webpages were reviewed for population and other projections and included in the Demographics - Section 2 of the plan. Information from the Texas Forest Service was used to appropriately rank the wildfire hazard, and to help identify potential grant opportunities. Materials from FEMA and TDEM were reviewed for guidance on plan development requirements.

Incorporation of Existing Plans into the HMAP Process

A capability assessment was completed by key departments from the participating entities within Brazos County which provided information pertaining to existing plans, policies, ordinances, and regulations to be integrated into the goals and objectives of the plan. The relevant information was included in Appendix F - Capability Assessment.

Existing projects and studies were utilized as a starting point for discussing hazard mitigation actions among planning team members. Additionally, policies and ordinances were reviewed by several of the participating entities. These entities have included actions to develop and implement routine debris clearing programs and restrict future development in high-risk areas. Other plans were reviewed, such as Emergency Operations Plans and Capital Improvement Plans, to identify any additional mitigation actions.

Finally, the 2023 Texas State Hazard Mitigation Plan, developed by TDEM, was discussed in the initial planning meeting to develop a specific group of hazards to address in the planning effort. The 2023 Texas State Hazard Mitigation Plan was also used as a guidance document, along with FEMA materials, in the development of the Brazos County Hazard Mitigation Action Plan 2024.

Incorporation of the HMAP into Other Planning Mechanisms

Planning team members will integrate implementation of the plan with other planning mechanisms for Brazos County, such as the Emergency Operations Plan. Existing plans for participating entities will be reviewed and incorporated into the plan, as appropriate. This section discusses how the plan will be implemented by the participating entities within Brazos County. It also addresses how the plan will be evaluated and improved over time, and how the public will continue to be involved in the hazard mitigation planning process.

Participating entities within Brazos County will be responsible for implementing hazard mitigation actions contained in Section 16. Each hazard mitigation action has been assigned to a specific department within each participating entity that is responsible for tracking and implementing the action.

A funding source has been listed for each identified hazard mitigation action and may be utilized to implement the action. An implementation period will be determined to each hazard mitigation action, as per entities discretion and determined by fundings and availability.

Participating entities within Brazos County will integrate hazard mitigation actions contained in the plan with existing planning mechanisms such as Subdivision Regulations, Emergency Operations or Management Plans, Evacuation Plans, and other local and area planning efforts. Brazos County will work closely with area organizations to coordinate implementation of hazard mitigation actions that benefit the planning area in terms of financial and economic impact.

Upon formal adoption of the plan, planning team members from the participating entities will review existing plans along with building codes to guide development and ensure that hazard mitigation actions are implemented. Each of the entities will be responsible for coordinating a

periodic review of the plan with members of the advisory planning team to ensure integration of hazard mitigation strategies into these planning mechanisms and codes.

The planning team will also conduct periodic reviews of various existing planning mechanisms and analyze the need for any amendments or updates considering the approved plan. Participating entities within Brazos County will ensure that future long-term planning objectives will contribute to the goals of the plan to reduce the long-term risk to life and property from moderate and high-risk hazards to the extent possible. Within one year of formal adoption of the plan, existing planning mechanisms will be reviewed and analyzed as they pertain to the plan.

Planning team members will review and revise, as necessary, the long-range goals and objectives in its strategic plan and budgets to ensure that they are consistent with the plan.

Furthermore, Brazos County will work with neighboring entities to advance the goals of the plan as it applies to ongoing, long-range planning goals and actions for mitigating risk to natural hazards throughout the planning area.

Table: 3.1, identifies types of planning mechanisms and examples of methods for incorporating the Plan into other planning efforts.

Planning Mechanism	Examples of Methods
Annual Budget Review	Various departments and key personnel that participated in the planning process for participating entities within Brazos County will review the plan and mitigation actions therein when conducting their annual budget review. Allowances will be made in accordance with grant applications sought, and mitigation actions that will be undertaken, according to the implementation schedule of the specific action.
Capital Improvement Plans	Participating entities within Brazos County have a Capital Improvement Plan (CIP) in place. Prior to any revisions to the CIP, County, City departments, including ISDs, will review the risk assessment and mitigation strategy sections of the HMAP, as limiting public spending in hazardous zones is one of the most effective long-term mitigation actions available to local governments.
Comprehensive Plans	Since comprehensive plans involve developing a unified vision for a community, the mitigation vision and goals of the plan will be reviewed in the development or revision of a Comprehensive Plan.
Floodplain Management Plans	Floodplain management plans include preventative and corrective actions to address the flood hazard. Therefore, the actions for flooding, and information found in Section 6 of this plan discussing the people, property, and animals at risk to flood, will be reviewed, and revised when participating entities within Brazos County update their management plans or develop new plans.

Grant Applications	The plan will be evaluated by participating entities within Brazos County when grant funding is sought for mitigation projects. If a project is not in the plan, an addendum may be necessary to include the action in the plan.
Regulatory Plans	Currently, participating entities within Brazos County have regulatory plans in place, such as Emergency Management Plans, Economic Development and Evacuation Plans. The plan will be consulted when County and City departments, including ISDs, review or revise their current regulatory planning mechanisms. Development of regulatory plans that are not currently in place.

Table: 3.1-Types of Planning Mechanisms and Examples of Methods for Incorporating the Plan
Source: Brazos County HMAP (2019-2024)[2]

It should be noted for the purposes of the plan that the HMAP has been used as a reference when reviewing and updating all plans and ordinances for the entire planning area, including all participating entities. The Emergency Management Plan has been developed by Brazos County; the Cities of Bryan, College Station, Kurten, and Wixon Valley; and Texas A&M University. The annexes of the plan will be updated on a rotating basis every 5 years and incorporate goals, objectives, and actions identified in the Hazard Mitigation Action Plan.

Plan Review and Plan Update

As with the development of the plan, participating entities within Brazos County will oversee the review and update process for relevance and to make necessary adjustments, as needed. Within the first quarter of each fiscal year, after approval, planning team members will meet to evaluate the plan and review other planning mechanisms to ensure consistency with long-range planning efforts are being achieved. In addition, planning participants will monitor and evaluate the plan and will meet once to twice a year, as updates are needed, by conference call or presentation, to re-evaluate prioritization of the hazard mitigation actions. For more information on monitoring, evaluation, disaster declarations, plan amendments, HMAP review, and continued public involvement see Section 17.

Timeline for Implementing Mitigation Actions

The planning team will engage in discussions regarding a timeframe for how and when to implement each hazard mitigation action. Considerations include when the action will be started, how existing planning mechanisms' timelines affect implementation, and when the action should be fully implemented. Timeframes may be general, and there will be short, medium, and long-term goals for implementation based on prioritization of each action.

The planning team will evaluate and prioritize the most suitable hazard mitigation actions to implement. The timeline for implementation of actions will partially be directed by participating entities' comprehensive planning process, budgetary constraints, and community needs. Participating entities within Brazos County are committed to addressing and implementing hazard mitigation actions that may be aligned with and integrated into the plan.

Overall, the planning team agrees that the goals and actions of the plan shall be aligned with the timeframe for implementation of hazard mitigation actions with respect to annual review and updates of existing plans and policies.

Public and Stakeholder Involvement

An important component of hazard mitigation planning is public participation and stakeholder involvement. Input from individual citizens and the community provides the planning team with a greater understanding of local concerns and increases the likelihood of successfully implementing hazard mitigation actions. If citizens and stakeholders, such as local businesses, non-profits, hospitals, and schools are involved, they are more likely to gain a greater appreciation of the risks that hazards may present in their community and take steps to reduce or mitigate their impact.

The public has been involved in the development of the Brazos County Hazard Mitigation Action Plan 2024 at different stages prior to official Plan approval and adoption. Public input was sought using three methods: (1) open public meetings; (2) survey instruments; and (3) making the draft plan available for public review at participating entities' websites.

The draft plan will be made available to the public for review and comment on participating entities' websites. The public was notified at the public meetings that the draft plan would be available for review. Currently no feedback has been received on the draft plan, although questions given on a public survey, and all relevant information provided through the surveys were incorporated into the plan. Public input was utilized to assist in identifying hazards that were of most concern to the citizens of the County and what actions they felt should be included and prioritized. The plan will be posted on the Brazos County and participating entities' websites upon approval from FEMA, and a copy will be kept at the Brazos County website (https://bcdem.org/emergemcy/plans).

Stakeholder Involvement

Stakeholder involvement is essential to hazard mitigation planning since a wide range of stakeholders can provide input on specific topics and from various points of view. Throughout the planning process, members of community groups, local businesses, and neighboring jurisdictions were invited to participate in development of the plan. Stakeholders and participants from neighboring communities that attended the planning team and public meetings played a key role in the planning process.

During the development of the Brazos County Hazard Mitigation Action Plan, involvement was sought from stakeholders and the community at large. Opportunities for feedback were available in multiple ways including open public meetings, community engagement events (TAMU, City of Bryan Open House, Brazos County Health Fair, and National Night Out), physical and online surveys, and as stated above, a draft plan was made available on our websites. Opportunities were announced through stakeholders, social and traditional media channels, and paper flyers on community bulletin boards. To ensure underserved and vulnerable populations were informed and included, targeted invitations were given to participants of programs through the Brazos

County Health District, American Red Cross, and other Voluntary Organizations Active in Disasters (VOADs) in the planning area.

Public and stakeholder involvement met all requirements under CFR Title 44 §201.6(b).

Public Meetings

A series of public meetings were held throughout the planning area to collect public and stakeholder input. Topics of discussion included the purpose of hazard mitigation, the planning process, and types of natural hazards. Each participating entity within Brazos County released information regarding the public meetings in the area to increase public participation in the plan development process, through posting on their website, on social media sources including Facebook and Twitter, through the local media, and/or posting the information on bulletin boards in public facilities. A sampling of these notices can be found in Appendix D and E, along with the documentation on the public meetings. Representatives from area neighborhood associations and area residents were invited to participate.

Public meetings were held on the following dates and locations:

- Monday, November 13, 2023, at the Brazos Center in the city of Bryan.
- Monday, December 11, 2023, at the Brazos Center in the city of Bryan.
- Meeting three (3) will take place after the preliminary approval of the Hazard Mitigation Action Plan.

Public Participation Survey

In addition to public meetings, the planning team developed a public survey designed to solicit public input during the planning process from citizens and stakeholders and to obtain data regarding the identification of any potential hazard mitigation actions or problem areas. This survey was written in both English and Spanish.

The survey was promoted by local officials and a link to the survey was posted on participating entities' websites. A total of 131 surveys were completed online. The questions are displayed, and the results are analyzed in Appendix C. Participating entities within Brazos County reviewed the input from the surveys and decided which information to incorporate into the plan as hazard mitigation actions.

The Hazard Mitigation Team established the following avenues to solicit public opinion and participation, as required by CFR Title 44 §201.6(b):

- Offering surveys in English and Spanish.
- Providing facilities for meetings.
- Making decisions on the planning process and content.
- Establishing new goals.

- Consistently reviewing and providing comments on drafts with each participating entity.
- Identifying projects and mitigation actions for each hazard.
- Posting on social media and the CEOC website (brazosceoc.org).
- Discussing the planning process with various groups: Voluntary Organizations Active in Disasters, Health District, American Red Cross, Texas Department of Emergency Management, Texas Department of Public Safety.
- Coordinating the formal adoption of the plan.

Open Meetings

Open meetings were scheduled, announced, and held at the Brazos Center and the VOAD Quarterly Meetings at Rellis Campus, to collect feedback from the diverse populations within Brazos County. Each meeting was posted publicly with paper flyers and online notifications as well as through social and traditional media channels. Announcements were made in both English and Spanish on the Brazos County website using the website translator.

The public meetings were held at the Brazos Center located at 3232 Briarcrest Drive in Bryan, Texas. This location was chosen for its centrality within the planning area, its familiarity as a public, multi-use event facility, and its accessibility for all members of the community including those with functional and access needs. Meetings were conducted in English with interpreters upon request.

Documentation from public meetings and sample announcements are available in Appendices D and E of this document. A third public meeting will be held announcing the FEMA-approved plan version, and public feedback and commentary will continue to be solicited and welcomed as part ongoing effort to make the Brazos County Hazard Mitigation Action Plan a living document.

Physical and Online Surveys

A survey was created to obtain valuable community feedback regarding disaster experience, preparation, perception, and overall knowledge within the planning area. The survey was published online in both English and Spanish, and physical copies of the survey in English and Spanish, were provided at in-person outreach events and public meetings throughout the planning area. In addition, paper flyers with a QR code were placed on community message boards and stakeholder locations. At the date of initial plan submission, the total number of surveys received was 131. The survey will remain open indefinitely as part of the ongoing effort to collect and maintain community feedback for the continuous improvement of the Brazos County Hazard Mitigation Action Plan.

The survey questions as well as a results analysis are available in Appendix C of this document.

Review Copies of the Draft Plan

Copies of the draft plan were available to the public for review and comment on stakeholder websites. The community was advised of these opportunities during outreach events, public

meetings, and through social and traditional media channels. At the date of initial plan submission, no feedback or commentary had been received on the draft plan.

Use of Feedback and Commentary

Input from the public was utilized to identify hazards in the planning area as well as clarify historic impacts and existing public perception of future risk. In addition, feedback was and will continue to be used to inform public information and outreach direction and needs.

Ongoing Feedback and Commentary Opportunities

A draft version of the Brazos County Hazard Mitigation Action Plan remains available for public review and comment on stakeholder websites. This version will be replaced with the final version after approval from FEMA, and public feedback and commentary will continue to be solicited and welcomed. In addition, the online survey in both English and Spanish will remain available indefinitely. The feedback and comments received will be reviewed and incorporated as applicable during the annual plan review process.

Vulnerable Populations

While every effort was made to reach everyone in Brazos County through the multiple efforts and outreaches listed above, only minimal participation was captured as evidenced by the small amount of participation in not only the community meetings, but also the community survey.

As mentioned before the survey was brought to many community outings around Brazos County and its participating entities as well as online. While we acknowledge this lack of participation, we also will continue our outreach efforts through community events as well as keeping the online questionnaire available for the community to voice their opinions and help guide us in what is needed to support the county in moving forward. In the updates of the HMAP as defined, we will revise our numbers of those participating and the different events that we attend to spread awareness and solicit input throughout the communities.

Continuing efforts and every opportunity to reach everyone within Brazos County and participating entities areas will be utilized.

References – Section 3

1. *Federal Emergency Management Agency. Mitigation Planning Process. https://www.fema.gov/grants/mitigation/guide/part-11/a/2*
2. *Brazos County HMAP (2019-2024). Main Page. https://bcdem.org/emergency/plans*

This page intentionally left blank.

Section 4 – Capabilities Assessment

Description

The purpose of conducting a *Capability Assessment* is to determine the ability of a local jurisdiction to implement a comprehensive mitigation strategy, and to identify potential opportunities for establishing or enhancing specific mitigation policies, programs, or projects. As in any planning process, it is important to try to establish which goals, objectives, and actions are feasible, based on an understanding of the organizational capacity of those agencies or departments tasked with the implementations.

A *Capability Assessment* helps to determine which mitigation actions are practical and likely to be implemented over time given a local government's planning and regulatory framework, level of administrative and technical support, the number of fiscal resources, and current political climate.

The completed *Capability Assessment* Chart, included in Appendix F, provides information on existing policies, plans, and regulations for Brazos County and the participating entities.

Each community has a unique set of capabilities, including policies, programs, staff, funding, and other resources available to accomplish hazard mitigation objectives and reduce long term vulnerability. The planning team identified existing capabilities that currently reduce disaster losses or could be used to reduce losses in the future, and capabilities that inadvertently increase risks in the community.

Hazard Mitigation Baseline Capabilities

Hazard mitigation is widely recognized as one of the five primary phases of emergency management. The four other phases are prevention, preparedness, response, and recovery. Each phase is interconnected with hazard mitigation, as seen in Figure 4.1. Opportunities to reduce potential losses through mitigation practices are most often implemented before a disaster event, such as elevation of flood-prone structures or through the continuous enforcement of policies that prevent and regulate development that is vulnerable to hazards because of its location, design, or other characteristics. Mitigation opportunities can also be identified during immediate preparedness or response activities, and in many instances during the long-term recovery and redevelopment process following a disaster event.

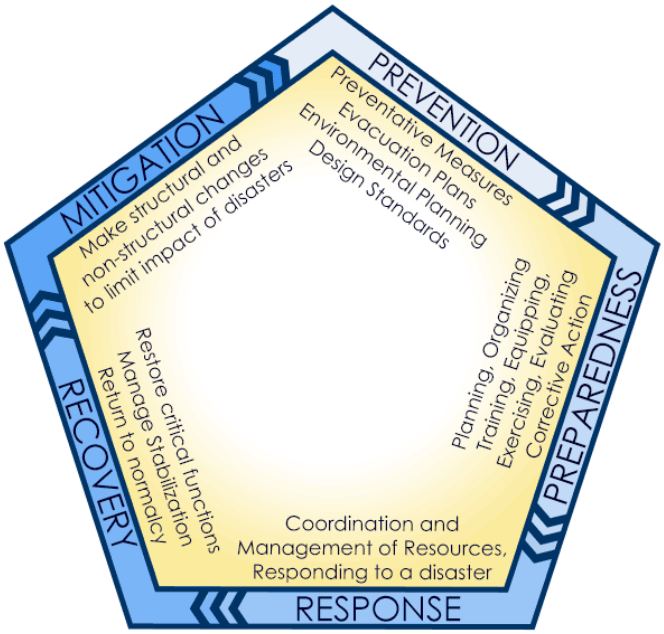


Figure: 4.1 – The Five Phases of Emergency Management

Brazos County and the participating entities have the following internal capabilities related to hazard mitigation which serve as a *baseline* of what they can accomplish with relation to hazard mitigation goals and strategies (Table 4.1).

Emergency Response	
South Brazos County ESD 1	South Brazos County VFD
Brazos County District 2 ESD	Brazos County District 2 VFD
Brazos County Precinct 3 VFD	Brazos County VFD 4
City of Bryan Fire Department	City of College Station Fire Department
City of Bryan Police Department	City of College Station Police Station
Brazos County Sheriff's Department	Texas A & M University Police Department
Plans	
Interjurisdictional Emergency Management Plan	
Basic Plan	
Annex A	Annex L
Annex B	Annex M
Annex C	Annex N
Annex D	Annex O
Annex E	Annex P

Annex F	Annex Q
Annex G	Annex R
Annex H	Annex S
Annex I	Annex T
Annex J	Annex U
Annex K	Annex V

Table: 4.1 – Baseline Capabilities Source: Brazos County HMAP (2019-2024)[1]

More information can be found on the plans and annexes in Table: 4.1, above at:

https://bcdem.org/emergency/plans.

Capability Assessment Findings

The findings of the capability assessment are summarized in this plan to provide insight into the relevant capacity of the participating entities in Brazos County to implement hazard mitigation activities. All information is based upon the review of the existing HMAP and local government websites and the Emergency Management Coordinators through the *Capability Assessment*.

Planning and Regulatory Capabilities

Planning and regulatory capability is based on the implementation of plans, ordinances, and programs that demonstrate a local participating entities commitment to guiding and managing growth, development, and redevelopment in a responsible manner while maintaining the general welfare of the community. It includes emergency response and mitigation planning, comprehensive land use planning, and transportation planning; the enforcement of zoning or subdivision ordinances and building codes that regulate how land is developed and structures are built; as well as protecting environmental, historic, and cultural resources in the community.

Although some conflicts can arise, these planning initiatives generally present significant opportunities to integrate hazard mitigation principles and practices into the local decision-making process. This assessment is designed to provide a general overview of the key planning and regulatory tools and programs that are in place or under development for the participating entities in Brazos County along with their potential effect on loss reduction. This information will help identify opportunities to address existing gaps, weaknesses, or conflicts with other initiatives in addition to integrating the implementation of this plan with existing planning mechanisms where appropriate. Appendix F provides a summary of the capability assessment results for Brazos County and participating entities, regarding relevant planning and regulatory capabilities.

Hazard Mitigation Plan: An HMAP represents a community's blueprint for how it intends to reduce the impact of natural and human-caused hazards on people and the built

environment. The essential elements of an HMAP include a risk assessment, capability assessment, and mitigation strategy.

Disaster Recovery Plan: A disaster recovery plan serves to guide the physical, social, environmental, and economic recovery and reconstruction process following a disaster. In many instances, hazard mitigation principles and practices are incorporated into local disaster recovery plans with the intent of capitalizing on opportunities to break the cycle of repetitive disaster losses. Disaster recovery plans can also lead to the preparation of disaster redevelopment policies and ordinances to be enacted following a hazard event.

Emergency Operations Plan: An emergency operations plan outlines responsibilities and the means by which resources are deployed during and following an emergency or disaster.

Continuity of Operations Plan: A continuity of operations plan establishes a chain of command, line of succession, and plans for backup or alternate emergency facilities in case of an extreme emergency or disaster event.

Flood Response Plan: A flood response plan establishes procedures for responding to a flood emergency including coordinating and facilitating resources to minimize the impacts of flood.

General Planning

The implementation of hazard mitigation activities often involves agencies and individuals beyond the emergency management profession. Stakeholders may include local planners, public works officials, economic development specialists, and others. In many instances, concurrent local planning efforts will help to achieve or complement hazard mitigation goals, even though they are not designed as such.

Comprehensive Land Use Plan: A comprehensive land use plan establishes the overall vision for what a community wants to be and serves as a guide for future governmental decision making. Typically, a comprehensive plan contains sections on demographic conditions, land use, transportation elements, and community facilities. Given the broad nature of the plan and its regulatory standing in many communities, the integration of hazard mitigation measures into the comprehensive plan can enhance the likelihood of achieving risk reduction goals, objectives, and actions.

Capital Improvements Plan: A CIP guides the scheduling of spending on public improvements. A capital improvements plan can serve as an important mechanism for guiding future development away from identified hazard areas. Limiting public spending in hazardous areas is one of the most effective long-term mitigation actions available to local governments.

Historic Preservation Plan: A historic preservation plan is intended to preserve historic structures or districts within a community. An often-overlooked aspect of the historic preservation plan is the assessment of buildings and sites located in areas subject to natural hazards and the identification of ways to reduce future damage. This may involve retrofitting

or relocation techniques that account for the need to protect buildings that do not meet current building standards or are within a historic district that cannot easily be relocated out of harm's way.

Open Space Management Plan: An open space management plan is designed to preserve, protect, and restore largely undeveloped lands in their natural state and to expand or connect areas in the public domain such as parks, greenways, and other outdoor recreation areas. In many instances, open space management practices are consistent with the goals of reducing hazard losses, such as the preservation of wetlands or other flood-prone areas in their natural state in perpetuity.

Stormwater Management Plan: A stormwater management plan is designed to address flooding associated with stormwater runoff. The stormwater management plan is typically focused on design and construction measures that are intended to reduce the impact of more frequently occurring minor urban flooding.

Codes and Ordinances

Zoning Ordinance: Zoning represents the primary means by which land use is controlled by local governments. As part of a community's police power, zoning is used to protect the public health, safety, and welfare of those in a given jurisdiction that maintains zoning authority. A zoning ordinance is the mechanism through which zoning is typically implemented. Since zoning regulations enable municipal governments to limit the type and density of development, a zoning ordinance can serve as a powerful tool when applied in identified hazard areas.

Subdivision Ordinance: A subdivision ordinance is intended to regulate the development of residential, commercial, industrial, or other uses, including associated public infrastructure, as land is subdivided into buildable lots for sale or future development. Subdivision design that accounts for natural hazards can dramatically reduce the exposure of future development.

Building Codes, Permitting, and Inspections: Building codes regulate construction standards. In many communities, permits and inspections are required for new construction. Decisions regarding the adoption of building codes (that account for hazard risk), the type of permitting process required both before and after a disaster, and the enforcement of inspection protocols all affect the level of hazard risk faced by a community.

Floodplain Management: Flooding represents the greatest natural hazard facing the nation. At the same time, the tools available to reduce the impacts associated with flooding are among the most developed when compared to other hazard-specific mitigation techniques. In addition to approaches that cut across hazards such as education, outreach, and the training of local officials, the NFIP contains specific regulatory measures that enable government officials to determine where and how growth occurs relative to flood hazards. Participation in the NFIP is voluntary for local governments; however, program participation is strongly encouraged by FEMA as a first step for implementing and sustaining an effective hazard mitigation program. It is

therefore used as part of this assessment as a key indicator for measuring local capability.

Community Rating System: An additional indicator of floodplain management capability is the active participation of local jurisdictions in the Community Rating System (CRS). The CRS is an incentive-based program that encourages counties and municipalities to undertake defined flood mitigation activities that go beyond the minimum requirements of the NFIP by adding extra local measures to provide protection from flooding. All of the 18 creditable CRS mitigation activities are assigned a range of point values. As points are accumulated and reach identified thresholds, communities can apply for an improved CRS class rating. Class ratings, which range from 10 to 1. As class rating improves (the lower the number the better), the percent reduction in flood insurance premiums for NFIP policyholders in that community increases.

Flood Damage Prevention Ordinance: A flood damage prevention ordinance establishes minimum building standards in the floodplain with the intent to minimize public and private losses due to flood conditions.

Floodplain Management Plan: A Floodplain Management Plan (FMP, or flood mitigation plan) provides a framework for action regarding corrective and preventative measures to reduce flood- related impacts.

Appendix F provides a summary of the capability assessment results for Brazos County and participating entities, regarding relevant codes and ordinances. See Appendix F – for additional information.

Administrative and Technical Capabilities

The ability of a local government to develop and implement mitigation projects, policies, and programs is directly tied to its ability to direct staff time and resources for that purpose. Administrative capability can be evaluated by determining how mitigation-related activities are assigned to local departments and if there are adequate personnel resources to complete these activities. The degree of intergovernmental coordination among departments will also affect administrative capability for the implementation and success of proposed mitigation activities. Technical capability can generally be evaluated by assessing the level of knowledge and technical expertise of local government employees, such as personnel skilled in using GIS to analyze and assess community hazard vulnerability. The *Capability Assessment* was used to capture information on administrative and technical capability through the identification of available staff and personnel resources. Appendix F provides a summary of the capability assessment results for Brazos County and participating entities, regarding relevant staff and personnel capabilities.

Financial Capabilities

The ability of a local government to act is often closely associated with the amount of money available to implement policies and projects. This may take the form of outside grant funding awards or locally based revenue and financing. The costs associated with mitigation policy and

project implementation vary widely. In some cases, policies are tied primarily to staff time or administrative costs associated with the creation and monitoring of a given program. In other cases, direct expenses are linked to an actual project, such as the acquisition of flood-prone homes, which can require a substantial commitment from local, state, and federal funding sources. Appendix F provides a summary of the financial assessment results for Brazos County and participating entities, regarding relevant financial capabilities.

Outreach and Education Capabilities

One of the most difficult capabilities to evaluate involves the outreach/education of a jurisdiction to enact meaningful outreach and education designed to reduce the impact of future hazard events. Hazard mitigation may not be a local priority or may conflict with or be seen as an impediment to other goals of the community, such as growth and economic development. Therefore, the local outreach/education climate must be considered in designing mitigation strategies as it could be the most difficult hurdle to overcome in accomplishing their adoption and implementation. Appendix F provides a summary of the outreach/educational assessment results for Brazos County and participating entities, regarding relevant outreach and education capabilities.

Expanding and Improving Capabilities

The purpose of the Capability Assessment is to assist Brazos County and the participating entities in identifying gaps in planning, staff, and resourcing and examine the potential to expand and improve capabilities. Options for improving capabilities include the following:

- Engaging planning team members with the authority to monitor the HMAP and identify grant funding opportunities for expanding staff.
- Identifying opportunities for cross-training or increasing the technical expertise of staff by attending free training available through FEMA and the Texas Division of Emergency Management (TDEM) via preparingtexas.org.
- Reviewing current floodplain ordinances for opportunities to increase resiliency such as modifying permitting or building codes.
- Identifying partnerships where communities may form Mutual Aid Agreements or Memorandums of Understanding to aid and bolster existing resources and solicit assistance from national sources such as Flood Smart[2] and state sources such as the Texas Association of Counties.

The participating entities used the *Capability Assessment* as part of the basis for the Mitigation Actions that are identified in Appendix F; therefore, each entity addresses their ability to expand on and improve their existing capabilities through the identification of their Mitigation Actions.

The conclusions of the *Risk Assessment* and *Capability Assessment* serve as the foundation for the development of a meaningful hazard mitigation strategy. During the process of identifying specific mitigation actions to pursue, as well as existing capabilities to minimize or eliminate a risk.

References – Section 4

1. *Brazos County HMAP (2019-2024). Main Page. https://bcdem.org/emergency/plans*
2. *Flood Smart. The National Flood Insurance Program. https://www.floodsmart.gov/*

This page intentionally left blank.

Section 5 – Risk Overview

Hazard Identification

The first phase of the risk assessment is providing background information for the hazard identification process and descriptions for the hazards identified. The risk assessment continues with Sections 5 through 15, which include hazard descriptions and vulnerability assessments.

Upon review of the full range of natural hazards suggested under the FEMA planning guidance, participating entities within Brazos County identified ten (10) hazards that are addressed in the Hazard Mitigation Plan.

Of the hazards identified, eight (8) were natural hazards, one (1) a quasi-technological hazard (dam failure), and one (1) infectious disease were identified as significant.

The hazards were identified through input from planning team members and a review of the current 2023 Texas State Hazard Mitigation Plan. Additionally, readily available online information from reputable sources such as federal and state agencies were also evaluated and utilized to supplement information as needed.

In general, there are three main categories of hazards: atmospheric, hydrologic, and technological.

- Atmospheric hazards are events or incidents associated with weather generated phenomenon. Atmospheric hazards that have been identified as significant for the planning area include extreme heat, hail, thunderstorms, tornadoes, and severe winter storms.
- Hydrologic hazards are events or incidents associated with water related damage and account for over 75 percent of federal disaster declarations in the United States. Hydrologic hazards identified as significant for the planning area include flooding and drought.
- Technological hazards refer to the origins of incidents that can arise from human activities, such as the construction and maintenance of dams. They are distinct from natural hazards primarily because they originate from human activity. The risks presented by natural hazards may be increased or decreased because of human activity, however they are not inherently human-induced. Therefore, dam failure is classified as a quasi-technological hazard and referred to as “technological”. Other causes of dam failure can be the shrinking and swelling of the clay-like soil within the planning area.

For the risk assessment, wildfire hazard is considered “other,” since wildfires are not considered atmospheric, hydrologic, nor technological.

Also, for risk assessment, infectious diseases are considered “other” since infectious diseases are not considered atmospheric, hydrologic, or technological.

Property and crop damages were estimated by gathering data from the National Centers for Environmental Information (NCEI) and National Oceanic and Atmospheric Administration

(NOAA)[1]. The assessment also examined the impact of various hazards on the built environment, including general building stock, critical facilities, lifelines, and infrastructure.

The resulting risk assessment profiled hazard events provided information on locations, previous occurrences, estimated probability of future events, and potential damages and losses and an assessment of the impact for each hazard on the people and property of Brazos County.

Climate Vulnerability

While climate change will impact the whole Brazos County and participating entities communities, there are certain communities that are particularly vulnerable to climate change and will experience disproportionate impacts. These populations include:

- Communities of color.
- Low-income communities.
- Older adults.
- People with disabilities.

While these populations have strong communities who support them in withstanding disasters, barriers created by marginalization and historic disinvestment may make it more difficult for these populations to prepare for, recover quickly, or reduce the potential impacts of disasters.

Social vulnerability refers to the potential negative effects on communities caused by external stresses on human health. Such stresses include natural or human-caused disasters, or disease outbreaks.

These communities possess multiple risk factors that qualify them as more vulnerable to the planning area's changing climate[2]. Some common risk factors across these vulnerable population groups are identified in Figure: 5.1.

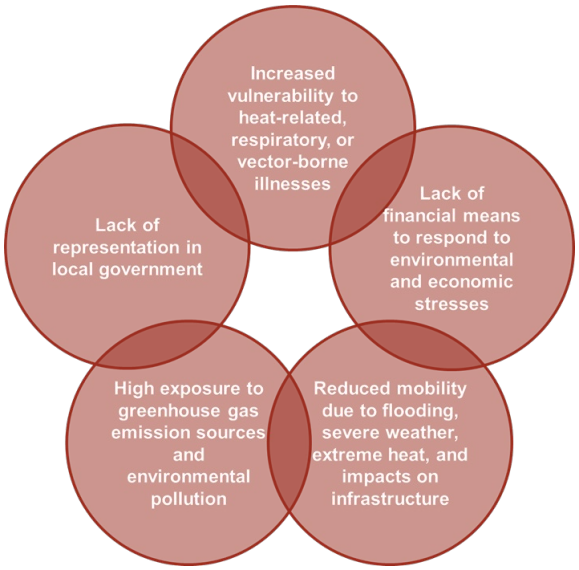


Figure: 5.1 – Common Risk Factors of Populations Vulnerable to Climate Change Source: CDC[2]

Climate Change and Natural Hazards

Climate change is defined as a long-term hazard which can increase or decrease the risk of other weather hazards. It directly endangers property due to sea level rise and biological organisms due to habitat destruction. More information on how climate change is affecting each state can be found at the website State Climate Summaries[3] but is subject to change; there are also other websites for climate change information.

Global climate change is expected to exacerbate the risks of certain types of natural hazards impacted through rising sea levels, warmer ocean temperatures, higher humidity, the increased frequency of stronger storms, and an increase in wind and flood damages due to storm surges. More information on the global impact can be found at the NASA website[4] but is subject to change; there are also other websites for climate change information.

While sea level rise is a natural phenomenon and has been occurring for several thousand years, the general scientific consensus is that the rate has increased in the past 200 years, from 0.5 millimeters per year to 2 millimeters per year. More information about the projection of the rising of the sea levels can be found at the website for the National Oceanic Atmospheric Administration (NOAA)[5] but is subject to change; there are also other websites for climate change information.

Texas is considered one of the more vulnerable states in the U.S. to both abrupt climate changes and to the impact of gradual climate changes to the natural and built environments. Mega-droughts can trigger abrupt changes to regional ecosystems and the water cycle, drastically increase extreme summer temperature and fire risk, and reduce availability of water resources, as Texas experienced during 2011-2015[6]. More information on understanding what climate change can mean for Texas and the planning area can be found through the United States Environmental Protection Agency on their website[7] but is subject to change; there are also other websites for climate change information.

Paleoclimate records also show that the climate over Texas had large changes between periods of frequent mega-droughts and the periods of mild droughts that Texas experienced throughout 2023. While the cause of these fluctuations is unclear, it would be wise to anticipate that such changes could occur again and may even be occurring now[6].

Climate change in and of itself is not necessarily a hazard, but it may increase the frequency and/or intensity of identified hazards over time. Climate change could affect communities in a variety of ways, but it is currently unclear what extent the impacts will have on the planning area. It is anticipated that hazard-causing events will fluctuate due to climate change over time. As new information and new models are developed, a climate change risk assessment may be enhanced to measure and assess these impacts more accurately.

Climate Change and Infectious Diseases

Increasing global temperatures due to climate change is contributing to the spread of infectious diseases. Climate change can directly impact infectious disease emergence and reemergence through effects on pathogen survival, vector survival and reproduction, and their animal

reservoirs (i.e., hosts). Milder winters, warmer summers, and fewer days of frost make it easier for infectious diseases to expand to new geographic areas and infect more people. Additionally, climate change-related extreme weather events create circumstances where infectious microorganisms flourish and novel infections emerge[8].

Climate change has forced some animal species into new habitats as their natural habitat disappears, increasing opportunities for contact between humans and animals that can potentially spread zoonotic diseases (e.g., wildlife carrying the rabies virus, spread of deadly diseases, such as Ebola, Lassa, Rift Valley fever, and monkeypox)[8].

Hazard Analysis

Each of the hazard profiles includes a description of a general vulnerability assessment. Vulnerability is the total of assets that are subject to damage from a hazard, based on historic recorded damages.

To better understand how future growth and development in the Brazos County region might affect hazard vulnerability, it is useful to consider population growth, occupied and vacant land, the potential for future development in hazard areas, and current planning and growth management efforts. Hazard vulnerability for all participating entities within Brazos County was reviewed based on recent development changes that have occurred throughout the planning area.

Focus on Critical Infrastructure

This hazard mitigation plan focuses on critical infrastructure as this is the most cost-effective way to mitigate effects on assets identified as most important to the community. This infrastructure includes, but is not limited to, facilities critical to emergency operations, facilities with government functions, facilities for vulnerable populations, and locations of economic or cultural value.

For most hazards addressed in this plan, the highest potential for significant damage exists at critical facilities located in flood-prone areas. Critical facilities in the path of a tornado or nearby pipelines may also sustain considerable damage.

Priority Risk Index Definitions

The Priority Risk Index is increasingly used as a methodology for quantifying jurisdictional risk for hazard mitigation action planning purposes, and it can evolve to meet specific community needs. The index incorporates probability, impact, spatial extent, warning time, and duration when assessing each hazard, but it does not explicitly integrate a vulnerability and consequence analysis into its final scoring[9].

The definitions on the table below (Table: 5.1) were developed by the Brazos County Hazard Mitigation Team. Table 5.2 shows the planning entities and their priority risk index.

PRI Category	Degree of Risk			Assigned Weighting Factor
	Level	Criteria	Index Value	
Probability	Unlikely	Less than 1% annual probability	1	30%
	Possible	Between 1 and 10% annual probability	1	
	Likely	Between 10 and 100% annual probability	2	
	Highly Likely	100% annual probability	3	
Impact (Impact is subdivided into 3 categories: social impact, property impact, and CIKR impact)	Minor	Very few injuries, if any. Only minor property damage and minimal disruption to quality of life. Temporary shutdown of critical facilities.	4	30%
	Limited	Minor injuries only. More than 10% of property in affected area damaged or destroyed. Complete shutdown of critical facilities for more than one day.	1	
	Critical	Multiple deaths/injuries possible. More than 25% of property in affected areas was damaged or destroyed. Complete shutdown of critical facilities for more than one week.	2	
	Catastrophic	High number of deaths/injuries possible. More than 50% of property in affected area damaged or destroyed. Complete shutdown of critical facilities for 30 days or more	3	
Spatial extent	Negligible	Less than 1% of area affected	1	20%
	Small	Between 1 and 10% of area affected	2	
	Moderate	Between 10 and 50% of area affected	3	
	Large	Between 50 and 100% of area affected	4	
Warning Time	More than 24 hours	Self-explanatory	1	10%
	12 to 24 hours	Self-explanatory	2	
	6 to 24 hours	Self-explanatory	3	
	Less than 6 hours	Self-explanatory	4	
Duration	Less than 6 hours	Self-explanatory	1	10%
	Less than 24 hours	Self-explanatory	2	
	Less than one week	Self-explanatory	3	
	More than one week	Self-explanatory	4	

Table: 5.1 – Priority Risk Index Definitions Source: Brazos County HMAP (2019-2024)[10]

	PROBABILITY	EXTENT	IMPACT					DURATION	WARNING TIME	PRI
			Social Impact		Property Impact	CIKR Impact		Incident Exposure		
	Probability	Spatial Extent	Historical Human	Possible Human	Extent of Damage	Duration of Shutdown	Average Impact	Duration of Exposure	Warning Time	Priority Risk Index
Weights	0.3	0.2					0.3	0.1	0.1	
Brazos County	P1: Prob	S1: Extent	H1: Extent	H2: Number	Pr1: Extent	CI1: Shutdown	Severity	D1: Duration	W1: Warning	PRI
Flood	3	3	2	4	4	2	3.00	3	3	3
Drought	3	4	1	1	2	1	1.25	4	1	2.575
Urban and Wildland Fires	4	1	1	1	2	1	1.25	1	4	2.275
Winter Storms	1	4	2	1	1	1	1.25	2	3	1.975
Tornados	1	2	1	3	3	3	2.50	1	4	1.95
Hail	3	2	1	1	2	1	1.25	1	4	2.175
Thunderstorms	4	3	1	1	2	1	1.25	2	3	2.675
Dam Failure	1	2	1	4	4	4	3.25	3	3	2.275
Excessive Heat	1	4	2	2	1	1	1.50	4	1	2.05
Infectious Diseases	1	4	3	3	1	3	3.00	4	1	2.575
City of Bryan	P1: Prob	S1: Extent	H1: Extent	H2: Number	Pr1: Extent	CI1: Shutdown	Severity	D1: Duration	W1: Warning	PRI
Flood	3	3	2	4	4	2	3.00	3	3	3
Drought	3	4	1	1	2	1	1.25	4	1	2.575
Urban and Wildland Fires	4	1	1	1	2	1	1.25	1	4	2.275
Winter Storms	1	4	2	1	1	1	1.25	2	3	1.975
Tornados	1	2	1	3	3	3	2.50	1	4	1.95
Hail	3	2	1	1	2	1	1.25	1	4	2.175
Thunderstorms	4	3	1	1	2	1	1.25	2	3	2.675
Dam Failure	1	2	1	4	4	4	3.25	3	3	2.275
Excessive Heat	1	4	2	2	1	1	1.50	4	1	2.05
Infectious Diseases	1	4	3	3	1	3	3.00	4	1	2.575
City of College Station	P1: Prob	S1: Extent	H1: Extent	H2: Number	Pr1: Extent	CI1: Shutdown	Severity	D1: Duration	W1: Warning	PRI
Flood	3	3	2	4	4	2	3.00	3	3	3
Drought	3	4	1	1	2	1	1.25	4	1	2.575
Urban and Wildland Fires	4	1	1	1	2	1	1.25	1	4	2.275
Winter Storms	1	4	2	1	1	1	1.25	2	3	1.975
Tornados	1	2	1	3	3	3	2.50	1	4	1.95
Hail	3	2	1	1	2	1	1.25	1	4	2.175
Thunderstorms	4	3	1	1	2	1	1.25	2	3	2.675
Dam Failure	1	2	1	4	4	4	3.25	3	3	2.275
Excessive Heat	1	4	2	2	1	1	1.50	4	1	2.05
Infectious Diseases	1	4	3	3	1	3	3.00	4	1	2.575
City of Kurten	P1: Prob	S1: Extent	H1: Extent	H2: Number	Pr1: Extent	CI1: Shutdown	Severity	D1: Duration	W1: Warning	PRI
Flood	3	3	2	4	4	2	3.00	3	3	3
Drought	3	4	1	1	2	1	1.25	4	1	2.575
Urban and Wildland Fires	4	1	1	1	2	1	1.25	1	4	2.275
Winter Storms	1	4	2	1	1	1	1.25	2	3	1.975
Tornados	1	2	1	3	3	3	2.50	1	4	1.95
Hail	3	2	1	1	2	1	1.25	1	4	2.175
Thunderstorms	4	3	1	1	2	1	1.25	2	3	2.675
Dam Failure	0	0	0	0	0	0	0.00	0	0	0
Excessive Heat	1	4	2	2	1	1	1.50	4	1	2.05
Infectious Diseases	1	4	3	3	1	3	3.00	4	1	2.575
City of Wixon Valley	P1: Prob	S1: Extent	H1: Extent	H2: Number	Pr1: Extent	CI1: Shutdown	Severity	D1: Duration	W1: Warning	PRI
Flood	3	3	2	4	4	2	3.00	3	3	3
Drought	3	4	1	1	2	1	1.25	4	1	2.575
Urban and Wildland Fires	4	1	1	1	2	1	1.25	1	4	2.275
Winter Storms	1	4	2	1	1	1	1.25	2	3	1.975
Tornados	1	2	1	3	3	3	2.50	1	4	1.95
Hail	3	2	1	1	2	1	1.25	1	4	2.175
Thunderstorms	4	3	1	1	2	1	1.25	2	3	2.675
Dam Failure	0	0	0	0	0	0	0.00	0	0	0
Excessive Heat	1	4	2	2	1	1	1.50	4	1	2.05
Infectious Diseases	1	4	3	3	1	3	3.00	4	1	2.575
TAMU	P1: Prob	S1: Extent	H1: Extent	H2: Number	Pr1: Extent	CI1: Shutdown	Severity	D1: Duration	W1: Warning	PRI
Flood	3	1	1	4	4	4	3.25	2	2	2.475
Drought	1	4	1	1	1	1	1.00	4	1	1.9
Urban and Wildland Fires	2	1	1	1	1	1	1.00	1	1	1.3
Winter Storms	1	4	1	1	1	1	1.00	2	1	1.7
Tornados	1	3	1	3	3	3	2.50	2	4	2.25
Hail	2	3	1	1	1	1	1.00	1	3	1.9
Thunderstorms	3	4	1	1	1	1	1.00	1	3	2.4
Dam Failure	1	1	1	4	4	4	3.25	1	1	1.675
Excessive Heat	1	4	1	1	1	1	1.00	4	1	1.9
Infectious Diseases	1	4	3	3	1	3	3.00	4	1	2.575

Table: 5.2 – Priority Risk Index by Planning Index Source: Brazos County HMAP (2019-2024)[10]

All Values of Infectious Disease Risk Categories are standard amongst Brazos County, City of Bryan, City of College Station, City of Kurten, City of Wixon Valley, and TAMU.

Due to the mechanisms, and nature of Infectious Diseases

Justification – Probability (1)

According to the Brazos County Health District's epidemiology team Dr. Yao Akpalu, Dr. Ed Davila, the probability of infectious disease outbreak is "1". This suggests that there is a possibility of an outbreak of infectious disease within the area. Due to climate change, favorable survival conditions for infectious diseases have increased the odds of their spread[13]. This statement underscores the importance of public health surveillance, effective interventions, vaccination programs, and community awareness[13].

Justification – Spatial Extent (4)

According to the Brazos County Health District's epidemiology team, the spatial extent of an infectious disease outbreak is "4". In a study published by the CDC, Smith, and Mennis (2020) argue that the spread of infectious disease is a spatial process. Since an infectious disease is not tied down to one physical location, it can become widespread[15].

Justification – Historical Human/Possible Human (3)

The social impact of an infectious disease, rated as "3" by the Brazos County Health District's epidemiology team, indicates a significant level of disruption. Both the historical human and possible human impact is rated at a "3". In a study published by the CDC, Sharma et al. (2020) highlights the social effects of COVID-19[14]. According to Sharma et al. (2020), COVID-19 not only caused physical harm to many individuals, it also further destabilized individuals who were already struggling with the economic crisis that the infectious disease had caused[14]. Unemployment significantly increased, 11.5 million individuals within the first months of lockdown due to the infectious disease[14]. Additionally, Sharma et al. (2020) noted a significant decrease in food insecurity during the pandemic[14]. These findings highlight the profound effects of infectious disease on social determinants of health[14].

Justification – Property Impact (1)/ CIKR Impact (3)

According to the Brazos County Health District's epidemiology team, the property impact of an infectious disease is "1". This suggests a limited risk of damage to property. However, the major risk with infectious diseases lies within critical infrastructure. Brazos County Health District's epidemiology team rated the CIKR (Critical Infrastructure and Key Resources) impact of an infectious disease as "3". Using COVID-19 as a recent example of a widespread infectious disease, it is evident that there was a heavy burden on critical infrastructure. In a study published by the CDC, French (2021), explored the impacts on critical infrastructure[12]. French (2021) highlighted that surge in COVID-19 cases resulted in stressed hospital systems, negatively affected public health and health care, and degraded national critical systems[12]. French (2021) explored the effects on ICU care wards, noting that across the nation ICU wards had exceeded 75% critical capacity[12]. This burden critically strained the health care system and disrupted many individuals from receiving care from other conditions[12].

Justification – Duration (4) / Warning (1)

According to Brazos County Health District's epidemiology team, the duration of an infectious disease is rated at "4". According to U.S. Department of Defense (2023), the incidence of exposure lasted far more than a week[16]. The Brazos County Health District's epidemiology team designated the warning to be "1". According to AJMC Staff (2021) there was a significant warning period where the WHO (World Health Organization) declared the appearance of the infectious disease and the subsequent emergence of cases within the United States[11].

References – Section 5

1. *National Centers for Environmental Information (NCEI) and National Oceanic and Atmospheric Administration (NOAA). Data. https://www.ncei.noaa.gov/*
2. *Centers for Disease Control and Prevention. Populations and Vulnerabilities. https://www.cdc.gov/nceh/tracking/topics/PopulationsVulnerabilities.htm*
3. *NCICS. State Climate Summaries. https://statesummaries.ncics.org/*
4. *NASA. Understanding Our Planet. Global Climate Change. https://climate.nasa.gov/*
5. *National Oceanic and Atmospheric Administration. Sea Level Rising. https://oceanservice.noaa.gov/*
6. *Water Data for Texas. Texas Reservoirs. https://www.waterdatafortexas.org/reservoirs/statewide*
7. *US Environmental Protection Agency. Regulations. https://www.epa.gov/*
8. *World Health Organization. Climate Change. https://www.who.int/health-topics/climate-change#tab=tab_1*
9. *Harris, J., Bartlett, G., Joyner, T.., Hart, M., & Tollefson, W. (2021). Modification of the Priority Risk Index: Adapting to Emergency Management Accreditation Program standards for institutes of higher learning hazard mitigation plans. Journal of emergency management (Weston, Mass.), 19(2), 165–171. https://doi.org/10.5055/jem.0568*
10. *Brazos County HMAP (2019-2024). Main Page. https://bcdem.org/emergency/plans*
11. *AJMC Staff. (2021, January 1). A Timeline of COVID-19 Developments in 2020. Retrieved from AJMC website: https://www.ajmc.com/view/a-timeline-of-covid19-developments-in-2020.*
12. *French, G. (2021). Impact of Hospital Strain on Excess Deaths During the COVID-19 Pandemic — United States, July 2020–July 2021. MMWR. Morbidity and Mortality Weekly Report, 70(46). https://doi.org/10.15585/mmwr.mm7046a5*
13. *Healthy People 2030. (2020). Social determinants of health. Retrieved from Healthy People 2030 website: https://health.gov/healthypeople/priority-areas/social-determinants-health.*
14. *Sharma, S. V., Chuang, R.-J., Rushing, M., Naylor, B., Ranjit, N., Pomeroy, M., & Markham, C. (2020). Social Determinants of Health–Related Needs During COVID-19 Among Low-Income Households with Children. Preventing Chronic Disease, 17(17). https://doi.org/10.5888/pcd17.200322.*
15. *Smith, C. D., & Mennis, J. (2020). Incorporating Geographic Information Science and Technology in Response to the COVID-19 Pandemic. Preventing Chronic Disease, 17(Volume 17). https://doi.org/10.5888/pcd17.200246*
16. *U.S. Department of Defense. (2023, April 19). Coronavirus: Timeline. Retrieved from U.S. Department of Defense website: https://www.defense.gov/Spotlights/Coronavirus-DOD-Response/Timeline/.*

This page intentionally left blank.

Section 6 – Flood

Hazard Description

Brazos County is in a state particularly vulnerable to flooding due to several factors: miles of the Gulf of Mexico coastline; the proximity to the Pacific Ocean off the west coast of Mexico; the geographical location near the Rocky Mountains of Colorado and Arizona; the high-altitude jet stream; and the nearness to the unique West Texas "dry line", a shifting invisible atmospheric separation of dry desert air from the moist Gulf air[1].

These factors create a breeding ground for the big storms of spring and fall that spawn tornadoes and suck up Gulf or Pacific moisture that feed the heavy rains that cause flash flooding. All these geographic factors can cause Texas to experience extensive storms. Flooding takes many forms in the planning area[1].

Flooding occurs in seasonal patterns when warm, moist air collides with cool, dry air. The most common time for flooding is in the spring (April through June) and the fall (October through December). Flash, ravine, and urban flooding events can cause substantial impacts to the planning area including loss of life, injuries, temporary or permanent loss of critical infrastructure, and personal property damage.

Types of Flooding

Flash Flooding

Flash flooding is caused by slow-moving thunderstorms, repeated storms in one area, or heavy rains caused by tornados or hurricanes. Flooding can occur within minutes to hours of excessive rainfall. Often there are no warnings for flash floods[2].

Riverine Flooding

Riverine flooding is a natural occurrence. It is the overbank flooding of rivers, streams, and creeks; typically occurring when large scale weather systems generate prolonged rainfall. Some riverine flooding occurs because of winter and spring runoff, and the river, creek, and stream basins fill too quickly[2].

Urban Flooding

Urban flooding occurs in areas that were once fields or woodlands that are now converted into roadways, housing developments, parking lots, and buildings. These conversions force the natural hydraulic systems within a basin to fail, allowing runoff two to six times more than

QUICK FACTS

FEMA Repetitive Loss List

Brazos County: 4
Bryan: 37
College Station: 3
Wixon Valley: 0
Kurten: 0

FEMA Severe Repetitive Loss List

Brazos County: 0
Bryan: 3
College Station: 0
Wixon Valley: 0
Kurten: 0

Critical Facilities and Infrastructure at Risk in Brazos County

Total: 298
Inside 100-year flood plain: 129
Susceptible to flooding: 43.29%

Deadliest Flooding Event in Brazos County:

October 17, 1998 – 1 death

Costliest Flooding Events in Brazos County:

Aug. 2017: $15m
Oct. 1994: $5m
Oct. 1998: $2.5m
May 2004: $250k
May 2007: $130k
Feb. 2012: $100k
May 2016: $100k

Source: Brazos County CEOC[12]

natural terrain. Urban flooding can cause roadways to become swift moving rivers and underground parking garages and underpasses to become inundated and filled with water[2].

Hazardous Areas

Areas most prone to flooding are determined through analysis of the following:

- Analysis of river flow, storm tide, and rainfall records.
- Floodplain, stream, and river topography and physiography.
- Hydrologic and hydraulic analysis.

FEMA maintains Flood Insurance Rate Maps (FIRMs)[3] which identify hazardous areas including Special Flood Hazard Areas (areas within the 100-year flood plain) and Moderate Flood Hazard Areas (areas within the 500-year flood plain)[3]. The location of flood hazard areas for Brazos County and participating entities are shown in Figure: 6.1. The following map identifies flood zones throughout the planning area with potential for loss of life and/or property damage.

Areas along the Brazos River on the west side of the county and along the Navasota River on the east side of the county are the most vulnerable to *riverine* flooding events[3].

A property's vulnerability to a flood depends on its location and proximity to the floodplain[3]. Structures that lie along banks of a waterway are the most vulnerable and are often repetitive loss structures. The County and all participating entities encourage development outside of the floodplain, and the impact for flood for the entire planning area is limited as facilities and services would be shut down for 24 hours or less, depending on the scale of the storm.

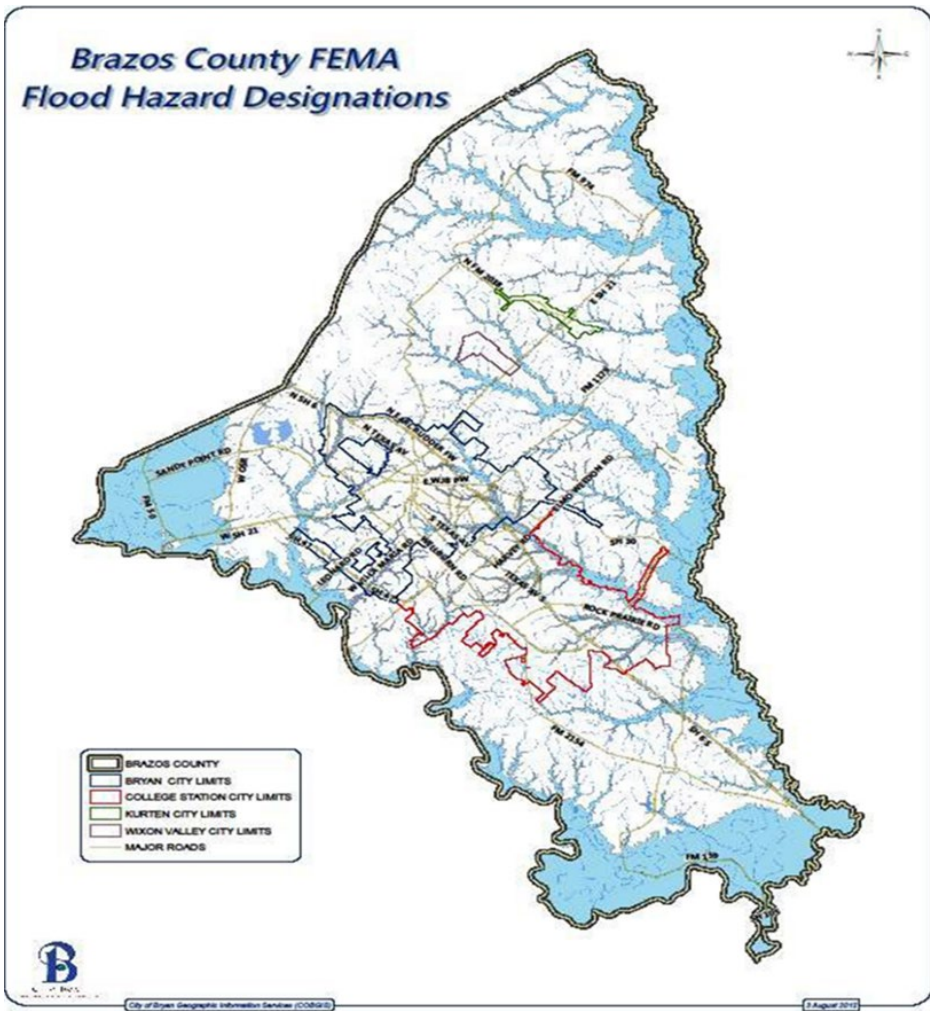


Figure: 6.1 – Flooding Potential for Planning Area Source: FEMA[3]

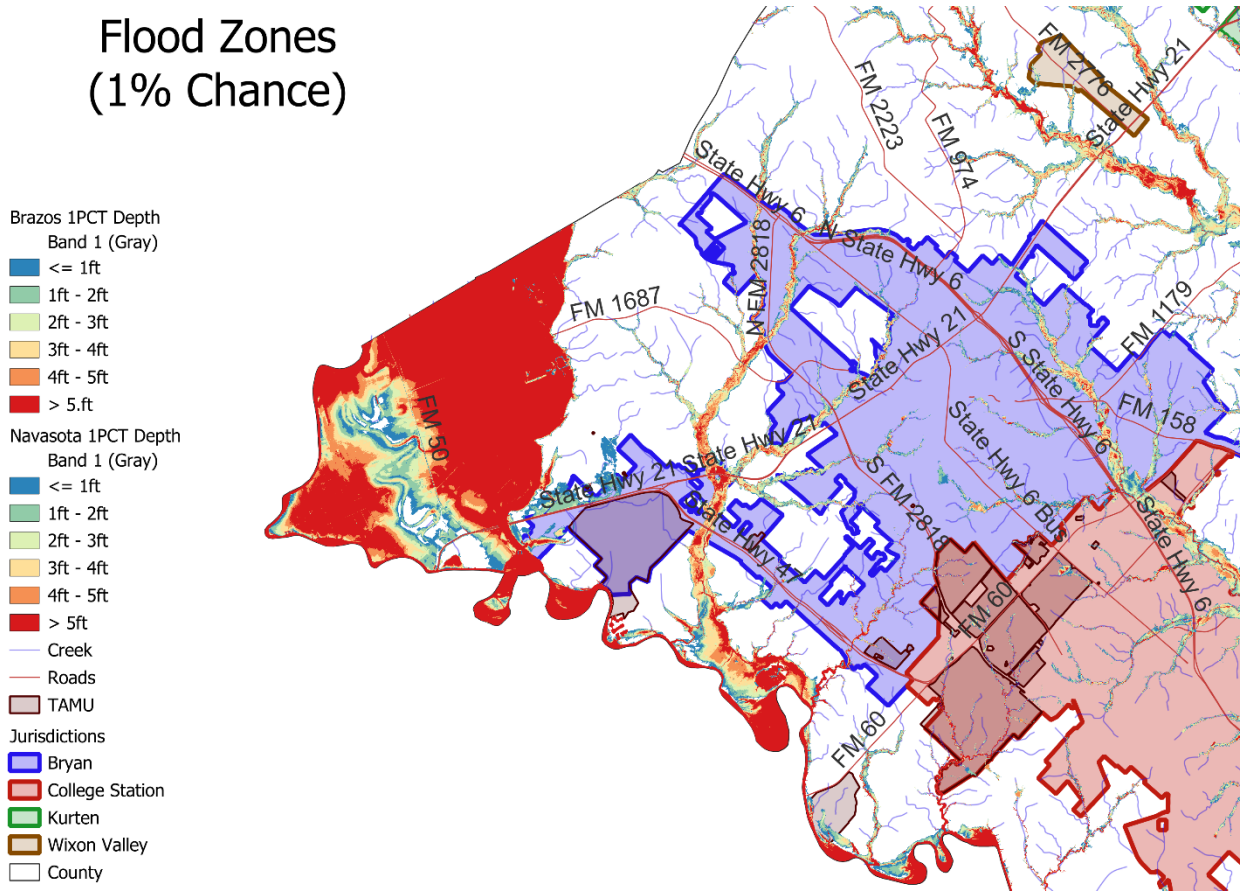


Figure 6.2- Brazos County 1% Flood Zones to include the cities of Bryan, College Station and TAMU Source: FEMA

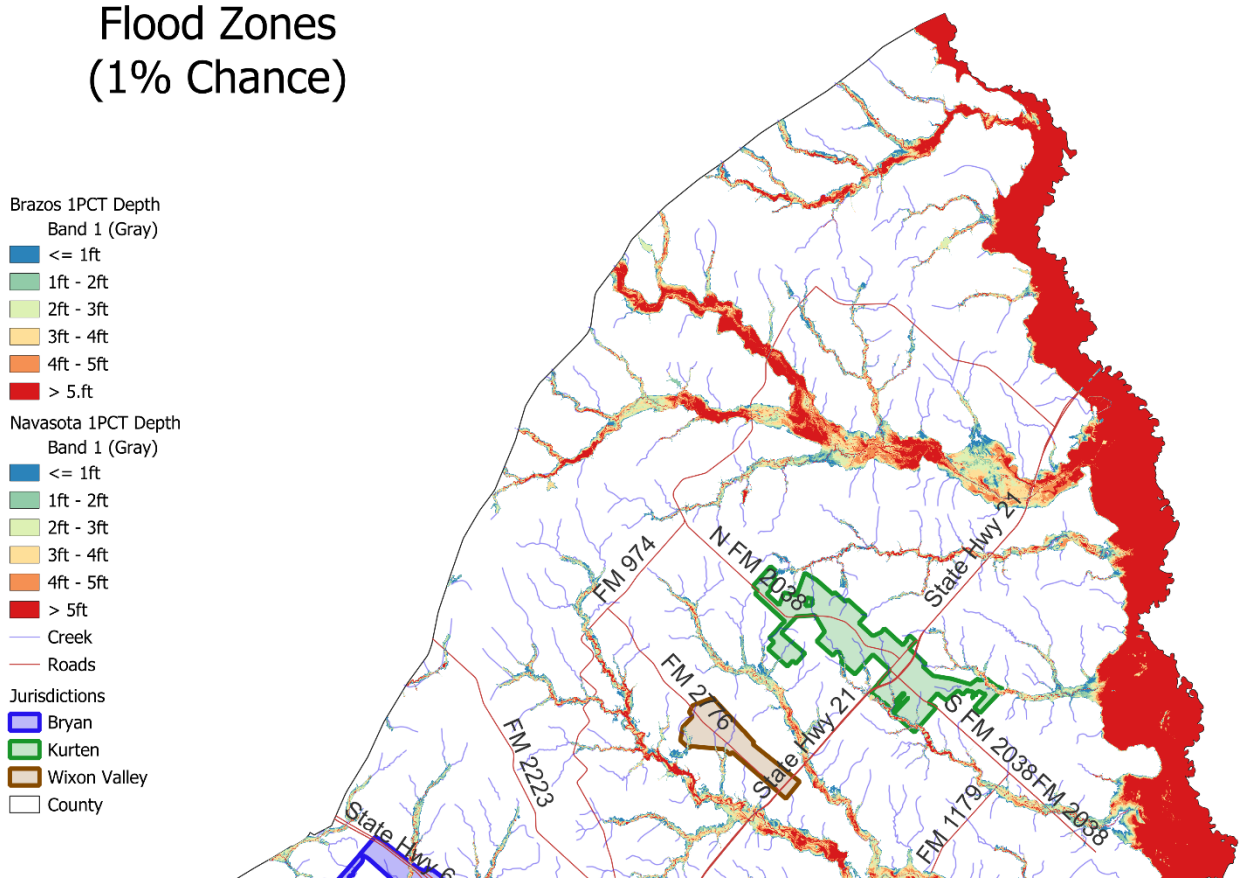


Figure 6.3 – Brazos County 1% Flood Zones to include the cities of Kurten and Wixon Valley Source: FEMA

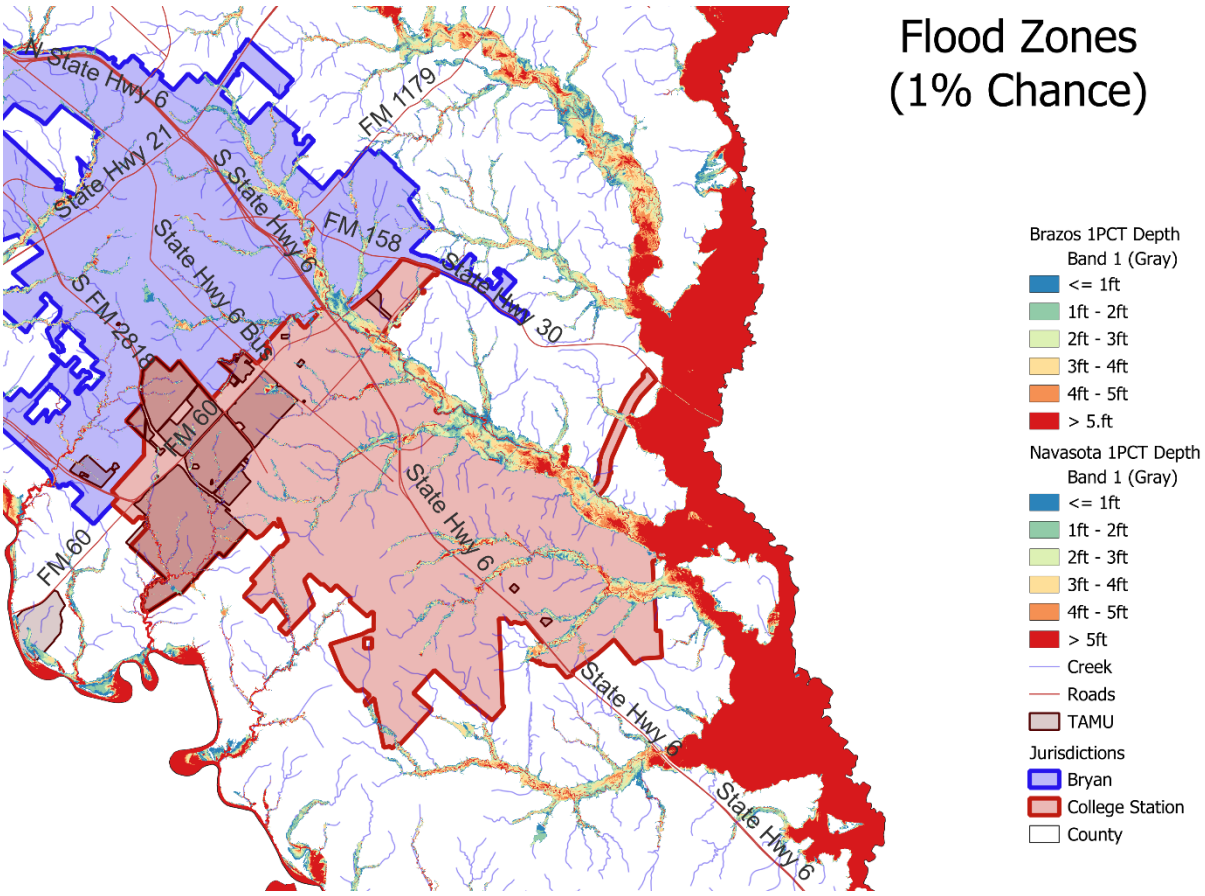


Figure 6.4- Brazos County 1% Flood Zones to include College Station Source: FEMA

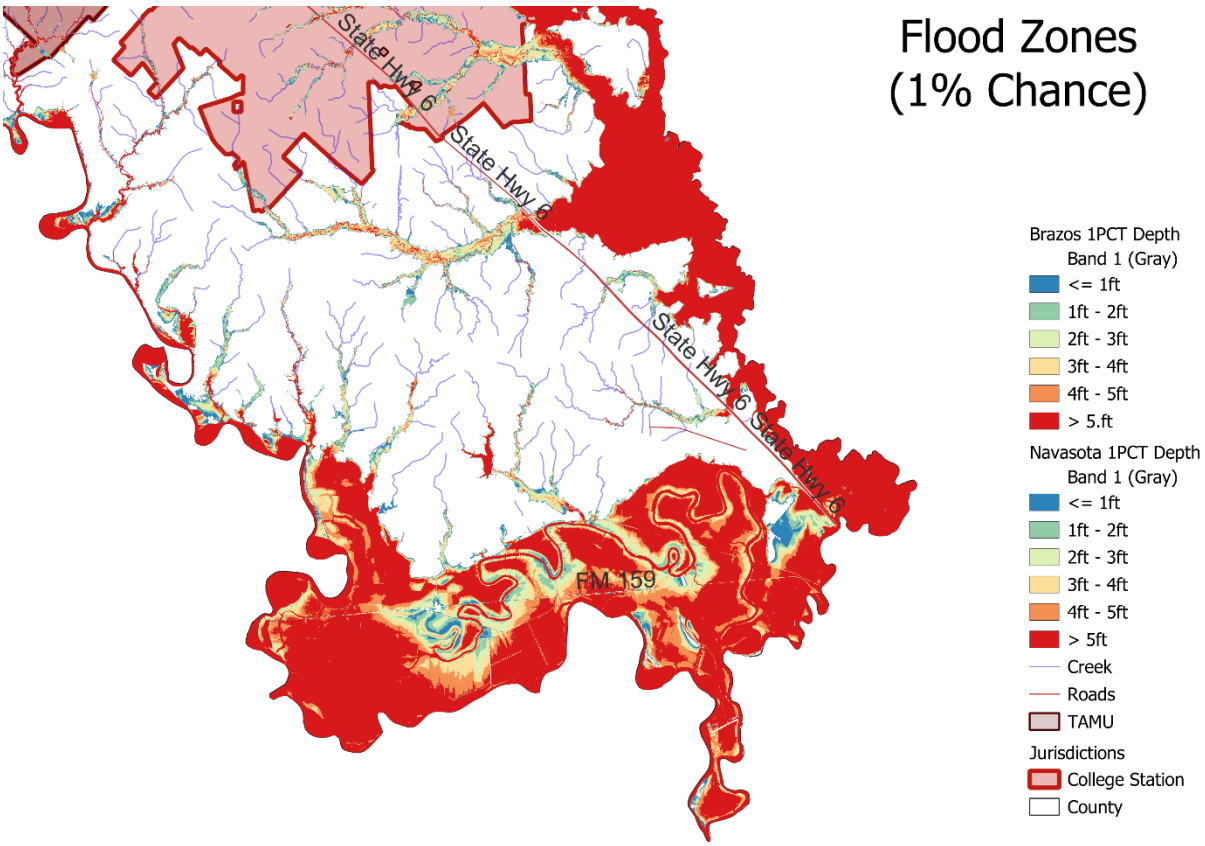


Figure 6.5- Brazos County 1% Flood Zones Sothern Brazos County Source: FEMA

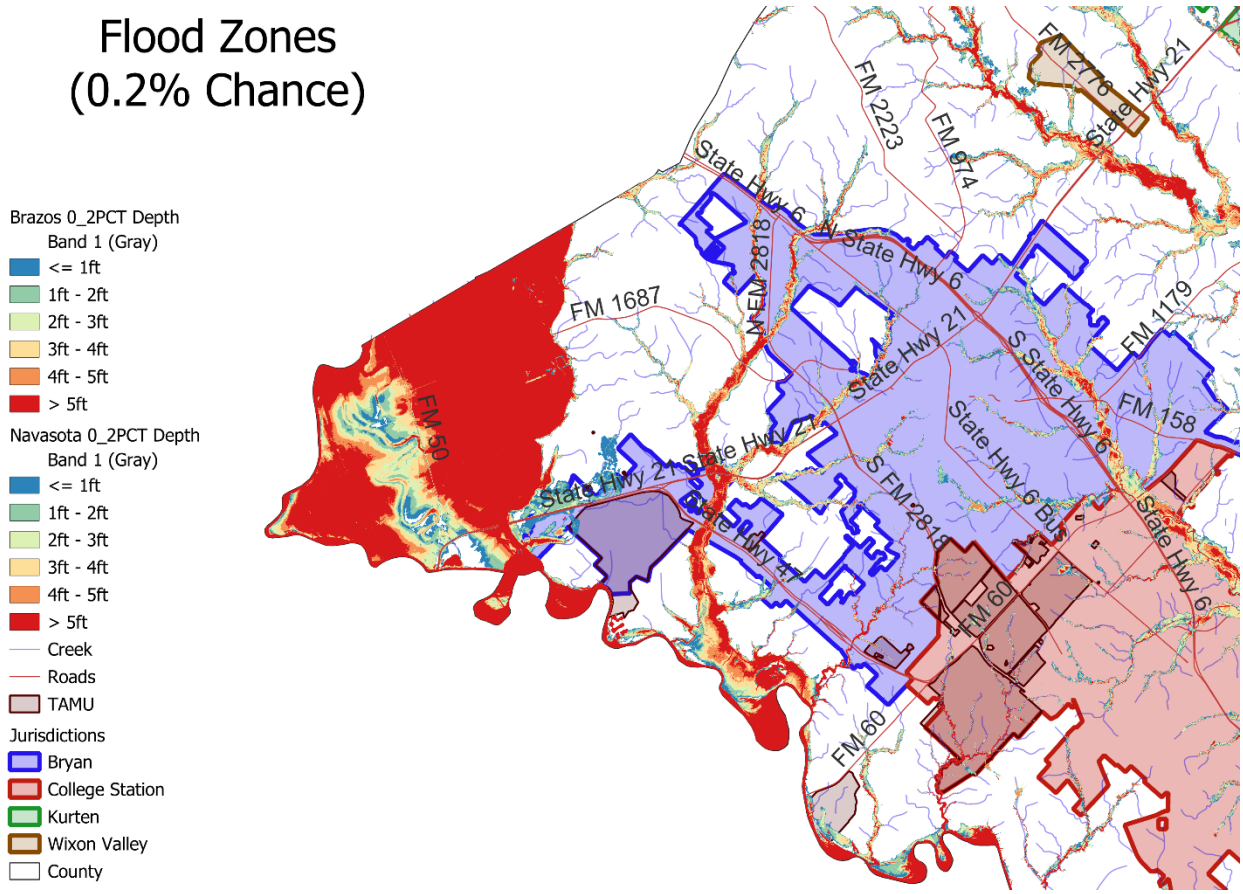


Figure 6.6- Brazos County 0.2% Flood Zones to include the cities of Bryan, College Station and TAMU
Source: FEMA

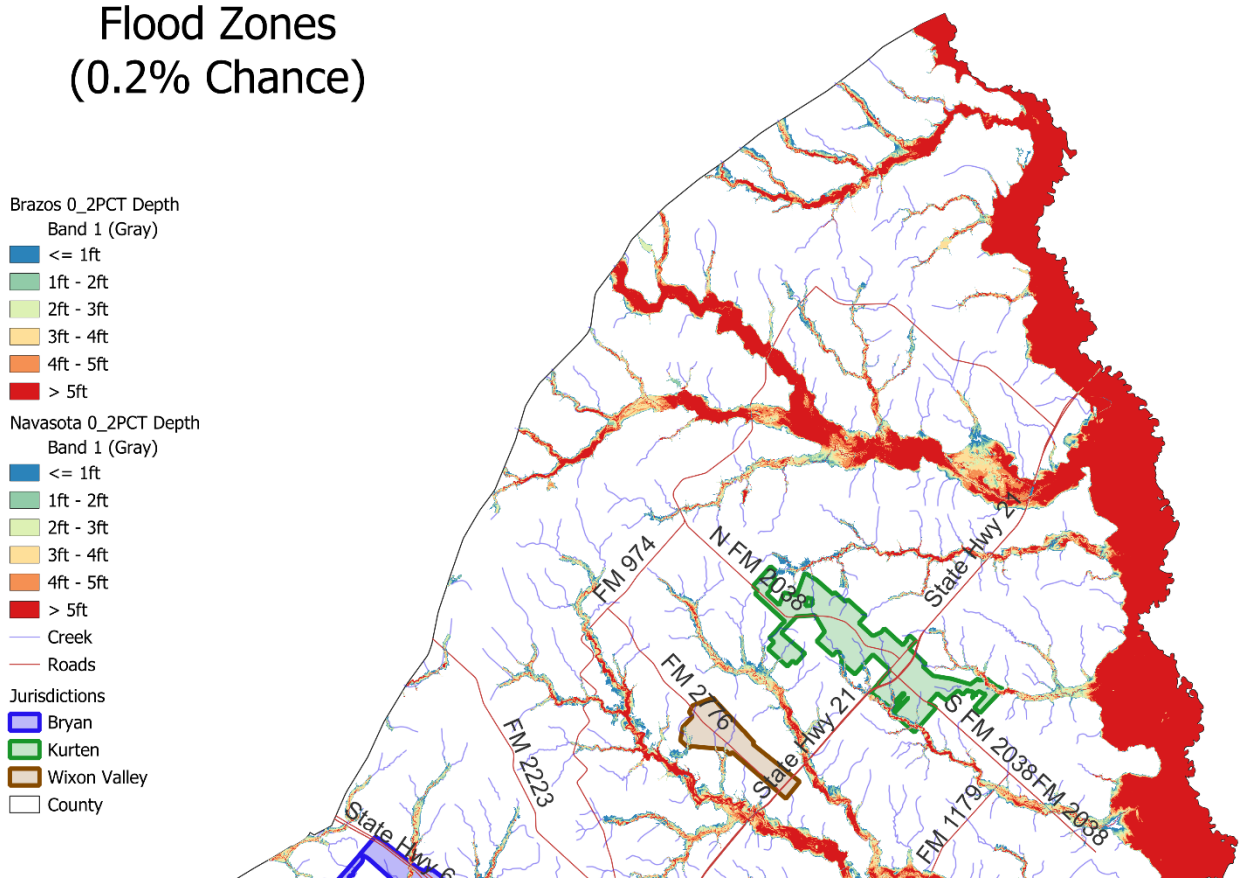


Figure 6.7 – Brazos County 0.2% Flood Zones to include the cities of Kurten and Wixon Valley Source: FEMA

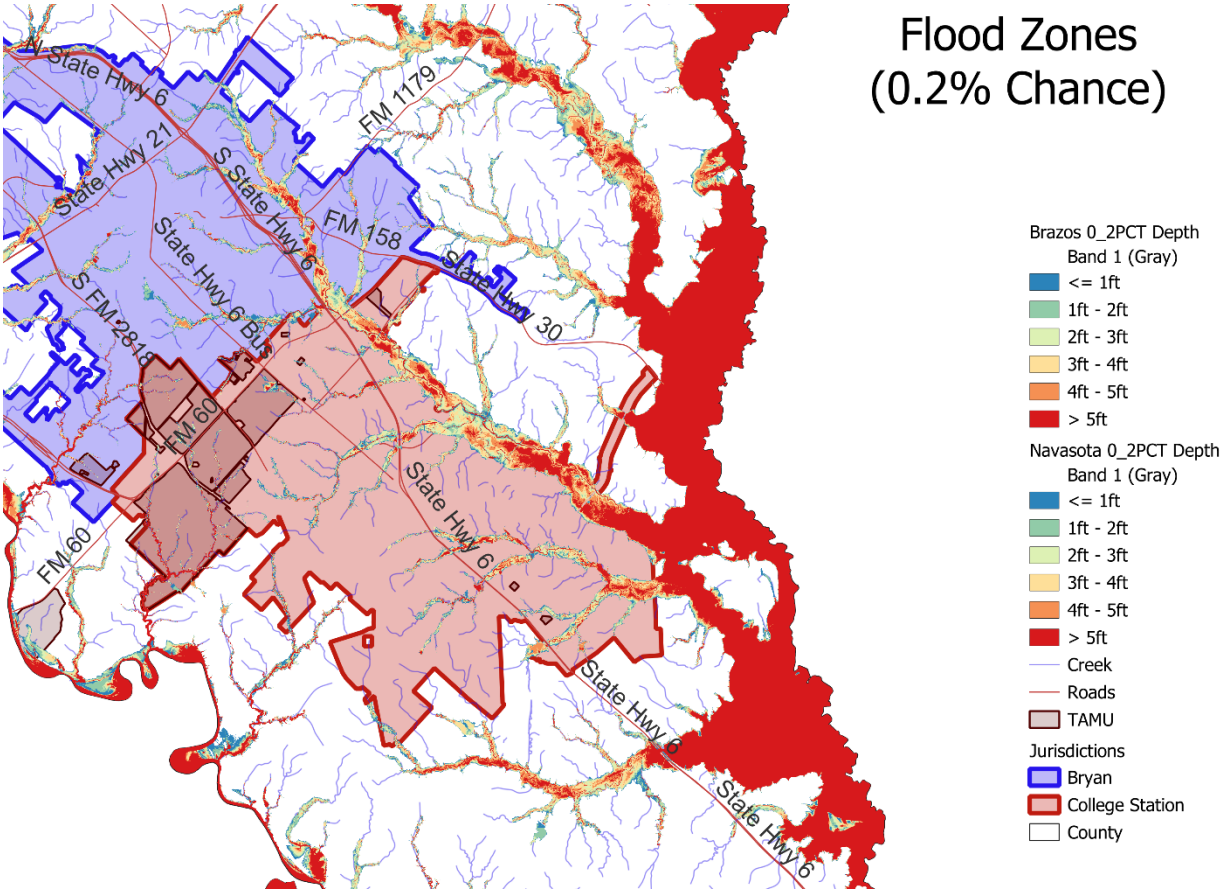


Figure 6.8- Brazos County 0.2% Flood Zones to include College Station Source: FEMA

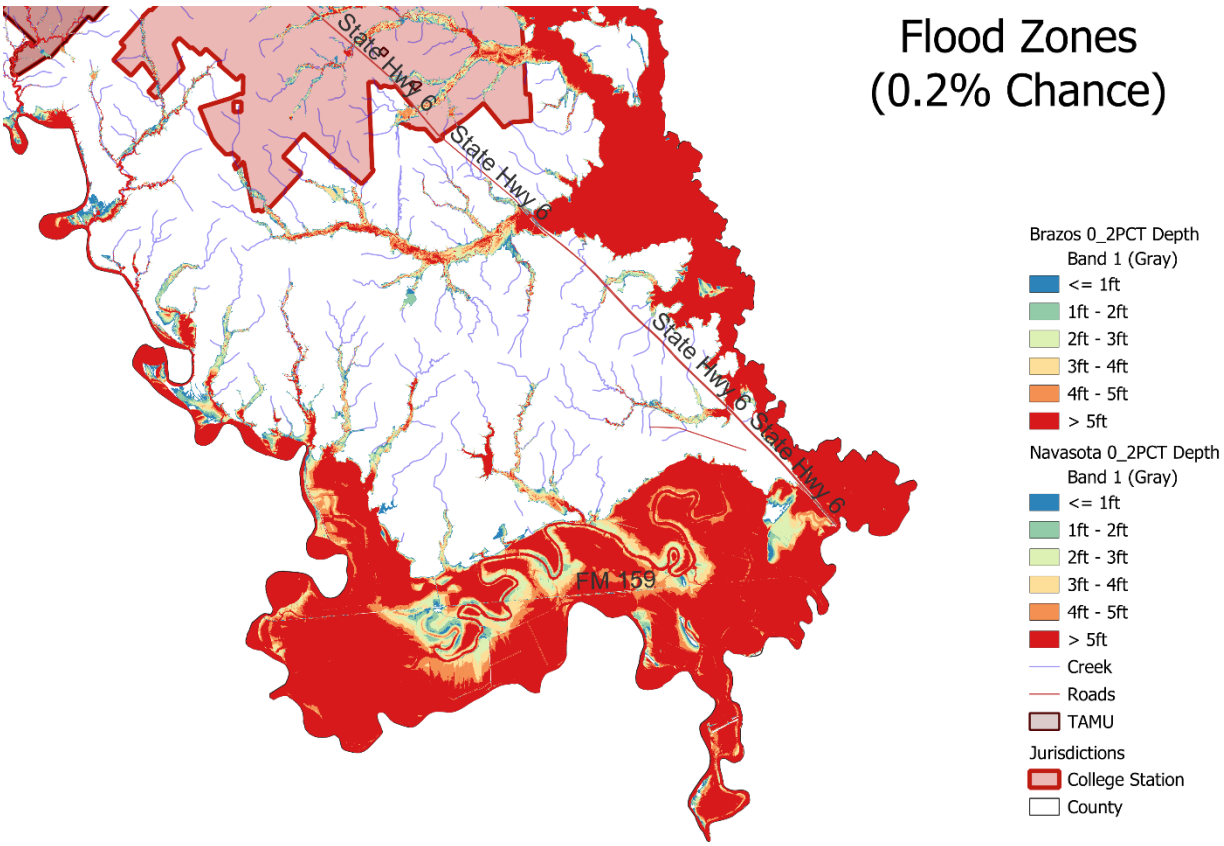


Figure 6.9- Brazos County 0.2% Flood Zones Sothern Brazos County Source: FEMA

Major flooding and flash flooding events can have a substantial severity of impact to Brazos County and the participating entities. They can cause multiple deaths, shut down facilities for thirty days or more, and cause more than fifty percent of affected properties to be destroyed or suffer major damage[3]. The frequency of occurrence of flooding in the planning area is likely. Brazos County and participating entities have infrastructure and critical facilities that are vulnerable to floods. There are also residential structures that are vulnerable to flooding, and mitigation actions regarding those structures are addressed in Section 16 of this plan.

Previous Occurrences

From January 1, 1994, through 2017, Brazos County has experienced more than 40 flooding incidents including flash flooding. A complete list of these events, as sourced from the National Weather Service[4], is in Table: 6.1.

Type	Location	Date	Deaths	Injuries	Property Damage ($)	Crop Damage ($)
Flash flooding	Brazos	10/16/1994	0	0	$5.0M	$50K
Flash flooding/ flood	Brazos	12/15/1994	0	0	50K	5K
Flash flood	Bryan/ College Station	09/21/1995	0	0	5K	0
Flash flood	Countywide	02/20/1997	0	0	5K	0
Flash flood	North Portion	10/13/1997	0	0	5K	0
Flash flood	College Station	01/06/1998	0	0	5K	0
Flash flood	College Station	10/17/1998	0	0	5K	0
Flooding, riverine	County	10/17/1998	1	0	0	0
Flash flood	College Station	10/18/1998	0	0	2K	0
Flash flood	Countywide	10/18/1998	0	0	15K	0
Flooding, riverine	County	11/12/1998	0	0	0	0
Flash flood	Countywide	11/02/2000	0	0	1.0M	0
Flash flood	Countywide	11/03/2000	0	0	25K	0
Flash flood	Countywide	11/03/2000	0	0	25K	0
Flash flood	Countywide	11/03/2000	0	0	1.0M	0
Flash flood	Countywide	09/09/2001	0	0	50K	0
Flash flood	Bryan	07/14/2002	0	0	20K	0
Flash flood	Countywide	11/04/2002	0	0	95K	0
Flash flood	Countywide	02/20/2003	0	0	8K	0
Flash flood	Bryan	05/13/2004	0	0	250K	0
Flash flood	College Station	06/15/2004	0	0	55K	0
Flash flood	Bryan	06/30/2004	0	0	15K	0
Flash flood	Countywide	11/22/2004	0	0	0	0

Flash flood	Bryan	05/01/2007	0	0	130K	0
Flash flood	Countywide	12/15/2007	0	0	5K	0
Flash flood	Bryan	04/25/2009	0	0	1K	0
Flash flood	Bryan	06/09/2010	0	0	1K	0
Flash flood	College Station	06/09/2010	0	0	0	0
Flash flood	College Station	06/09/2010	0	0	0	0
Flash flood	College Station	06/09/2010	0	0	0	0
Flash flood	College Station	06/09/2010	0	0	0	0
Flash flood	College Station	02/03/2012	0	0	100K	0
Flash flood	Bryan (Edge)	02/03/2012	0	0	2K	2K
Flash flood	Bryan	05/09/2013	0	0	10K	0
Flash flood	College Station	09/28/2013	0	0	0	0
Flash flood	Bryan	06/25/2014	0	0	0	0
Flash flood	College Station	07/17/2014	0	0	50K	0
Flash flood	Bryan	09/12/2014	0	0	3K	0
Flash flood	Bryan	05/25/2015	0	0	5K	0
Flash flood	Bryan	10/24/2015	0	0	0	0
Flash flood	College Station	12/27/2015	0	0	0	0
Flash flood	County Wide	05/26/2016	0	0	100K	0
Flood	County Wide	08/24/2017- 08/28/2017	0	0	TBD	0

Table 6.1 – Flooding Incidents in Brazos County Source: National Weather Service[4]

Future Probability

Texas consistently outranks other states in deaths and damage from floods with more than 200 flood-related deaths between 2010 and 2022. From 2012 to 2022, Texas experienced over 500 flash floods as well as three 100-year floods[4].

Based on recorded historical occurrences and extent within the Brazos County planning area, including all participating entities, flooding is highly likely, and an incident will likely occur within the next year. According to Risk Factor, 4,981 properties in Brazos County are likely to be severely affected by flooding over the next 30 years[5].

Climate Change

Projections for two long-term climate scenarios were calculated using Climate Explorer data[6] for number of days with greater than 3 inches of precipitation. One scenario describes a future in which humans stop increasing harmful emissions by 2040 and then continue to reduce emissions

through the end of the century (Lower Emissions)[7]. The second scenario describes a future in which harmful emissions continue to increase through the end of the century (Higher Emissions)[7]. Another source was examined to determine the impacts of climate change on river flooding. The Environmental Protection Agency (EPA)[8] developed an interactive map that examines the historical magnitude and frequency of river flooding in the U.S. since 1965 and climate change indicators during the same time. The data is consistent with the Climate Explorer data in that it shows little to no change in magnitude and frequency for river flooding[8].

However, climate change could influence some or all the factors that contribute to erosion. Several hazards were examined for effects of climate change in other hazard chapters. These hazards each play a unique role in the riverine erosion process. For example, extended periods of drought can cause vegetation root density to decrease and trees to die off during a dry season making the soil more susceptible to erosion and the trees more vulnerable to falling in the stream and creating logjams when a flood eventually comes. With multiple factors influencing riverine erosion to consider, climate change could increase risks of riverine erosion for the Planning Area for the next 80 years[7].

Infectious Disease and Risk

Floodwater contains many things that may harm health. We don't know exactly what is in floodwater at any given point in time[10]. Floodwater can contain:

- Downed power lines.
- Human and livestock waste.
- Household, medical, and industrial hazardous waste (chemical, biological, and radiological).
- Coal ash waste that can contain carcinogenic compounds such as arsenic, chromium, and mercury.
- Other germs and contaminants that can lead to illness.
- Physical objects such as lumber, vehicles, and debris.
- Wild or stray animals such as rodents and snakes can be forced into non-flooded areas.

Exposure to contaminated floodwater can cause:

- Wound infections
- Skin rash
- Gastrointestinal illness
- Tetanus
- Leptospirosis
- Melioidosis (along the Gulf Coast)

It is important to protect yourself from exposure to floodwater regardless of the source of contamination. The best way to protect yourself is to stay out of the water[10].

If you come in contact with floodwater:

- Wash the area with soap and clean water as soon as possible. If you don't have soap or water, use alcohol-based wipes or sanitizer.
- Take care of wounds and seek medical attention if necessary.
- Wash clothes contaminated with flood or sewage water in hot water and detergent before reusing them.

If you must enter floodwater, wear rubber boots, rubber gloves, and goggles[10].

Other hazards that can be introduced during flooding and the receding of floodwater are:

- Unsafe food—Floodwaters contain disease-causing bacteria, dirt, oil, human and animal waste, and farm and industrial chemicals. Their contact with food items, including food crops in agricultural lands, can make that food unsafe to eat. Refrigerated and frozen foods are affected during power outages caused by flooding. Foods in cardboard, plastic bags, jars, bottles, and paper packaging may be unhygienic with mold contamination[10].
- Contaminated drinking and washing water and poor sanitation—Flooding impairs clean water sources with pollutants. The pollutants also saturate into the groundwater. Flooded wastewater treatment plants can be overloaded, resulting in backflows of raw sewage. Private wells can be contaminated by floodwater. Private sewage disposal systems can become a cause of infection if they overflow[10].
- Mosquitoes and animals—Floods provide new breeding grounds for mosquitoes in wet areas and stagnant pools. The public should dispose of dead animals that can carry viruses and diseases only in accordance with guidelines issued by local animal control authorities. Leptospirosis—a bacterial disease associated predominantly with rats (but can be often found in standing water)—often accompanies floods in every country, although the risk is low in industrialized regions unless cuts or wounds have direct contact with disease-contaminated flood waters or animals[10].
- Mental stress and fatigue—People who live through a devastating flood can experience long-term psychological impact. The expense and effort required to repair flood-damaged homes places severe financial and psychological burdens on the people affected. Post-flood recovery can cause anxiety, anger, depression, lethargy, hyperactivity, and sleeplessness. There is also a long-term concern among the affected that their homes could be flooded again in the future[10].

Current loss estimation models such as Hazus are not equipped to measure public health impacts such as these. Hazus is a nationally standardized risk modeling methodology.[14] Hazus identifies areas with high risk for natural hazards and estimates physical, economic, and social impacts of earthquakes, hurricanes, floods, and tsunamis.[14] The Hazus Program is managed by FEMA.[14] The best preparation for these effects includes awareness that they can occur, education of the public on prevention, and planning to deal with them during responses to flood events[10].

- Poor hygiene.
- Overcrowding in shelters.

Possible Disease Outbreaks

Waterborne diseases:

Norovirus

Norovirus is a very contagious virus that causes vomiting and diarrhea. Anyone can get infected and sick with norovirus. Norovirus is sometimes called the "stomach flu" or "stomach bug". However, norovirus illness is not related to the flu, which is caused by influenza virus[10].

Rotavirus

Rotavirus is a contagious gastrointestinal (GI) infection that causes inflammation of the stomach and intestines (gastroenteritis). This can lead to severe diarrhea and vomiting, especially in young children. Kids tend to get rotavirus during the winter and spring. It spreads when they come in contact with the poop (stool) of someone who has it and then touch their own mouth[10].

Hepatitis A and E

Hepatitis A accounts for 20 percent to 25 percent of hepatitis cases in developed countries. Hepatitis A is usually transmitted through the fecal-oral route, meaning a person somehow ingests contaminated feces from an infected person. If an infected person did not wash his or her hands properly after using the bathroom, the disease may spread from the person's hands. The incubation period is two to six weeks, during which the infected individual is contagious. Another cause of hepatitis A is eating shellfish harvested from contaminated water[10].

Hepatitis E, also called enteric hepatitis (enteric means related to the intestines), is similar to hepatitis A, and more prevalent in Asia and Africa. It is also transmitted through the fecal-oral route. It is generally not fatal, though it is more serious in women during pregnancy and can cause fetal complications. Most patients with hepatitis E recover completely[10].

The prognosis for hepatitis A patients is excellent with self-limiting courses, and recovery is complete. About 85 percent of people with hepatitis A recover within three months, and almost all recover within six months[10].

When hearing about hepatitis A, many people think about contaminated food and water. However, in the United States, hepatitis A is more commonly spread from person to person[15]. Since March 2017, CDC's Division of Viral Hepatitis (DVH) has been assisting multiple state and local health departments with hepatitis A outbreaks, spread through person-to-person contact[15]. The following groups are at highest risk for acquiring HAV infection or developing serious complications from HAV infection in these outbreaks and should be offered the hepatitis A vaccine in order to prevent or control an outbreak[15]:

- People who use drugs (injection or non-injection).
- People experiencing unstable housing or homelessness.

- Men who have sex with men (MSM).
- People who are currently or were recently incarcerated.
- People with chronic liver disease, including cirrhosis, hepatitis B, or hepatitis C.

Cholera

Cholera is an acute, diarrheal illness caused by infection of the intestine with the toxigenic bacterium Vibrio cholerae. An estimated 1.3 to 4 million people around the world get cholera each year and 21,000 to 143,000 people die from it. People who get cholera often have mild symptoms or no symptoms, but cholera can be severe. Approximately 1 in 10 people who get sick with cholera will develop severe symptoms such as watery diarrhea, vomiting, and leg cramps. In these people, rapid loss of body fluids leads to dehydration and shock. Without treatment, death can occur within hours[10].

Cholera bacterium is usually found in water or in foods that have been contaminated by feces (poop) from a person infected with cholera bacteria. Cholera is most likely to occur and spread in places with inadequate water treatment, poor sanitation, and inadequate hygiene[10].

Cholera bacteria can also live in the environment in brackish rivers and coastal waters. Shellfish eaten raw have been a source of infection. Rarely, people in the U.S. have contracted cholera after eating raw or undercooked shellfish from the Gulf of Mexico[10].

Typhoid

Typhoid fever and paratyphoid fever are similar diseases caused by bacteria. Salmonella Typhi bacteria causes typhoid fever. Salmonella Paratyphi bacteria causes paratyphoid fever[10].

People infected with these bacteria can spread them to others. This typically happens when an infected person uses the bathroom and does not wash their hands. The bacteria can stay in their hands and contaminate everything that the person touches, including food and drinks[10].

Typhoid fever and paratyphoid fever cause similar symptoms. People with these diseases usually have a fever that can be as high as 103 to 104°F (39 to 40°C). They also may have weakness, stomach pain, headache, diarrhea or constipation, cough, and loss of appetite. Some people have a rash of flat, rose-colored spots. Internal bleeding and death can occur but are rare[10].

Choose food and drinks carefully[10]:

- Only eat foods that are cooked and served hot.
- Avoid food that has been sitting on a buffet.
- Eat raw fruits and vegetables only if you have washed them in clean water or peeled them.
- Only drink beverages from factory-sealed containers.
- Avoid ice because it may have been made from unsafe water.
- Only drink pasteurized milk.

- Wash your hands often with soap and water for 20 seconds, especially after using the bathroom and before eating.
- If soap and water are not readily available, use an alcohol-based hand sanitizer with at least 60% alcohol.
- Keep your hands away from your face and mouth.

Vector-borne diseases:

Yellow Fever

Yellow fever is an epidemic-prone mosquito-borne vaccine preventable disease that is transmitted to humans by the bites of infected mosquitoes. Yellow fever is caused by an arbovirus (a virus transmitted by vectors such mosquitoes, ticks, or other arthropods) transmitted to humans by the bites of infected Aedes and Haemagogus mosquitoes[9].

These day-biting mosquitoes breed around houses (domestic), in forests or jungles (sylvatic), or in both habitats (semi-domestic). Yellow fever is a high-impact high-threat disease, with risk of international spread, which represents a potential threat to global health security[9].

The incubation period for yellow fever is 3 to 6 days. Many people do not experience symptoms. Common symptoms include fever, muscle pain, headache, loss of appetite, nausea or vomiting. In most cases, symptoms disappear after 3 to 4 days[9].

A small percentage of patients enter a second, more toxic phase within 24 hours of recovering from initial symptoms. High fever returns and several body systems are affected, usually the liver and the kidneys. In this phase, people are likely to develop jaundice (yellowing of the skin and eyes, hence the name yellow fever), dark urine, and abdominal pain with vomiting. Bleeding can occur from the mouth, nose, eyes, or stomach. Half of the patients who enter the toxic phase die within 7–10 days[9].

Climate change has long been seen to increase the burden of mosquito-borne diseases such as dengue and malaria. Warmer, wetter weather provides mosquitoes with larger habitats, and enables them to infest places they were previously unable to thrive in. There is already strong evidence that climate change will alter the habitat and global spread of *Aedes aegypti*, which will inevitably affect the way it transmits the yellow fever virus[16].

West Nile Fever

West Nile virus (WNV) is the leading cause of mosquito-borne disease in the continental United States. It is most spread to people by the bite of an infected mosquito. Cases of WNV occur during mosquito season, which starts in the summer and continues through fall. There are no vaccines to prevent or medications to treat WNV in people. Fortunately, most people infected with WNV do not feel sick. About 1 in 5 people who are infected develop a fever and other symptoms. About 1 out of 150 infected people develop a serious, sometimes fatal, illness. You can reduce your risk of WNV by using insect repellent and wearing long-sleeved shirts and long pants to prevent mosquito bites[10].

No symptoms in most people. Most people (8 out of 10) infected with West Nile virus do not develop any symptoms. Febrile illness (fever) in some people. About 1 in 5 people who are infected develop a fever with other symptoms such as headache, body aches, joint pains, vomiting, diarrhea, or rash. Most people with febrile illness due to West Nile virus recover completely, but fatigue and weakness can last for weeks or months. Serious symptoms in a few people. About 1 in 150 people who are infected develop a severe illness affecting the central nervous system such as encephalitis (inflammation of the brain) or meningitis (inflammation of the membranes that surround the brain and spinal cord). Symptoms of severe illness include high fever, headache, neck stiffness, stupor, disorientation, coma, tremors, convulsions, muscle weakness, vision loss, numbness, and paralysis[10].

Severe illness can occur in people of any age; however, people over 60 years of age are at greater risk for severe illness if they are infected (1 in 50 people). People with certain medical conditions, such as cancer, diabetes, hypertension, kidney disease, and people who have received organ transplants, are also at greater risk. Recovery from severe illness might take several weeks or months. Some effects to the central nervous system might be permanent. About 1 out of 10 people who develop severe illness affecting the central nervous system die[10].

Dengue

Dengue viruses are spread to people through the bite of an infected Aedes species (Ae. aegypti or Ae. albopictus) mosquito. Almost half of the world's population, about 4 billion people, live in areas with a risk of dengue. Dengue is often a leading cause of illness in areas with risk[10].

About one in four people infected with dengue will get sick. For people who get sick with dengue, symptoms can be mild or severe. Severe dengue can be life-threatening within a few hours and often requires care at a hospital. The most common symptom of dengue is fever with any of the following: Nausea, Vomiting, Rash, Aches, and pains (eye pain, typically behind the eyes, muscle, joint, or bone pain). Symptoms of dengue typically last 2–7 days. Most people will recover after about a week[10].

Respiratory diseases:

Influenza

Associated risks between flooding and increased influenza diagnoses were geographically specific, with the greatest risk in the most densely populated areas. Flu is a contagious respiratory illness caused by influenza viruses that infect the nose, throat, and sometimes the lungs. It can cause mild to severe illness, and at times can lead to death. Influenza (flu) can cause mild to severe illness, and at times can lead to death. Flu symptoms usually come on suddenly. People who have flu often feel some or all these symptoms[10]:

- Fever* or feeling feverish/chills.
- Cough.
- Sore throat.
- Runny or stuffy nose.
- Muscle or body aches.

- Headaches.
- Fatigue (tiredness).
- Some people may have vomiting and diarrhea, though this is more common in children than adults.

*It's important to note that not everyone with flu will have a fever.

Respiratory Syncytial Virus Infection (RSV)

Respiratory Syncytial Virus, or RSV, is a common respiratory virus that usually causes mild, cold-like symptoms. Most people recover in a week or two, but RSV can be serious. Infants and older adults are more likely to develop severe RSV and need hospitalization[10].

People infected with RSV usually show symptoms within 4 to 6 days after getting infected. Symptoms of RSV infection usually include:

- Runny nose.
- Decrease in appetite.
- Coughing.
- Sneezing.
- Fever.
- Wheezing.

**These symptoms usually appear in stages and not all at once. In very young infants with RSV, the only symptoms may be irritability, decreased activity, and breathing difficulties[10].

COVID-19

COVID-19, also called coronavirus disease 2019, is a sickness caused by a virus called severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). This virus is a coronavirus. Coronavirus is a family of viruses that can cause illnesses such as the common cold, severe acute respiratory syndrome (SARS) and Middle East respiratory syndrome (MERS). Many people with COVID-19 have mild to moderate symptoms and can recover on their own. But COVID-19 can serious illness and lead to death in some people. People at higher risk include older adults, and the risk increases with age. Also at higher risk for serious illness are people with existing medical conditions. Symptoms of coronavirus disease 2019 (COVID-19) may appear 2 to 14 days after exposure. This time after exposure and before having symptoms is called the incubation period. You can still spread COVID-19 before you have symptoms. This is called presymptomatic transmission. Common symptoms can include[10]:

- Fever.
- Cough.
- Tiredness.
- Early symptoms of COVID-19 may include a loss of taste or smell.

Other symptoms may include[10]:

- Shortness of breath or difficulty breathing.
- Muscle aches.
- Chills.
- Sore throat.
- Runny nose.
- Headache.
- Chest pain.
- Pink eye (conjunctivitis).
- Nausea.
- Vomiting.
- Diarrhea.
- Rash.

**This list isn't complete. Children have similar symptoms to adults and generally have mild illness. The severity of COVID-19 symptoms can range from very mild to severe. Some people may have only a few symptoms. Some people may have no symptoms at all but can still spread it. This is called asymptomatic transmission[10].

Other Diseases:

Tetanus

Tetanus is an infection caused by bacteria called Clostridium tetani. When these bacteria enter the body, they produce a toxin that causes painful muscle contractions. Another name for tetanus is “lockjaw”. It often causes a person’s neck and jaw muscles to lock, making it hard to open the mouth or swallow[10].

The spores can get into someone’s body through broken skin, usually through injuries. Tetanus bacteria are more likely to infect certain breaks in the skin. These include[10]:

- Wounds contaminated with dirt, feces (poop), or saliva (spit).
- Puncture wounds (wounds caused by an object, like a nail or needle, breaking the skin).
- Burns.
- Crush injuries (injury to a body part due to pressure from another object or being squeezed between two heavy objects).
- Injuries with dead tissue.
- Insect bites.

Public Health Response Activities Before, During, and After Floods[10]:

- Vector control programs in flood prone areas.
- Vaccination programs for preventable diseases in areas susceptible to and other natural disasters

- Rapid risk assessment and data collection to identify interventions needed.
- Designation of evacuation sites for healthcare facilities and Long-Term Care Facilities affected by flooding.
- Provision of shelters, nutrition, water, hygiene, and sanitation facilities.
- Provision of disease prevention and control measures including insecticide sprays and repellents, masks, hand sanitizers.
- Protective clothing against insect bites.

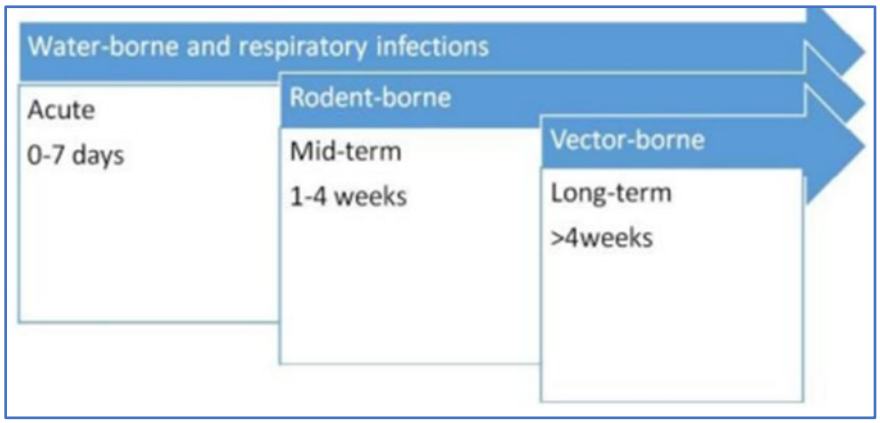


Figure: 6.2 – Incubation Periods for Waterborne, Respiratory, Rodent, and Vector borne Illnesses Source: WHO[9]

Risk of Disease Outbreaks in Flood Disasters.

For flooding, BCHD has access to supplies of mosquito larvicide dunks that can be placed throughout the community by BCHD that can help control the population of mosquitoes[11].

In the days leading up to a hurricane, tornado, or flood, BCHD can do a landing rate count and then after the event do the same study[11]. The Landing Rate Count (LRC) is a measurement of the density of adult mosquitoes attempting to land on a person over a short period of time (i.e., 1 minute)[17]. This is a way to quantify the effect of the flood on the mosquito population and to decide if treatment is needed. This is all accomplished through grants as well as state and federal funds, as they become available after a disaster[11].

Potential Damages and Losses

Potential annualized losses and damages are estimated by multiplying the exposed values by the probability of a 100-year flood event. The following Table: 6.2, currently shows the potential impacts of riverine flooding on critical facilities and infrastructure within the planning area.

Entity	Total Exposure	Annualized Loss (Residential)	Annualized Loss (Commercial)	Annualized Loss (Industrial)	Total Annualized Loss*

Brazos County	$376,450	$1,395,480	$172,623	$26,231	$1,625,501
Bryan	$922,068	$1,522,547	$2,211,071	$216,362	$3,981,457
College Station	$1,308,451	$3,693,291	$1,830,204	$125,288	$5,649,848
Wixon Valley	$1,017	$3,671	$0	$0	$4,392
Kurten	$4,555	$19,402	$0	$0	$19,667

Table: 6.2 - Probability of 100-Year Flood Cost *Rounded to the nearest dollar* Source: Brazos County HMAP (2019-2024)[12]

The following Table: 6.3 shows the potential wet exposure in the event of a 100-year riverine flood:

	Bryan	**College Station**	**Wixon Valley**	**Kurten**	**Brazos County Total***
Residential Parcels	1858	692	0	18	3,484
Residential Value	$441,289	$274,347	0	$4,329	$1.49m
Rental Parcels	113	77	0	0	192
Rental Value	$101,544	$754,779	0	0	$858,886
Commercial Parcels	287	191	0	0	508
Commercial Value	$631,620	$601,215	0	0	$1.3m
Industrial Parcels	16	2	0	0	24
Industrial Value	$58,165	$34,217	0	0	$104,041

Table: 6.3 -100-Year Riverine Flood Cost *Includes Navasota and unincorporated areas* Source: Brazos County HMAP (2019-2024)[12]

Extent

The severity of a flood event is determined by a combination of several factors including stream and river basin topography and physiography; precipitation and weather patterns; recent soil moisture conditions; and degree of vegetative clearing and a dense surface. Typically, floods are long-term events that may last for several days[3].

Determining the intensity and magnitude of a flood event is dependent upon the flood zone and location of the flood hazard area in addition to depths of flood waters. The extent of flood damage can be expected to be more damaging in the areas that will spread across a base flood. FEMA categorizes areas on the terrain according to how the area will spread flood water. Flood zones are the categories that are mapped on Flood Insurance Rate Maps. Table 6.4 provides a description of FEMA flood zones and the flood impact in terms of severity or potential harm. Flood Zones A, AE and X are the only hazard areas mapped in the region. Figures 6.1 through

Intensity	Zone	Description
HIGH	ZONE A	Areas with a one percent annual chance of flooding and a 26 percent chance of flooding over the life of a 30-year mortgage. Because detailed analyses are not performed for such areas, no depths or base flood elevations are shown within these zones.
	ZONE A1- 30	These are known as numbered A Zones (e.g., A7 or A14). This is the base floodplain where it shows a Base Flood Elevation (BFE) (old format).
	ZONE AE	The base floodplain where base flood elevations are provided. AE Zones are now used on the new format FIRMs instead of A1-A30 Zones.
	ZONE AO	River or stream flood hazard areas and areas with a one percent or greater chance of shallow flooding each year, usually in the form of sheet flow, with an average depth ranging from one to three feet. These areas have a 26 percent chance of flooding over the life of a 30-year mortgage. Average flood depths derived from detailed analyses are shown within these zones.
	ZONE AH	Areas with a one percent annual chance of shallow flooding, usually in the form of a pond, with an average depth ranging from one to three feet. These areas have a 26 percent chance of flooding over the life of a 30-year mortgage. Base flood elevations derived from detailed analyses are shown at selected intervals within these zones.
	ZONE A99	Areas with a one percent annual chance of flooding will be protected by a federal flood control system where construction has reached specified legal requirements. No depths or base flood elevations are shown within these zones.
	ZONE AR	Areas with a temporarily increased flood risk due to the building or restoration of a flood control system (such as a levee or a dam). Mandatory flood insurance purchase requirements will apply, but rates will not exceed the rates for unnumbered A zones if the structure is built or restored in compliance with Zone AR floodplain management regulations.
HIGH COASTAL	ZONE VE, V1-30	Coastal areas with a 1% or greater chance of flooding and an additional hazard associated with storm waves. These areas have a 26 percent chance of flooding over the life of a 30-year mortgage. No base flood elevations are shown within these zones.
MODERATE TO LOW	ZONE X 500	An area inundated by 500-year flooding; an area inundated by 100-year flooding with average depths of less than one foot or with drainage areas less than one square mile; or an area protected by levees from 100-year flooding.

6.4 should be read in conjunction with the extent for flooding to determine the intensity of a potential flood event[3].

Flood maps show how likely it is for an area to flood. Any place with a 1% chance or higher chance of experiencing a flood each year is considered to have a high risk. Those areas have at least a one-in-four chance of flooding during a 30-year period[3].

Table: 6.4 - Flood Zone Designators - FEMA flood zones and the flood impact[3].

Zone A is interchangeably referred to as the 100-year flood, the one percent-annual chance flood, the Special Flood Hazard Area (SFHA), or more commonly, the base flood. This is the area that will convey the base flood and constitutes a threat to the planning area. The impact from a flood event can be more damaging in areas that will spread across a base flood.

Structures built in the SFHA are subject to damage by rising waters and floating debris. Moving flood water exerts pressure on everything in its path and causes erosion of soil and solid objects. Utility systems, such as heating, ventilation, air conditioning, fuel, electrical systems, sewage maintenance systems and water systems, if not elevated above base flood elevation, may also be damaged.

The intensity and magnitude of a flood event is also determined by the depth of flood water.

This year (2024) 9.99% of properties in Brazos County have a risk of flooding. In 30 years, 9.98% of properties in Brazos County will have flooding[5]. Figure: 6.3 below shows a comparison for the USA, Texas, Port Arthur, and Brazos County. In addition to property damage, flooding can also cut off access to utilities, emergency services, transportation, and may impact the overall economic well-being of an area. Overall, Brazos County has a minor-moderate risk of flooding over the next 30 years, which means flooding is likely to impact day-to-day life within the community. This is based on the level of risk the properties face rather than the proportion of properties with risk[5].

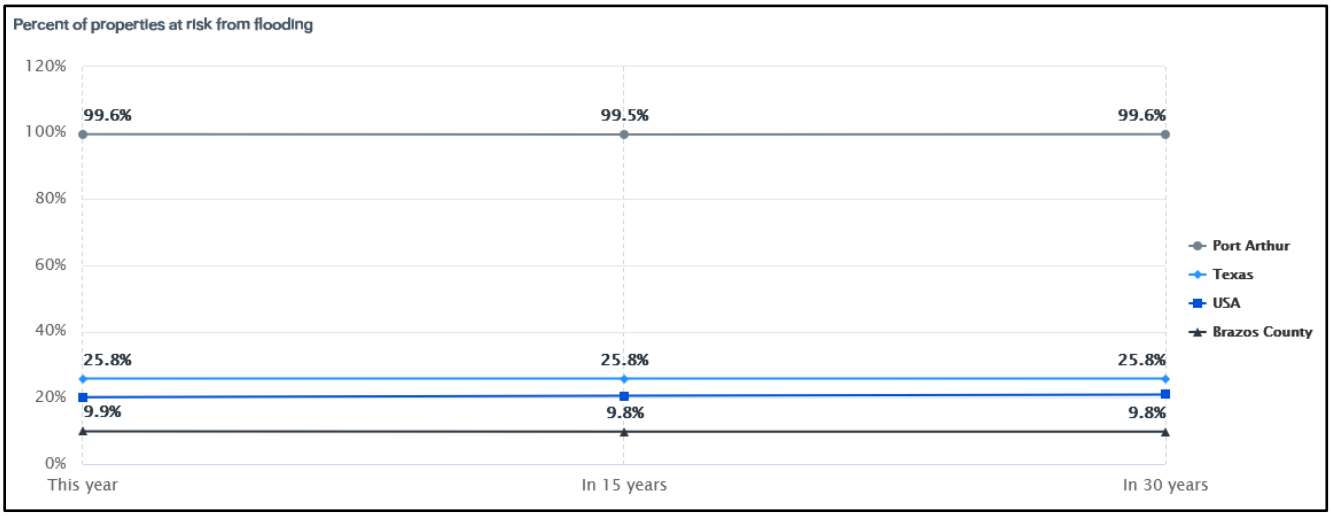
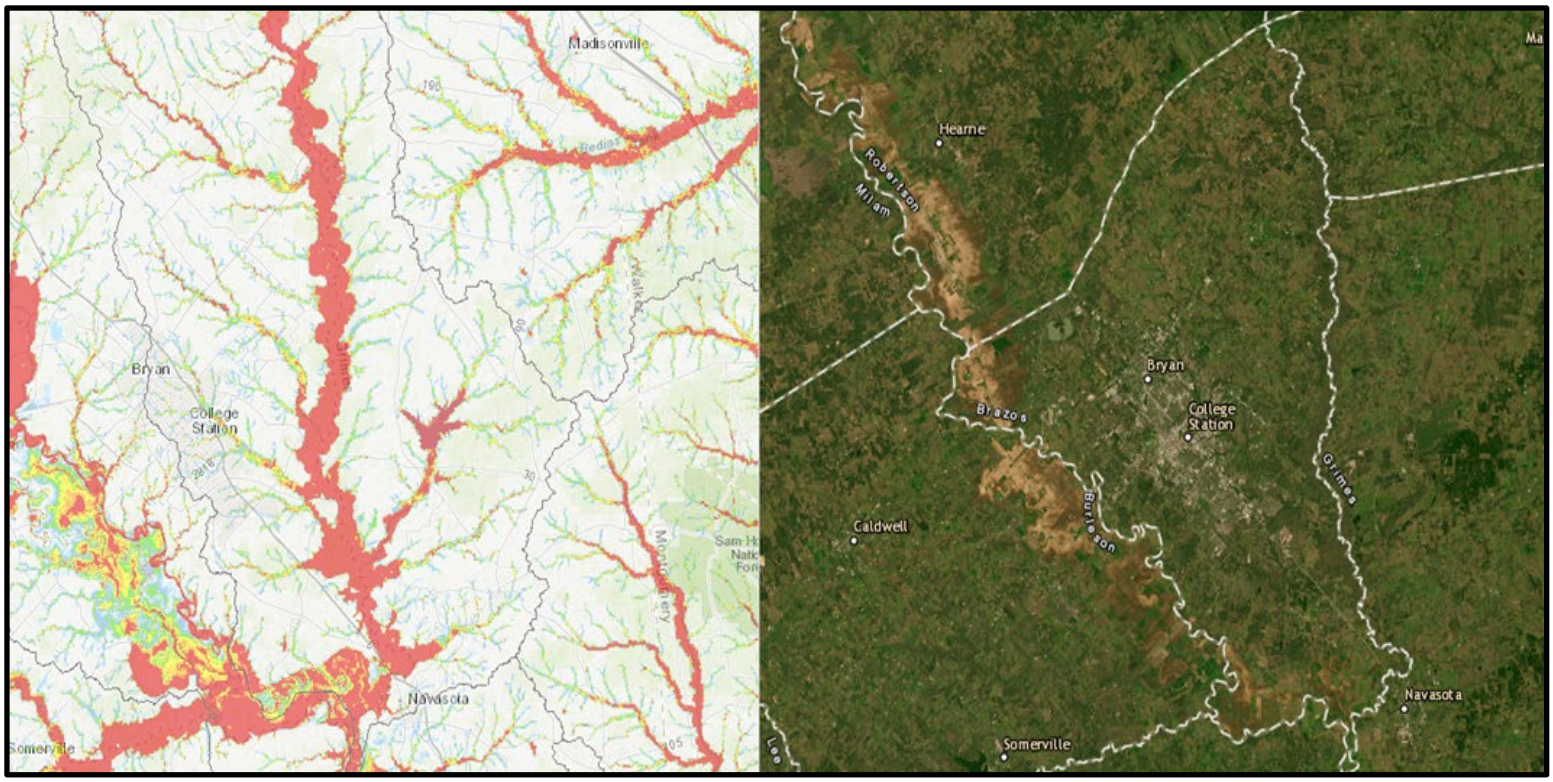


Figure: 6.3 – Extent for current and future flooding events in Brazos County [5].

A flood exposure analysis was performed to guide the Lower Brazos Regional Flood Plan by establishing a consistent measure of flood hazard within the basin. The analysis considered vulnerability, land use, estimated precipitation data, and constructed drainage-related infrastructure[18]. Datasets of hydrologic and hydraulic modeling and flood risk mapping from various sources were collected and compiled together to create a comprehensive, continuous set of the best available existing flood risk data for the Lower Brazos Planning Region. The compiled mapping included both the 1 percent and 0.2 percent annual chance event (ACE) storms. The sources of the flood risk datasets included the United States Army Corps of Engineers (USACE), United States Geological Survey (USGS), Federal Emergency Management



Agency (FEMA), and the Texas Water Development Board (TWDB). These different datasets were prioritized based on the quality and coverage extents to determine which information to use when the datasets were overlapping[18]. The extent of the flood hazard areas is estimated to increase by 10 percent in the Lower Brazos Planning Region in the next 30 years if no action is taken. As with existing conditions, additional studies are needed to develop comprehensive, consistent, and up-to-date future flood risk data across the region[18]. Figure 6.4 shows the flood depth for FEMA Region 6, specifically Brazos County and its participating entities[19]. This is the estimated water depths above land surface during a 1% annual chance storm event[19]. There are no areas of costal influence[19].

Figure: 6.4 – FEMA Region 6 Flood Depth Map (Estimated Base Flood Elevation). (Topographical and Base Map are shown) Legend shows the estimated water depths above land surface that can occur during a calendar year.

For more information please visit: https://webapps.usgs.gov/infrm/estbfe/

Assessment of Impacts

Flooding is the deadliest natural disaster that occurs in the U.S. each year, and it poses a constant and significant threat to the health and safety of the people in the Brazos County planning area. Impacts to the planning area can include:

- Flood-related rescues may be necessary at swift and low water crossings or in flooded neighborhoods where roads have become impassable, placing first responders in harm's way.
- Evacuations may be required for entire neighborhoods because of rising floodwaters, further taxing limited response capabilities and increasing sheltering needs for displaced residents.
- Health risks and threats to residents are elevated after the flood waters have receded due to contaminated flood waters (untreated sewage and hazardous chemicals) and mold growth typical in flooded buildings and homes.
- Significant flood events often result in widespread power outages increasing the risk to more vulnerable portions of the population who rely on power for health and/or life safety.
- Extended power outage can result in an increase in structure fires and/or carbon monoxide poisoning as individuals attempt to cook or heat their home with alternate, unsafe cooking or heating devices, such as grills or the misuse of generators.
- Floods can destroy or make residential structures uninhabitable, requiring shelter or relocation of residents in the aftermath of the event.
- First responders are exposed to downed power lines, contaminated and potentially unstable debris, hazardous materials, and generally unsafe conditions, elevating the risk of injury to first responders and potentially diminishing emergency response capabilities.
- Emergency operations and services may be significantly impacted due to damaged facilities.
- Significant flooding can result in the inability of emergency response vehicles to access areas of the community.
- Critical staff may suffer personal losses or otherwise be impacted by a flood event and unable to report for duty, limiting response capabilities.
- City or county departments may be flooded, delaying response and recovery efforts for the entire community.
- Private sector entities that the jurisdiction and its residents rely on, such as utility providers, financial institutions, medical care providers (including dialysis and long-term care facilities) may not be fully operational and may require assistance from neighboring communities until full services can be restored.
- Damage to infrastructure may slow economic recovery since repairs may be extensive and lengthy.

- Some businesses not directly damaged by the flood may be negatively impacted while utilities are being restored or water recedes, further slowing economic recovery.
- When the community is affected by significant property damage it is anticipated that funding would be required for infrastructure repair and restoration, temporary services and facilities, overtime pay for responders, and normal day-to-day operating expenses.
- Displaced residents may not be able to immediately return to work, further slowing the economic recovery.
- Residential structures substantially damaged by a flood may not be rebuilt for years and uninsured or underinsured residential structures may never be rebuilt, reducing the tax base for the community.
- Large floods may result in a dramatic population fluctuation, as people are unable to return to their homes or jobs and must seek shelter and/or work outside of the affected area.
- Businesses that are uninsured or underinsured may have difficulty reopening, which results in a net loss of jobs for the community and a potential increase in the unemployment rate.
- Flooding may cause significant disruptions of clean water and sewer services, elevating health risks and delaying recovery efforts.
- The psycho-social effects on flood victims and their families can traumatize them for long periods of time, creating long term increases in medical treatment and services.
- Extensive or repetitive flooding can lead to decreases in property value for the affected community.
- Flood poses a potential catastrophic risk to annual and perennial crop production and overall crop quality leading to higher food costs.
- Flood related declines in production may lead to an increase in unemployment.
- Large floods may result in loss of livestock, potential increased livestock mortality due to stress and water borne disease, and increased cost for feed.

The overall extent of damage caused by floods is dependent on the extent, depth and duration of flooding, and the velocities of flows in the flooded areas.

The effects of the growing population increase the risk of and exposure to floods due to increased development and impervious surfaces. Such development changes water flow patterns increasing the size of the flood prone areas. Additionally, populations that previously had not experienced flooding in the past may be at risk for future flooding.

The level of preparedness and pre-event planning done by government, businesses, and citizens will contribute to the overall economic and financial conditions in the aftermath of a flood event.

National Flood Insurance Program (NFIP) Participation

According to FEMA[13], jurisdictions participate in the NFIP by adopting and enforcing floodplain management ordinances to reduce future flood damage. In exchange, the NFIP makes federally backed flood insurance available to homeowners, renters, and business owners in these communities. Community participation in the NFIP is voluntary[13].

Brazos County and the cities of Bryan, College Station, and Wixon Valley currently participate in the NFIP and have adopted NFIP minimum floodplain management criteria via local regulation. Brazos County and the cities of Bryan and College Station have adopted the latest effective Flood Insurance Rate Map. It should be noted that Wixon Valley participates in the NFIP but has no floodplain within the city limits. The City of Kurten does not currently participate in NFIP because there is no identified floodplain in its city limits.

The cities of Bryan and College Station also participate in the NFIP's Community Rating System (CRS). This voluntary program provides policy holder discounts for community floodplain management activities that exceed the minimum NFIP requirements[13].

The designees or agencies implementing the commitments and requirements of NFIP are:

- Brazos County- Road and Bridge
- City of Bryan- Engineering
- City of College Station- Planning and Development
- City of Wixon Valley- Office of the Mayor

These jurisdictions maintain their NFIP compliance by:

- Requiring all new development in the identified flood hazard area to be permitted.
- Requiring revisions to existing structures in the identified flood hazard area to be permitted.
- Requiring elevation certificates to be submitted as part of the permitting process.
- Persons looking to purchase flood prone property are being advised of the flood hazard area through credited hazard disclosure measures.
- Continued preservation of open space in the floodplain.
- Acquisition of existing structures from the floodplain.
- Tracking building improvements and repairs to structures located in the identified flood hazard area.
- Continued enforcement of stream dumping regulations.

Further, the NFIP program for all the participating entities promotes sound development in floodplain areas and includes provisions designed to[13]:

- Protect human life and health.
- Minimize expenditure of public money for costly flood control projects.
- Minimize the need for rescue and relief efforts associated with flooding and generally undertaken at the expense of the public.
- Minimize prolonged business interruptions.
- Minimize damage to public facilities and utilities such as water and gas mains, electric, telephone and sewer lines, streets, and bridges located in floodplains.
- 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 areas.
- Ensure that potential buyers are notified that property is in a flood area.
- Implement actions identified in their floodplain management plans following an event that causes substantial damage.

The following table (6.5) shows participation in the NFIP by jurisdiction as well as the historical losses and payouts.

Location	Policies In Effect	Total Coverage (In Thousands)	Total Losses	Historical Dollars Paid
Brazos County	236	$68,635	34	$1,155,567
City of Bryan	503	$143,245.20	307	$4,406,382
City of College Station	641	$202,581	185	$1,082,188

Table: 6.5 - NFIP Participation in Planning Area (2021) Source: FEMA[13]

On an annual basis, each participating entity will review the list of NFIP insured structures that have been repetitively damaged by floods, to review mitigation actions that have been taken or could be taken; to minimize or prevent future damages.

References – Section 6

1. *Brazos County Hazard Mitigation Action Plan (2012-2017). Brazos Valley Council of Government. https://www.bvcog.org/Portals/0/Brazos-Co-Mitigation-Plan-2012.pdf*
2. *NOAA. Severe Floods 101. https://www.nssl.noaa.gov/education/svrwx101/floods/types/*
3. *FEMA. Flood Insurance Rate Map (FIRM). https://www.fema.gov/glossary/flood-insurance-rate-map-firm*
4. *National Weather Service. Weather. https://www.weather.gov/*
5. *Climate Change. What will Climate Change Cost You? https://riskfactor.com/*
6. *National Environmental Monitoring Conference. Environmental Measurement. https://www.nemc.us/*
7. *US Climate Change Resilience Toolkit. Climate Explorer. https://toolkit.climate.gov/tool/climate-explorer-0*
8. *US Environmental Protection Agency. Enviro-Atlas Interactive Map. https://www.epa.gov/enviroatlas/enviroatlas-interactive-map*
9. *World Health Organization. Floods: How to protect your health. https://www.who.int/news-room/questions-and-answers/item/how-do-i-protect-my-health-in-a-flood*
10. *Centers for Disease Control and Prevention. Water, Sanitation, & Hygiene (WASH)-related Emergencies and Outbreaks. https://www.cdc.gov/healthywater/emergency/extreme-weather/floods-standingwater.html*
11. *Brazos County Health District. Main Page. https://www.brazoscountytx.gov/161/Health-District*
12. *Brazos County HMAP (2019-2024). Main Page. https://bcdem.org*
13. *FEMA. National Flood Insurance Program. https://www.fema.gov/flood-insurance*
14. *FEMA. HAZUS Product. https://www.fema.gov/flood-maps/tools-resources/flood-map-products/hazus/about*
15. *Hepatitis in America. Person to Person Outbreaks. https://www.cdc.gov/hepatitis/outbreaks/2017March-HepatitisA.htm*
16. *Yellow Fever. More people could be put at risk from yellow fever because of climate change. https://www.gavi.org/vaccineswork/climate-change-could-put-thousands-more-risk-yellow-fever*
17. *Landing Rate Count. Mosquito Landing Rate. https://epi.dph.ncdhhs.gov/cd/vector/guidance/3-Hurricane-Florence-Landing-Rate-Instructions.docx*
18. *Wade, B. (2022). Region 8 – lower Brazos regional flood planning group. Texas Water Development Board. December 2022.*
19. *FEMA. Flood Depth. Brazos County. https://webapps.usgs.gov/infrm/estbfe/*

Section 7 - Drought

Hazard Description

Drought is a period without substantial rainfall that persists from one year to the next. Drought is a normal part of virtually all climatic regions, including areas with high and low average rainfall. Drought is the consequence of anticipated natural precipitation reduction over an extended period, usually a season or more in length. Droughts can be classified as meteorological, hydrologic, agricultural, and socioeconomic.

Keetch-Byram Drought Index[2] and Palmer Drought Index[6]

Brazos County uses the Keetch-Byram Drought Index (KBDI)[2] and the Palmer Drought Index[6] to measure droughts. The Palmer Drought Index[3] is used to measure the extent of drought by measuring the duration and intensity of long-term drought-inducing circulation patterns. The Keetch-Byram Drought Index (KBDI)[2], Table: 7.1, is an index used to determine forest fire potential. The drought index is based on a daily water balance, where a drought factor is balanced with precipitation and soil moisture (assumed to have a maximum storage capacity of 8-inches) and is expressed in hundredths of an inch of soil moisture depletion[2].

Long-term drought is cumulative, with the intensity of drought during the current month dependent upon the current weather patterns plus the cumulative patterns of previous months. The hydrological impacts of drought (e.g., reservoir levels, groundwater levels, etc.) take longer to develop. Table: 7.2 (Palmer Drought Index)[6] depicts magnitude of drought, while Table: 7.3 (Palmer Drought Index)[6] describes the classification descriptions.

Drought is monitored nationwide by the National Drought Mitigation Center (NDMC)[4] and the U.S. Drought Monitor[3]. Indicators are used to describe broad scale drought conditions across the United States and correspond to the intensity of drought. The U.S. Drought Monitor[3] is one of the factors that is used to make decisions for the county, such as instituting a burn ban. The drought severity categories are defined as follows:

QUICK FACTS

Types of Droughts

Meteorological Drought:

The degree of dryness or departure of action participation from an expected average or normal amount based on monthly, seasonal, or annual time scales.

Hydrologic Drought:

The effects of precipitation shortfalls on stream flows and reservoir, lake, and groundwater levels.

Agricultural Drought:

Soil moisture deficiencies relative to water demands of plant life (usually crops).

Socioeconomic Drought:

The effect of demands for water exceeding the supply because of a weather-related shortfall.

History

Two Costliest Droughts in Brazos County:

- August 1998 - $190.9m in crop and property damages
- September 2000 – $102.3m in crop damages

Source: The National Weather Service[1]

KBDI Values	Drought and Fire Potential Information
0 – 200	Soil and fuel moisture is high. Most fuels will not contribute much to wildfire intensity. This is often seen in spring after winter precipitation.
200 - 400	Fuels are beginning to dry and contribute to wildfire intensity. Heavier fuels will still not readily ignite and burn. This is often seen in late spring.
400 - 600	Wildfire intensity begins to increase significantly. Wildfires will readily burn, and larger fuels could burn or smolder for several days. This is often seen in late summer and early fall.
600 - 800	Wildfires will show extreme intensity. Deep-burning, intense wildfires with significant spotting can be expected. This is often associated with severe drought.

Table: 7.1 – Keetch-Byram Drought Index Source: Texas A&M Forest Service[2]

Drought Condition Classifications							
Drought Index	**Extreme**	**Severe**	**Moderate**	**Normal**	**Moderately Moist**	**Very Moist**	**Extremely Moist**
Z Index	-2.75 and below	-2.00 to -2.74	-1.25 to -1.99	-1.24 to +.99	+1.00 to +2.49	+2.50 to +3.49	n/a
Meteorological	-4.00 and below	-3.00 to -3.99	-2.00 to -2.99	-1.99 to +1.99	+2.00 to +2.99	+3.00 to +3.99	+4.00 and above
Hydrological	-4.00 and below	-3.00 to -3.99	-2.00 to -2.99	-1.99 to +1.99	+2.00 to +2.99	+3.00 to +3.99	+4.00 and above

Table: 7.2 - Drought Classification – Palmer Index Source: National Drought Mitigation Center[4]

Category	Description	Possible Impacts	Palmer Drought Index
D0	Abnormally Dry	Going into drought: short-term dryness slowing planting, growth of crops or pastures; fire risk above average. Coming out of drought: some lingering water deficits; pastures or crops not fully recovered.	-1.0 to -1.9
D1	Moderate Drought	Some damage to crops, pastures; fire risk high; streams, reservoirs, or wells low, some water shortages developing, or imminent, voluntary water use restrictions requested.	-2.0 to -2.9
D2	Severe Drought	Crop or pasture losses likely; fire risk very high; water shortages common; water restrictions imposed.	-3.0 to -3.9
D3	Extreme Drought	Major crop/pasture losses; extreme fire danger; widespread water shortages or restrictions.	-4.0 to -4.9
D4	Exceptional Drought	Exceptional and widespread crop/pasture losses; exceptional fire risk; shortages of water in reservoirs, streams, and wells, creating water emergencies.	-5.0 or less

Table: 7.3 - Drought Classification Descriptions Source: National Drought Mitigation Center[4]

Hazardous Areas

Droughts occur regularly throughout Texas and the Brazos County planning area and are a normal condition. However, they can vary greatly in their intensity and duration. The planning area has experienced abnormally dry to exceptional drought conditions numerous times throughout the years.

There is no distinct geographic boundary for drought; therefore, it can occur throughout the Brazos County planning area, including all participating entities. Figure: 7.1 currently shows the areas that are prone to drought within the planning area.

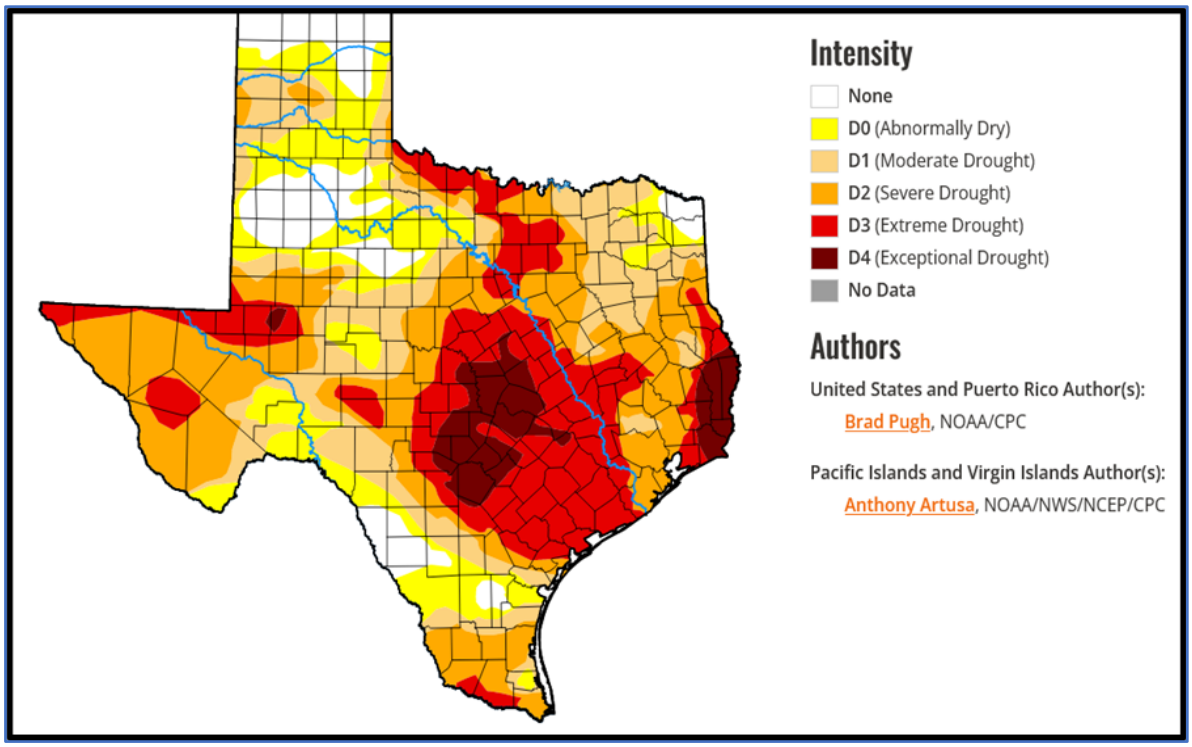


Figure: 7.1 – Drought Map within Planning Area Source: US Drought Monitor[3]

Previous Occurrences

From January 1996 through July 2023, Brazos County experienced 13 drought events as seen on as seen on table 7.4, sourced through the National Drought Mitigation Center[4] from 1996-2022.

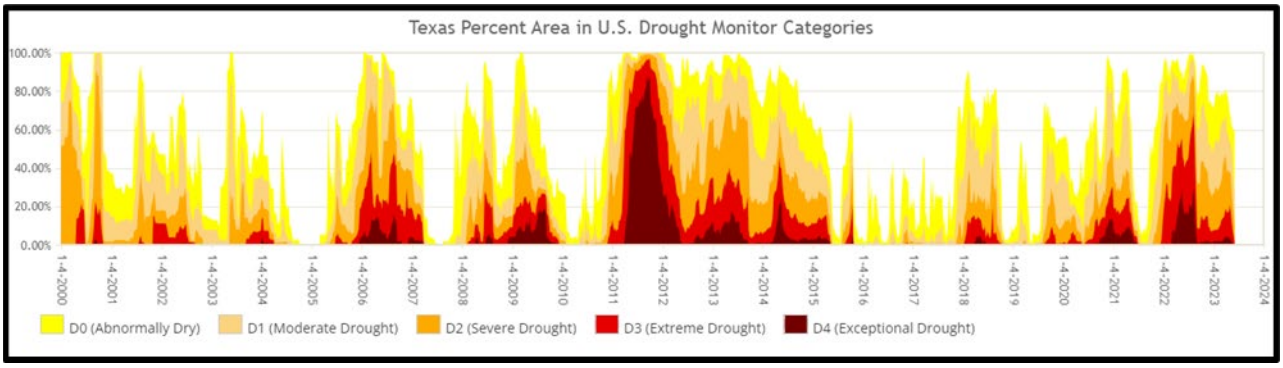


Table: 7.4 - Drought Incidents, 1996-2023 Source: National Drought Mitigation Center[4]

Future Probability

Droughts occur regularly in Texas but can vary greatly in their intensity and duration. On average, a year-long drought takes place somewhere in Texas every three years, and a multi-year major drought occurs in the state every 20 years[7].

Based on available records of historic events, there have been thirteen extended time periods of drought (ranging in length from approximately 30 days to over 1,100 days) within a 26-year reporting period, which provides a probability of one event every two to three years[7]. This frequency supports a likely probability of future events for the entire Brazos County planning area. Figure: 7.2 shows the ranges of abnormally dry to exceptionally dry conditions for Texas from the US Drought Monitoring Website located at USDrought.gov[5], currently.

Location	Date(s)	Deaths	Injuries	Property Damage	Crop Damage
Countywide	04/01/1996 – 06/01/1996	0	0	0	0
Countywide	05/01/1998- 08/01/1998	0	0	$23m	$167.9m
Countywide	08/01/2000 – 09/01/2000	0	0	0	$102.3m
Countywide	07/01/2011 – 08/01/2011	0	0	0	0
Countywide	06/14/2022 – 07/19/2022	0	0	0	0
Countywide	2023 (undetermined)	0	0	0	0
	Totals	**0**	**0**	**23m**	**270.20m**

Table: 7.5 - Percentage of Texas under drought conditions Source: US Drought Monitor[5]

Climate Change

Climate change may increase the frequency or intensity of hazards over time[8]. Projections for two long term climate scenarios were calculated for dry days. Dry days are defined as the

number of days in a year that receive less than 0.01 inch of rain. From 1961 to 1990, the average number of dry days per year was 243. For these projections, two harmful emissions scenarios are assessed. One scenario describes a future in which humans stop increasing harmful emissions by 2040 and then continue to reduce emissions through the end of the century (Lower Emissions)[8]. The second scenario describes a future in which harmful emissions continue to increase through the end of the century. (Higher Emissions)[8] The trend for the number of dry days per year is generally consistent over time and the two emission scenarios have only a slight impact on dry days in Brazos County and participating entities, over the next 80 years[8].

Infectious Disease and Risk

The increases in global temperatures expand the geographical range of vector borne pathogens.

All the current information on drought, infectious diseases, and risk (pages 68-71) was taken from the website: https://www.cdc.gov/nceh/drought/implications.htm[11]. (This website may become disabled as new information becomes available).

Drought poses many far-reaching health implications. Some drought-related health effects occur in the short-term and can be directly observed and measured. But the slow rise or chronic nature of drought also can result in longer term, indirect health implications that are not always easy to anticipate or monitor[11].

Drought can also cause long-term public health problems, including[11]:

- Shortages of drinking water and poor-quality drinking water
- Impacts on air quality, sanitation and hygiene, and food and nutrition.
- More diseases, such as West Nile Virus carried by mosquitoes breeding in stagnant water.

Water[11]

Reduced stream and river flows can increase the concentration of pollutants in water and cause stagnation. Higher water temperatures in lakes and reservoirs lead to reduced oxygen levels. These levels can affect fish and other aquatic life and water quality[11].

Runoff from drought-related wildfires can carry extra sediment, ash, charcoal, and woody debris to surface waters, killing fish and other aquatic life by decreasing oxygen levels in the water. Many parts of the United States depend on groundwater as a primary source of water. Over time, reduced precipitation and increased evaporation of surface water mean that groundwater supplies are not replenished at a typical rate[11].

Food and Nutrition[11]

Drought can limit the growing season and create conditions that encourage insect and disease infestation in certain crops. Low crop yields can result in rising food prices and shortages, potentially leading to malnutrition. Drought can also affect the health of livestock raised for food. During drought, livestock can become malnourished, diseased, and die[11].

Air Quality[11]

The dusty, dry conditions and wildfires that often accompany drought can harm health. Fire and dry soil and vegetation increase the number of particulates that are suspended in the air, such as pollen, smoke, and fluorocarbons. These substances can irritate the bronchial passages and lungs, making chronic respiratory illnesses like asthma worse. This can also increase the risk for acute respiratory infections like bronchitis and bacterial pneumonia[11].

Other drought-related factors affect air quality, including the presence of airborne toxins originating from freshwater blooms of cyanobacteria. These toxins can become airborne and have been associated with lung irritation, which can lead to adverse health effects in certain populations[11].

Sanitation and Hygiene[11]

Having water available for cleaning, sanitation, and hygiene reduces or controls many diseases. Drought conditions create the need to conserve water, but these conservation efforts should not get in the way of proper sanitation and hygiene[11].

Personal hygiene, cleaning, hand washing, and washing of fruits and vegetables can be done in a way that conserves water and reduces health risks. Installing low-flow faucet aerators in businesses and homes is one example of how to reduce water consumption while maintaining hand washing and other healthy hygienic behaviors[11].

Recreational Risks[11]

People who engage in water-related recreational activities during drought may be at increased risk for waterborne disease caused by bacteria, protozoa, and other contaminants such as chemicals and heavy metals. Exposure can occur through accidentally or intentionally swallowing water, direct contact of contaminants with mucous membranes, or breathing in contaminants[11].

Untreated surface water can be a health threat in drought conditions. In untreated surface waters, some pathogens, such as a type of amoeba (Naegleria fowleri), are more common during drought because low water levels may create warmer water temperatures that encourage their growth[11].

As the levels of surface waters used for boating, swimming, and fishing drop, the likelihood of injury increases. Low water levels in lakes can put people at risk of life-threatening injuries resulting from diving into shallow waters or striking objects that may not be immediately visible while boating. Low surface water levels can also expose potentially dangerous debris from the bottom of lakes, rivers, and ponds[11].

Infectious Disease[11]

Increases in infectious disease can be a direct consequence of drought.

Viruses, protozoa, and bacteria can pollute both groundwater and surface water when rainfall decreases. People who get their drinking water from private wells may be at higher risk for drought-related infectious disease. Other groups also at increased risk include those who have underlying chronic conditions[11].

Acute respiratory and gastrointestinal illnesses are more easily spread from person to person when hand washing is compromised by a perceived or real lack of available water. During water shortages, the risk for infectious disease increases when hygiene is not maintained[11].

E. coli and Salmonella are examples of bacteria that during drought can more readily contaminate food and cause infectious disease. Food can serve as a vehicle for disease transmission during a drought because water shortages can cause farmers to use recycled water to irrigate their fields and process the food they grow. When used to grow crops, improperly treated water can cause a host of infectious diseases (such as those caused by toxin-producing E. coli and Salmonella), which can be life-threatening for people in high-risk groups. In addition, the likelihood of surface runoff, which can occur when rain fails to penetrate the dry and compacted soil that often accompanies drought, can cause the inadvertent contamination of crops[11].

Other infectious disease threats arise when drought leads to the contamination of surface waters and other types of water that are used for recreational purposes. When temperatures rise and rainfall declines, people are more likely to participate in water-related recreation. Persons exposed to contaminated recreational waters are more likely to become infected with pathogens that thrive in the shallow warm waters that exist during drought conditions[11].

Chronic Disease[11]

Conditions associated with drought may negatively impact people who have certain chronic health conditions such as asthma and some immune disorders[11].

Drought-related changes in air quality, such as increased concentrations of air particulates and airborne toxins resulting from freshwater algal blooms, can irritate the eyes, lungs, and respiratory systems of persons with chronic respiratory conditions[11].

Changes in water quality, such as increased concentrations of contaminants, can threaten persons whose immune systems are compromised[11].

Diseases Transmitted by Insects and Animals[11]

In periods of limited rainfall, both human and animal behavior can change in ways that increase the likelihood of other vector borne diseases. For instance, during dry periods, wild animals are more likely to seek water in areas where humans live. These behaviors increase the likelihood of human contact with wildlife, the insects they host, and the diseases they carry[11].

Drought reduces the size of water bodies and causes them to become stagnant. This provides additional breeding grounds for certain types of mosquitoes (for example, Culex pipiens).

Outbreaks of West Nile virus, which is transmitted to humans via mosquitoes, have occurred under such conditions. Inadequate water supply can cause people to collect rainwater. This can lead to collections of stagnant water that can become manmade mosquito breeding areas[11].

Potential Damages and Losses

Drought impacts large areas and crosses jurisdictional boundaries. All existing and future buildings, facilities, and populations are exposed to this hazard and could potentially be impacted. However, drought impacts are mostly experienced in water shortages and crop/livestock losses on agricultural lands, infrastructure and may be affected by shifting/shrinking soil, within the area.

In terms of vulnerability, population, agriculture, property, socioeconomics, and environment are all vulnerable to drought in the Brazos County planning area. Typical demand can deplete water resources during extreme drought conditions. As resources are depleted, potable water is in short supply and overall water quality can suffer, elevating health concerns for all residents but especially vulnerable populations – typically children, the elderly, and the ill. In addition, potable water is used for drinking, sanitation, patient care, sterilization, equipment, heating and cooling systems, and many other essential functions in medical facilities.

The average person will survive only a few days without potable water, and this timeframe can be drastically shortened for those people with more fragile health – typically children, the elderly, and the ill. During summer drought, or hot and dry conditions, elderly persons, small children, infants and the chronically ill, who do not have adequate cooling units in their homes, may become more vulnerable to injury and/or death[10].

The economic impact of droughts can be significant as they produce a complex web of impacts that spans many sectors of the economy and reach well beyond the area experiencing physical drought. This complexity exists because water is integral to our ability to produce goods and provide services. If droughts extend over several years, the direct and indirect economic impact could be significant.

Habitat damage is a vulnerability of the environment during periods of drought for both aquatic and terrestrial species. The environment also becomes vulnerable during periods of extreme or prolonged drought due to severe erosion and land degradation[10].

Potential annualized losses and damages are estimated by analyzing 100 years of statistical data compiled by the University of Nebraska-Lincoln. A drought frequency estimate was developed to determine the effects of and potential losses from a drought on non-irrigated agriculture products. Based on these calculations, the estimated annualized loss for agricultural products in the planning area is $107,507,900.

Extent

Droughts are one of the most complex of all natural hazards as it is difficult to determine their precise beginning or end. In addition, droughts can lead to other hazards such as extreme heat and wildfires.

Over time, drought can cause substantial harm to multiple crops, livestock, water supplies, wildlife, and tourism. Dying and dead vegetation provides a fuel source for wildfires and is one of the factors that leads to an increase in the possibility of wildfires.

Meteorological Drought	The degree of dryness or departure of actual precipitation from an expected average or normal amount based on monthly, seasonal, or annual time scales.
Hydrologic Drought	The effects of precipitation shortfalls on stream flows and reservoir, lake, and groundwater levels.
Agricultural Drought	Soil moisture deficiencies relative to water demands of plant life, usually crops.
Socioeconomic Drought	The effect of demands for water exceeding the supply because of a weather-related supply shortfall.

Table: 7.6 – Classification Definitions

Based on the historical occurrences (Page 87) for drought and the location of the Brazos County and participating entities' planning area, the area can anticipate a range of drought from abnormally dry to exceptional, or D0 to D4, based on the Palmer Drought Category, Table: 7.3. The entire planning area has experienced exceptional drought conditions. This is the most extreme drought conditions the area can anticipate in the future.

Assessment of Impacts

The Drought Impact Reporter[12] was developed in 2005 by the University of Nebraska-Lincoln to provide a national database of drought impacts. Droughts can have an impact on agriculture, business, and industry; energy; fire; plants and wildlife; relief, response, and restrictions on water usage; society and public health; tourism and recreation; and water supply and quality[12]. The reports are submitted to individuals from Federal, State, and local agencies, as well as the public.

Drought does have the potential to impact people in the Brazos County planning area. While it is rare that drought, in and of itself, leads to a direct risk to the health and safety of people in the U.S., severe water shortages could result in inadequate supply for human needs. Drought also is frequently associated with a variety of impacts, including:

- The number of health-related low-flow issues (e.g., diminished sewage flows, increased pollution concentrations, reduced firefighting capacity, and cross-connection contamination) will increase as the drought intensifies.
- Public safety from forest/range/wildfires will increase as water availability and/or pressure decreases.
- Respiratory ailments may increase as the air quality decreases.
- There may be an increase in disease due to wildlife concentrations (e.g., rabies, Rocky Mountain spotted fever, Lyme disease).

- Jurisdictions and residents may disagree over water use/water rights, creating conflict.
- Political conflicts may increase between municipalities, counties, states, and regions.
- Water management conflicts may arise between competing interests.
- Increased code enforcement activities may be required to enforce water restrictions.
- Severe water shortages could result in inadequate supply for human needs as well as lower quality of water for consumption.
- Firefighters may have limited water resources to aid in firefighting and suppression activities, increasing risk to lives and property.
- During drought there is an increased risk for wildfires and dust storms.
- The community may need increased operational costs to enforce water restriction or rationing.
- Prolonged drought can lead to increases in illness and disease related to drought.
- Utility providers can see decreases in revenue as water supplies diminish.
- Utility providers may cut back energy generation and service to their customers to prioritize critical service needs.
- Hydroelectric power generation facilities and infrastructure would have significantly diminished generation capability. Dams simply cannot produce as much electricity from low water levels as they can from high water levels.
- Fish and wildlife food and habitat will be reduced or degraded over time during a drought and disease will increase, especially for aquatic life.
- Wildlife will move to more sustainable locations creating higher concentrations of wildlife in smaller areas, increasing vulnerability, and further depleting limited natural resources.
- Severe and prolonged drought can result in the reduction of a species or cause the extinction of a species altogether.
- Plant life will suffer from long-term drought. Wind and erosion will also pose a threat to plant life as soil quality will decline.
- Dry and dead vegetation will increase the risk of wildfire.
- Drought poses a significant risk to annual and perennial crop production and overall crop quality leading to higher food costs.
- Drought-related declines in production may lead to an increase in unemployment.
- Drought may limit livestock grazing resulting in decreased livestock weight, potential increased livestock mortality, and increased cost for feed.
- Negatively impacted water suppliers may face increased costs resulting from the transport water or developing supplemental water resources.
- Long term drought may negatively impact future economic development.

The overall extent of damage caused by periods of drought is dependent on its extent and duration.

The water demand increases during drought due to its scarcity. The growing population further amplifies the effects of drought due to the increased water demand.

The level of preparedness and pre-event planning done by government, businesses, and citizens will contribute to the overall economic and financial conditions in the aftermath of a drought event.

References – Section 7

1. *The National Weather Service. Drought Monitoring. https://www.weather.gov/ilm/drought*
2. *Texas A&M Forest Service. Fire Danger & Drought. https://tfsweb.tamu.edu/DroughtStudy/*
3. *US Drought Monitor. Current & Long-term Indicators. https://droughtmonitor.unl.edu/ConditionsOutlooks/CurrentConditions.aspx*
4. *National Drought Mitigation Center. Main Page. https://drought.unl.edu/*
5. *US Drought Monitor. Texas. https://droughtmonitor.unl.edu/currentmap/statedroughtmonitor.aspx?TX*
6. *Palmer Drought Index. Climate Guide Data. https://climatedataguide.ucar.edu/climate-data/palmer-drought-severity-index-pdsi*
7. *Texas Water Development. https://www.twdb.texas.gov/*
8. *National Environmental Monitoring Conference. Environmental Measurement. https://www.nemc.us/*
9. *US Climate Change Resilience Toolkit. Climate Explorer. https://toolkit.climate.gov/tool/climate-explorer-0*
10. *World Health Organization. Drought. https://www.who.int/health-topics/drought#tab=tab_1*
11. *Centers for Disease Control and Prevention. Health Implication of Drought. https://www.cdc.gov/nceh/drought/implications.htm*
12. *National Integrated Drought Integration Center (NDMC). Drought Impact Reporter. https://www.drought.gov/data-maps-tools/drought-impact-reporter-dir*

This page intentionally left blank.

Section 8 – Wildland Fires

Hazard Description

A wildland fire is any fire occurring on grassland, forest, or prairie regardless of ignition source, damages, or benefits. These fires can occur at any time of the year, but climatic conditions such as severe freezes or droughts can increase the likelihood and intensity of wildland fire events[1].

A wildfire event can rapidly spread out of control and occurs most often in the summer when the brush is dry, and flames can move unchecked through a highly vegetative area. Usually, dense smoke is the first indication of a wildfire[1].

A wildfire event often begins unnoticed and spreads quickly, lighting brush, trees, and homes on fire. For example, a wildfire may be started by a campfire that was not doused properly, a tossed cigarette, burning debris, arson, lightning, or downed power lines[1].

Texas has seen an increase in the number of wildfires in the past 30 years, which included wildland, and urban/wildland fires. Wildland fires are fueled almost exclusively by natural vegetation, while urban/wildland interface or intermix fires are fires in which vegetation and the built environment provide the fuel.

Prevalent in the Brazos County area, surface fires and ground fires are the majority, while crown fires can occur anywhere, they are unlikely to occur in the planning area.

Hazardous Areas

Fires can affect any part of the planning area, causing temporary or permanent closure of critical infrastructure and facilities and threatening human life, property, and the environment.

A wildfire event can be a potentially damaging consequence of drought. Wildland fire risk can vary considerably by month.

Wildfires can vary greatly in terms of size, location, intensity, and duration. While wildfires are not confined to any specific geographic location, they are most likely to occur in open grasslands. The threat to people and property from a wildfire event is greater in the fringe areas where developed areas meet open grass land[2]. The following Figure: 8.1 identifies wildfire observed dangers in Texas on 17 October 2023, including Brazos County:

QUICK FACTS

Types of Wildfires:

Urban/Wildland Interface:

Areas with housing and low-density vegetation within fire's reach (1.5 miles) of a large, contiguous block of wildland vegetation.

3 Classes of Wildfires

Surface Fire:

Most common; burns along the floor of a forest.

Ground Fire:

Usually started by lightning; burns on or below the forest floor down to the mineral soil.

Crown Fire:

Spread by wind; moves quickly along tops of trees.

Source: National Wildfire Coordinating Group[1]

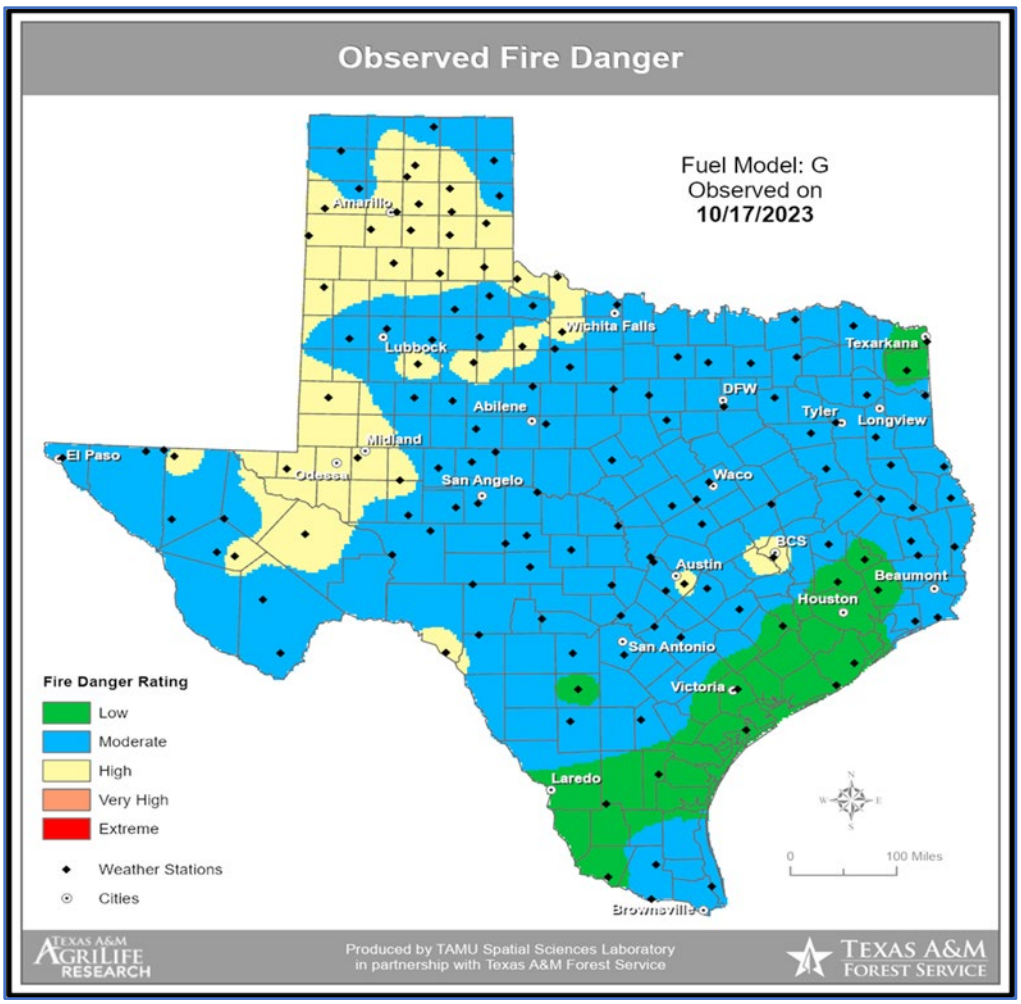


Figure: 8.1 – Sample of Observed Fire Danger Source: Texas A & M Forest Service[2]

Figure: 8.1, as shown above, is a current visual that was created by the Texas A & M Forest Service[2] to maintain a continual assessment of wildfire risk at the state, regional and local level, Texas A&M Forest Service[2] continually analyzes current and predicted weather conditions, wildfire occurrence and the presence and availability of vegetative fuels throughout the year. Using this information, agency staff develop daily and seasonal forecasts to assist state and local governmental entities in preparing for and responding to periods of elevated fire danger or fire seasons. The program produces information and products that are used at the national, state, and local level by firefighters, elected officials, and public administrators. Their key services include:

- Determining current and predicted weather conditions.
- Monitoring the condition of vegetation and other potential hazards.
- Calculating current and predicted fire behavior.
- Identifying high wildfire risk areas and values threatened.
- Tracking wildfire occurrence and ignition sources.
- Disseminating assessment information to stakeholders and the public.

Wildfire ignition densities in Brazos County are low, moderate, high, and very high and were determined based on the following criteria:

- Risks associated with fuel complexes.
- Risk associated with population.
- Weighted factors of population growth.

Previous Occurrences

The Texas A & M Forest Service2 reported statewide, 218,351 wildfire incidents between 2005 and 2021, burning approximately 11,803,382 acres during this period, 86% of all the wildfires were within 2-miles of a community[2] (See Figure: 8.2).

The historical data reflects wildfire response for Texas A&M Forest Service[2] and local fire departments. Prior to 2005, official wildfire data was not captured using current reporting methods. There is no official data prior to 2005. The map below shows approximate locations of wildfires, which can be grass or brushfires of any size.

In 2022, Texas experienced 12,411 wildfires with a combined loss of 650,712 acres. These figures outpace California's statistics by almost two times[3]. Table: 8.1, shows a sample of the previous types and locations of wildland fires within the area.

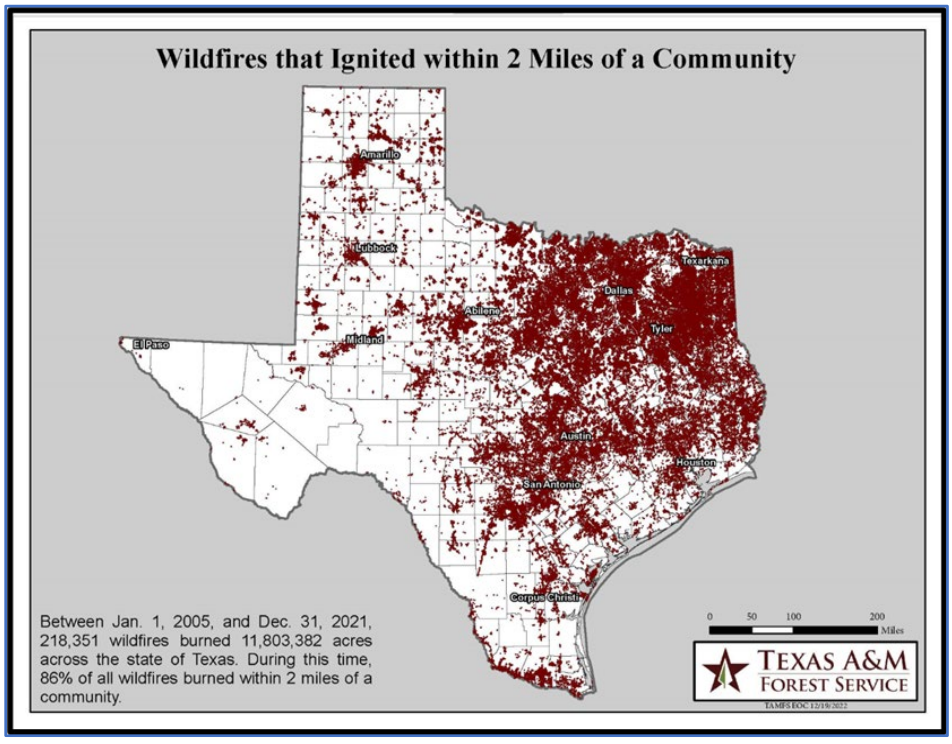


Figure: 8.2 – Historical Wildfire Data Map Source: Texas A&M Fire Service[2]

Type	Primary Fire Department	Date(S)	Cause	Acres Affected	Agencies Responding
Wildfire	Brazos County Pct. 4 VFD	10/06/2005	Burning debris	320	8
Wildfire	Brazos County Pct. 4 VFD	12/03/2005	Equipment use	375	6
Wildfire	Brazos County Dist. 2 VFD	12/24/2005	Miscellaneous	300	5
Wildfire	Brazos County Dist. 2 VFD	01/03/2006	Incendiary	500	7
Wildfire	Brazos County Dist. 2 VFD	01/07/2006	Incendiary	300	7
Wildfire	Brazos County Dist. 2 VFD	02/27/2006	Burning debris	70	2
Wildfire	Brazos County Dist. 2 VFD	03/31/2006	Burning debris	30	3
Wildfire	Brazos County Pct. 3 VFD	09/02/2006	Miscellaneous	148	3
Wildfire	South Brazos County FD	07/11/2008	Burning debris	75	5
Wildfire	Brazos County Pct. 3 VFD	11/05/2008	Burning debris	25	6
Wildfire	Brazos County Pct. 3 VFD	12/07/2008	Burning debris	50	3
Wildfire	Brazos County Pct. 3 VFD	01/07/2009	Burning debris	35	3
Wildfire	Brazos County Pct. 3 VFD	01/21/2009	Burning debris	40	4
Wildfire	Brazos County Pct. 3 VFD	01/31/2009	Burning debris	145	3
Wildfire	Brazos County Dist. 2 VFD	05/09/2011	Unknown	100	8
Wildfire	Brazos County Dist. 2 VFD	11/04/2017	Burning debris	40	5

Table: 8.1 - Sample of Previous Wildland Fires Source: Brazos County HMAP (2019-2024)[4]

Future Probability

Wildfires can occur at any time of the year. As the entities within the county move into undeveloped areas, the potential area of occurrence of wildfire increases. With 230,762 incidents in a 17-year period, in Texas, an event within Brazos County, including all participating entities, is highly likely, meaning an event is probable within the next year.

Climatic conditions such as severe freezes and drought can significantly increase the intensity of wildfires since these conditions kill vegetation, creating a prime fuel source for wildfires. The intensity and rate at which wildfires spread are directly related to wind speed, temperature, and relative humidity[5].

The severity of impact from major wildfire events can be substantial. Such events can cause multiple deaths, shut down facilities for 30 days or more, and cause more than 50 percent of affected properties to be destroyed or suffer major damage. Severity of impact is gauged by acreage burned, homes and structures lost, and the number of resulting injuries and fatalities[5].

The Keetch-Byram Drought Index (KBDI)[6] is one of the parameters used to determine forest fire potential. The drought index is based on a daily water balance and upper soil layers, where a drought factor is balanced with precipitation and soil moisture (assumed to have a maximum storage capacity of 8-inches) and is expressed in hundredths of an inch of soil moisture depletion.

The drought index ranges from 0 to 800, where a drought index of 0 represents no moisture depletion, and an index of 800 represents absolutely dry conditions. Presently, this index is derived from ground-based estimates of temperature and precipitation derived from weather stations and interpolated manually by experts at Texas A&M Forest Service[2] for counties across the state.

Researchers at Texas A&M University are working with Texas A&M Forest Service[2] to derive this index from the Advanced Very High-Resolution Radiometer (AVHRR) satellite[2] data and the

Next Generation Weather Radar (NEXRAD) radar[2] rainfall within a GIS. Figure: 8.2, shows the predictive capabilities of the KBDI[6]. The measurements used are located on Table: 8.3.

KBDI Values	Drought and Fire Potential Information
0 – 200	Soil and fuel moisture is high. Most fuels will not contribute much to wildfire intensity. This is often seen in spring after winter precipitation.
200 - 400	Fuels are beginning to dry and contribute to wildfire intensity. Heavier fuels will still not readily ignite and burn. This is often seen in late spring.
400 - 600	Wildfire intensity begins to increase significantly. Wildfires will readily burn, and larger fuels could burn or smolder for several days. This is often seen in late summer and early fall.
600 - 800	Wildfires will show extreme intensity. Deep-burning, intense wildfires with significant spotting can be expected. This is often associated with severe drought.

Table: 8.2 - Keetch-Byram Drought Index Source: Texas A&M Forest Service[2]

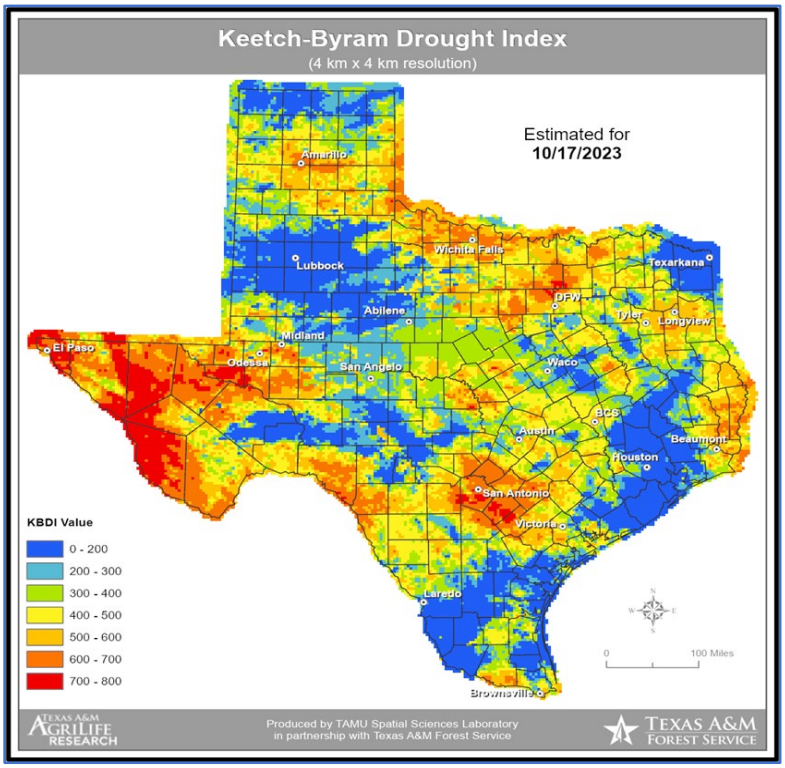


Figure: 8.3 – Sample of Keetch-Byram Drought Index Source: Texas A&M Forest Service (TFS)[2]

The KBDI[6] can also be a good measure of the readiness of fuels for a wildfire incident. It should be referenced as the area experiences changes in precipitation and soil moisture, while caution should be exercised in dryer, hotter conditions.

The range of intensity for the Brazos County planning area in a wildfire incident is within an average of 400 to 603[4]. But it is not uncommon to have a wildfire outside of these ranges. The average extent to be mitigated for the Brazos County planning area, including all participating entities, is a KBDI[6] of 400, including other factors. At this level fires more readily burn and will carry across an area with no gaps. According to RiskFactor.com[7], there are currently 62,610 properties in Brazos County that have some risk of being in a wildfire within the next 30 years[7].

Other parameters used to determine fire potential include humidity levels, increased wind speeds, vegetation moisture levels, and fire loads.

Climate Change

Climatic cycles have occurred naturally over hundreds of thousands of years. These cyclical fluctuations happen on varying time scales lasting from a couple of years to decades to centuries to millennia. Natural climate cycles can help determine what climate patterns are expected and how the recent increase in greenhouse gas emissions is causing deviations from these patterns[8]. Interannual to Decadal climate cycles involve the relationship between the ocean and the atmosphere which affect the cycles on a year to decade basis. El Niño[9] (or its opposite La Niña[9]) occurs every 3 to 7 years and delivers a variety of weather conditions around the world. There is some evidence that global warming may be intensifying El Niño/La Niña[9] (See Section 9), regarding information on El Nino/La Nina) events. La Niña is the weather phenomenon that is responsible for the drier climate, including drought, in the Southern U.S[9]. According to the EPA[10]: “Most of [Texas] has warmed between one-half and one degree (F) in the past century. In the Eastern two-thirds of the state, average annual rainfall is increasing, yet the soil is becoming drier.… In the coming decades, storms are likely to become more severe, deserts may expand, and summers are likely to become increasingly hot and dry, creating problems for agriculture and possibly human health.… Higher temperatures and drought are likely to increase the severity, frequency, and extent of wildfires, which could harm property, livelihoods, and human health.”[10] Research shows the fluctuations in climate have created warmer, more arid conditions that can cause a prolonged, more active fire season.

Potential Damages and Losses

Potential annualized losses and damages are estimated by using the statistical risk assessment methodology to compile local and national data, remove duplication, identify patterns in frequency and vulnerability, extrapolate statistical patterns, and produce meaningful results. Table: 8.3 currently shows the critical infrastructure located within the reporting area, that has the potential to become affected. Based on these calculations, the estimated annualized losses to fire in the planning area amount to $1,553,605 (Table: 8.4).

Type	Brazos County	Bryan	College Station	Texas A&M University	Wixon Valley	Kurten
Airports		1		1		
Animal Shelter	1	1				
Bus Lines		2		1		
City Halls		1	1		1	
Communication Stations		6	1	1		
Community Centers	2	4	8			
Courthouses	1	1	2			
Dialysis Clinics		3	2			
Electric Power Facilities		2	1	5		
Emergency Operations Centers	1			1		
Environmental Services		1	1			
Fire Stations	12	5	6			
Highways	5		2			
Major Employment Centers		4	1	1		1
Medical Centers		14	15	1		
Nuclear Science				1		
Assisted Living Facilities		10	4			
Places of Worship		108	144			
Law Enforcement Stations	1	3	1	1		
Post Offices	1	1	1	1		1
Public Works Services		1	1			
Railway Bridges						
Schools and Administration		33	18			
Public Works Operations Centers			1			
Wastewater Facilities		6	21	2		

Table: 8.3 – Critical Infrastructure within the Planning Area Source: Brazos County HMAP (2019-2024)[4]

County	Annualized Expected Property Losses ($)
Brazos	$1,553,605

Table: 8.4 - Annualized Expected Property Loss Source: Brazos County HMAP (2019-2024)[4]

Extent

Risk for a wildfire event is measured in terms of magnitude and intensity using the Keetch Byram Drought Index (KBDI), a mathematical system for relating current and recent weather conditions to potential or expected fire behavior[6]. The KBDI determines fire potential based on a daily water balance, derived by balancing a drought factor, which is the measurement of precipitation and soil moisture (assumed to have a maximum storage capacity of eight inches), and is expressed in hundredths of an inch of soil moisture depletion[6]. This information is derived from the use of ground-based temperatures and the level of precipitation in the area[2]. The extent of the wildfire or the rate of spread is highly dependent on several factors to include wind speed and direction, temperature, relative humidity, and fuel moisture. One of the other factors that determines extent is the topography of the land as wildfire burns faster uphill than they do downhill.

The extent of urban/wildland interface fires in Brazos County and participating entities is a major concern; fires can completely shut down small businesses and residents for at least two weeks and cause more than 25 percent of affected properties to be destroyed or incur damages[7]. The frequency of occurrence of urban/wildland interface fire events in Brazos County is likely, with an event probable in the next three years[7].

Winter is the peak period for major urban/wildland interface fires and fire deaths. The urban/wildland interface fire risk varies considerably by month[7]. Warning time for urban/wildland interface fire events is minimal to none.

The maps below (Figures 8.4, 8.5, and 8.6) show the wildfire exposure score for Brazos County. The wildfire exposure score combines two important wildfire factors related to structure exposure: the chance of wildfire (Burn Probability) and the potential damage to homes from wildfire (Damage Potential). These maps were produced by the Texas Wildfire Risk Explorer

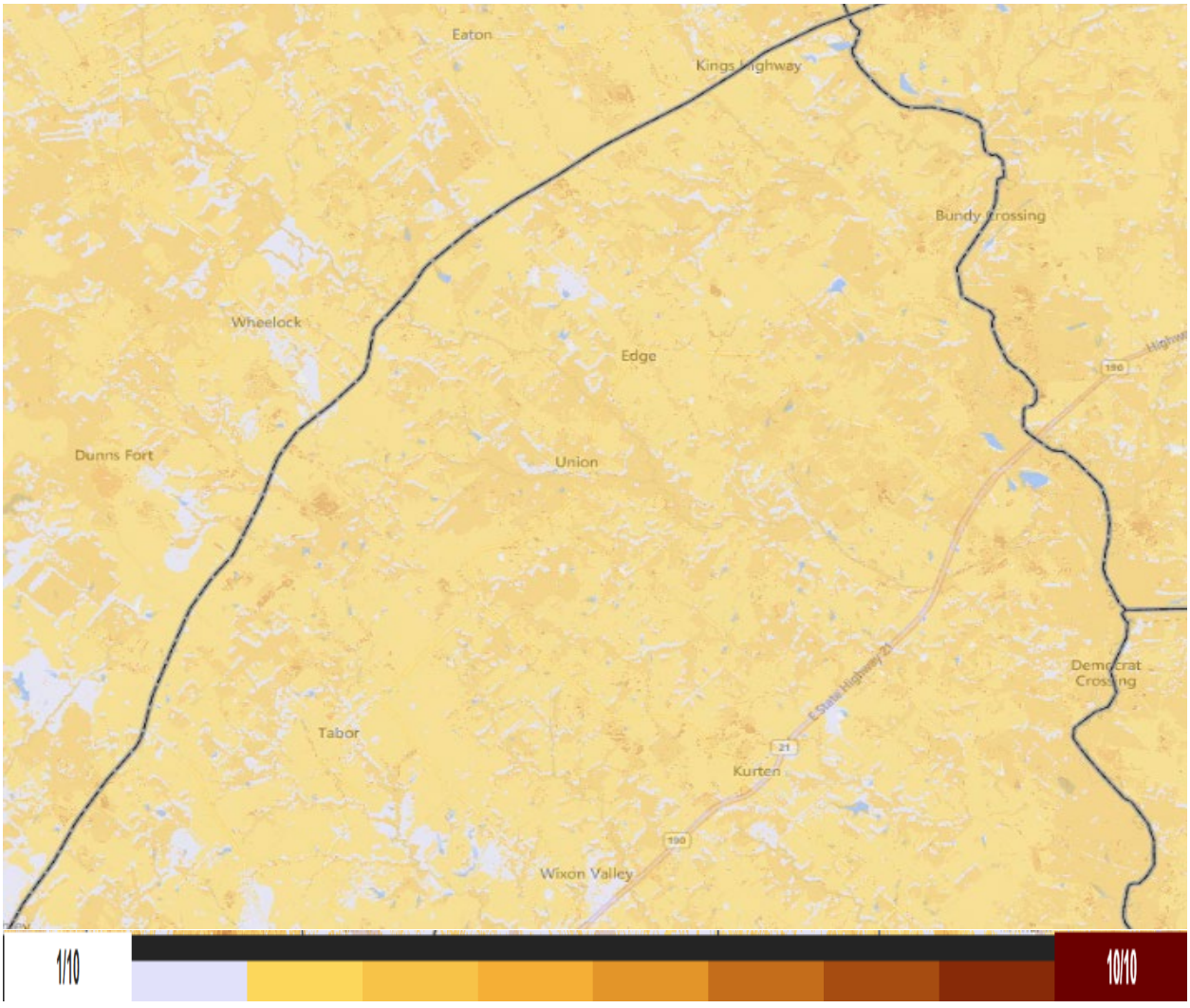


Figure 8.4 North Brazos County to include the Cities of Wixon Valley and Kurten
Source: Texas Wildfire Risk Explorer

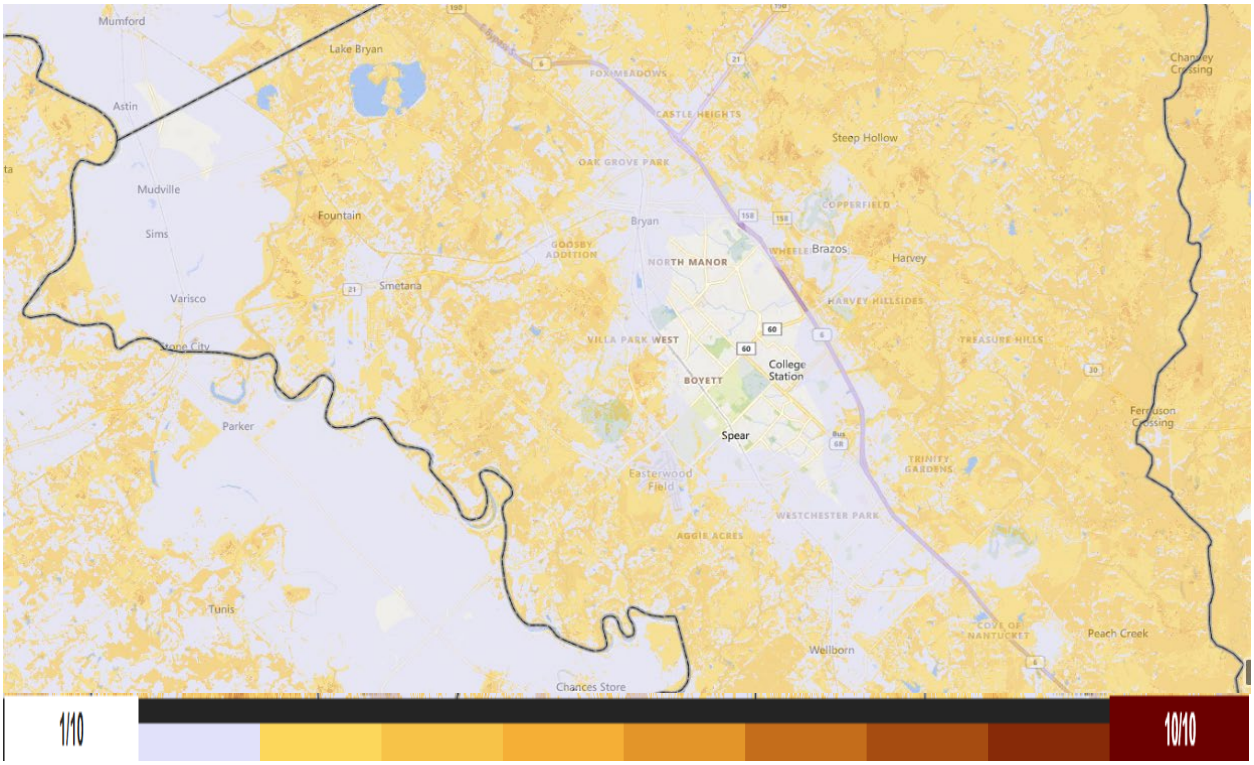


Figure 8.5 Central Brazos County to include Cities of Bryan and College Station to also include Texas A&M University Main Campus
Source: Texas Wildfire Risk Explorer

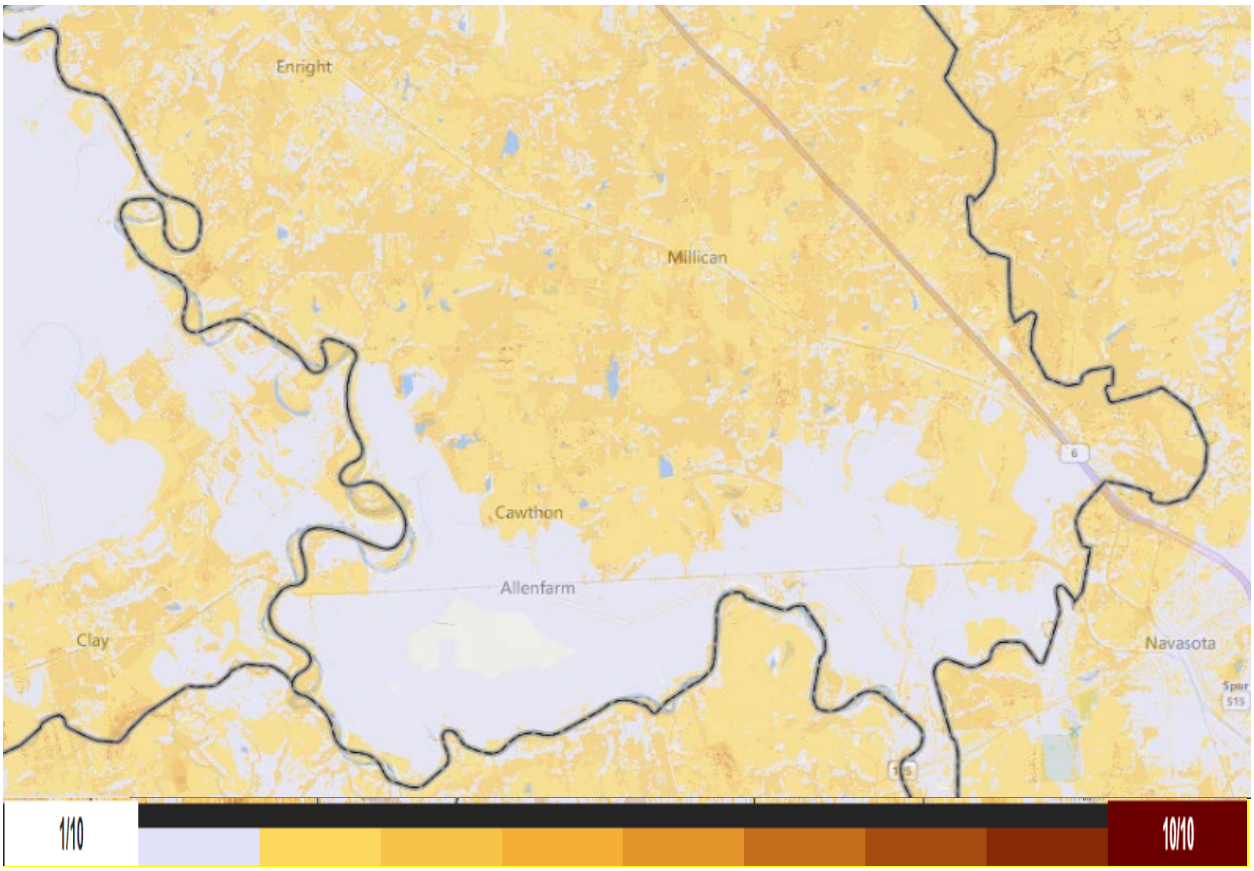


Figure 8.6 South Brazos County to include the communities of Millican, Cawthon, and Allen Farms.
Source: Texas Wildfire Risk Explorer

There are 62,610 properties in Brazos County that have some risk of being affected by wildfire over the next 30 years. This represents 88% of all properties in Brazos County. In addition to damaging properties, wildfire can also cut off access to utilities, emergency services, impact evacuation routes, and may impact the overall economic well-being of an area[7]. Overall, Brazos County has a moderate risk of wildfire[7].

Assessment of Impacts

A wildfire incident poses a potentially significant risk to public health and safety, particularly if the wildfire is initially unnoticed and spreads quickly. The impacts associated with a wildfire are not limited to direct damage. Potential impacts for the planning area include:

- Persons in the area at the time of the fire are at risk for injury or death from burns and/or smoke inhalation.
- First responders are at greater risk of physical injury since they are near the hazard while extinguishing flames, protecting property, or evacuating residents in the area.
- First responders can experience heart disease, respiratory problems, and other long term related illnesses from prolonged exposure to smoke, chemicals, and heat.

- Emergency services may be disrupted during a wildfire if facilities are impacted, roadways are inaccessible, or personnel are unable to report for duty.
- Critical city and/or county departments may not be able to function and provide necessary services depending on the location of the fire and the structures or personnel impacted.
- Non-critical businesses may be directly damaged, suffer loss of utility services, or be otherwise inaccessible, delaying normal operations and slowing the recovery process.
- Displaced residents may not be able to immediately return to work, furthering economic recovery.
- Roadways in or near the area of impact could be damaged or closed due to smoke and limited visibility.
- Some high-density neighborhoods feature small lots with structures close together, increasing the potential for fire to spread rapidly.
- Air pollution from smoke may exacerbate respiratory problems of vulnerable residents.
- Charred ground after a wildfire cannot easily absorb rainwater, increasing the risk of flooding.
- Wildfires can cause erosion, degrading stream water quality.
- Wildlife may be displaced or destroyed.
- Historical or cultural resources may be damaged or destroyed.
- Tourism can be significantly disrupted, further delaying economic recovery for the area.
- Economic disruption negatively impacts the programs and services provided by the community due to short- and long-term loss in revenue.
- Residential structures lost in a wildfire may not be rebuilt for years, reducing the tax base for the community.
- At locations like the Brazos River and area lakes such as Lake Bryan, recreation and tourism can be unappealing for years following a large wildfire, devastating directly related businesses.
- Direct impacts to municipal water supply may occur through contamination of ash and debris during the fire, destruction of aboveground delivery lines, and soil erosion or debris deposits into waterways after the fire.

The effects of changes in population increases the exposure to wildfires. As the population continues to grow, the wildland urban interface expands as people build structures and living occupancies in areas that were once pasture lands.

The economic and financial impacts of a wildfire incident on local government will depend on the scale of the event, what is damaged, costs of repair or replacement, lost business days in impacted areas, and how quickly repairs to critical components of the economy can be implemented.

The level of preparedness and pre-event planning done by government, businesses, and citizens will contribute to the overall economic and financial conditions in the aftermath of a wildfire incident.

References – Section 8

1. *National Wildfire Coordinating Group. Mitigation in the Wildland Urban Interface. https://www.nwcg.gov/sites/default/files/publications/pms052.pdf*
2. *Texas A & m Forest Service. Main Page. https://tfsweb.tamu.edu/*
3. *Forbes. Top Stated with the Most Homes at Risk for Wildfires. https://www.forbes.com/sites/brendarichardson/2019/09/12/top-states-with-the-most-homes-at-risk-of-wildfire-damage/?sh=46b8aa234c50*
4. *Brazos County HMAP (2019-2024). Main Page. https://bcdem.org/emergency/plans*
5. *Center for Climate and Energy Solutions. Wildfires and Climate Change. https://www.c2es.org/content/wildfires-and-climate-change/*
6. *Keetch – Byram Drought Index. Texas Weather Connection. https://twc.tamu.edu/kbdi*
7. *Risk Factor. What will Climate Cost You? https://riskfactor.com/*
8. *United State Department of Agriculture. Climate Change Resource Center. Natural Climate Cycles. https://www.fs.usda.gov/ccrc/education/climate-primer/natural-climate-cycles*
9. *National Oceanic and Atmospheric Administration. El Nino and La Nina. https://www.noaa.gov/education/resource-collections/weather-atmosphere/el-nino*
10. *US Environmental Protection Agency. What Climate Change Means for Texas. https://www.epa.gov/sites/default/files/2016-09/documents/climate-change-tx.pdf*

This page intentionally left blank.

Section 9 – Severe Winter Weather

Hazard Description

A severe winter storm incident is identified as a storm with snow, ice, or freezing rain. This type of storm can cause significant problems for area residents[2].

Winter storms are associated with freezing or frozen precipitation such as freezing rain, sleet, frost, snow, a blizzard, and the combined effects of winter precipitation and strong winds[1].

Wind chill is a function of temperature and wind. Low wind chill is a product of high winds and freezing temperatures[1].

Winter storms that threaten Brazos County planning area usually begin as powerful cold fronts that push south from central Canada. Although the county is at risk of ice hazards, extremely cold temperatures, and snow, the effects and frequencies of winter storm events are generally mild and short-lived[1].

The Brazos County planning area, including all participating entities, typically experience approximately 18-24 extreme cold days a year, meaning up to 24 days are at or around freezing temperatures.

During times of ice and snow accumulation, response times increase until public works road crews can make major roads passable.

Table: 9.1 below, displays the types of winter storms and the weather patterns that are associated with them.

QUICK FACTS

Winter Weather

Announced for snow, blowing, or drifting snow, freezing drizzle, freezing rain, or a combination.

Hazard Definitions

Freezing Rain/Drizzle

Rain or drizzle is likely to freeze on impact and may cause ice accumulation.

Sleet

Small particles of ice usually mixed with rain that can make travel hazardous.

Frost/Freeze Warning

Below freezing temperatures will cause damage to plants and crops.

Blizzard

Sustained winds of 35 mph or more along with considerable snow.

Wind Chill

A strong wind combined with temperatures below freezing.

Source: National Oceanic & Atmospheric Administration (NOAA)[1]

Type of Winter Storm	Description
Winter Weather Advisory	This alert may be issued for a variety of severe conditions. Weather advisories may be announced for snow, blowing or drifting snow, freezingdrizzle, freezing rain, or a combination of weather events.
Winter Storm Watch	Severe winter weather conditions may affect your area (freezing rain, sleet, or heavy snow may occur separately or in combination).
Winter Storm Warning	Severe winter weather conditions are imminent.
Freezing Rain or Drizzle	Rain or drizzle is likely to freeze upon impact, resulting in a coating of iceglaze on roads and all other exposed objects.
Sleet	Small particles of ice usually mixed with rain. If enough sleet accumulates on the ground, it makes travel hazardous.
Blizzard Warning	Sustained wind speeds of at least 35 mph are accompanied by considerable falling or blowing snow. This alert is the most perilous winterstorm with visibility dangerously restricted.
Frost or Freeze Warning	Below freezing temperatures are expected and may cause significant damage to plants, crops, and fruit trees.
Wind Chill	A strong wind combined with a temperature slightly below freezing can have the same chilling effect as a temperature nearly 50 degrees lower in a calm atmosphere. The combined cooling power of the wind and temperature on exposed flesh is called the wind-chill factor.

Table: 9.1 – Winter Storm Descriptions Source: National Weather Service[3]

Hazardous Areas

Winter storm events are not confined to specific geographic boundaries. Therefore, all existing and future buildings, facilities, and populations in the Brazos County planning area, including all participating entities, are exposed to a winter storm hazard, and could potentially be impacted[3].

The extent or magnitude of a severe winter storm is measured in intensity based on the temperature and level of accumulations as shown in Table: 9.2. Table: 9.3 should be read in conjunction with the wind-chill factor described in Figure: to determine the intensity of a winter storm. The chart is not applicable when temperatures are over 50°F or winds are calm. This is an index developed by the National Weather Service[3].

INTENSITY	TEMPERATURE RANGE (Fahrenheit)	EXTENT DESCRIPTION
Mild	40-50	Winds less than 10 mph and freezing rain orlight snow falling for short durations with little or no accumulations.
Moderate	30 – 40	Winds 10 – 15 mph and sleet and/or snow upto 4 inches.
Significant	25 – 30	Intense snow showers accompanied with strong gusty winds between 15 and 20 mph with significant accumulation.
Extreme	20 – 25	Wind driven snow that reduces visibility, heavy winds (between 20 to 30 mph), and sleet or ice up to 5 millimeters in diameter.
Severe	Below 20	Winds of 35 mph or more and snow and sleet greater than 4 inches.

Table: 9.2 – Magnitude of Severe Winter Storms Source: NOAA[4]

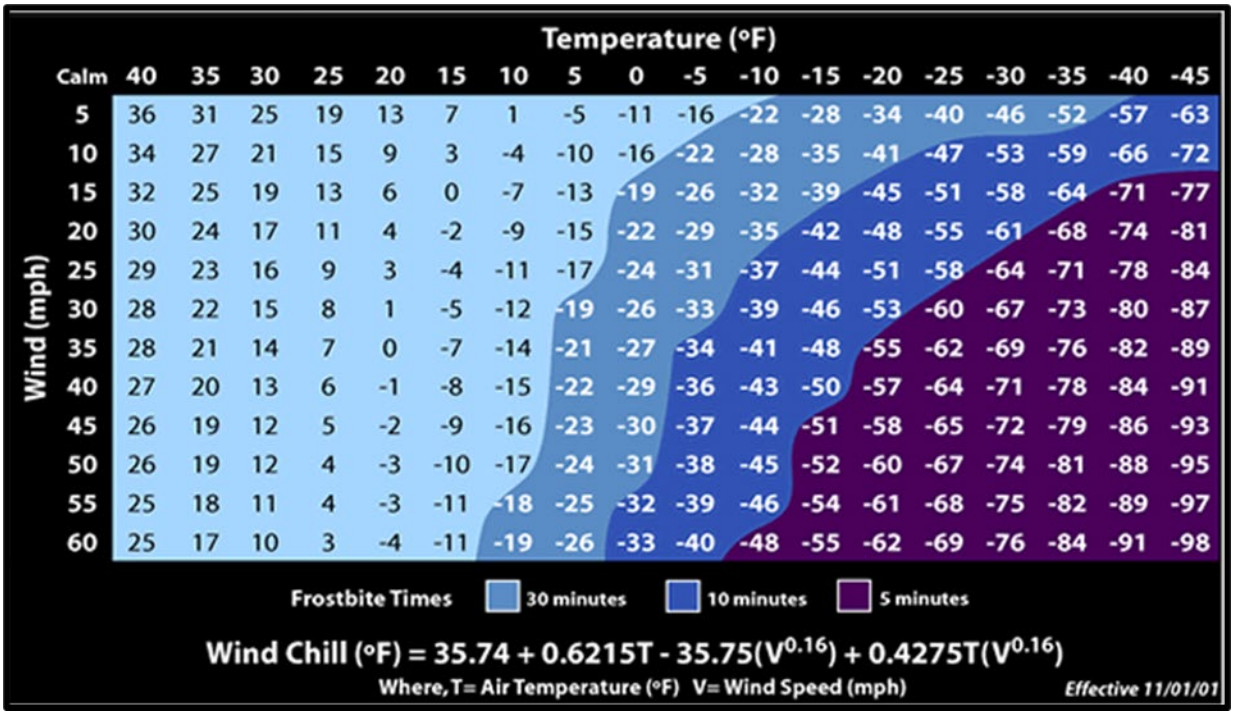


Table: 9.3 – Wind Chill Factor Chart Source: NOAA[4]

Wind chill temperature is a measure of how cold the wind makes real air temperature feel to the human body. Since wind can dramatically accelerate heat loss from the body, a blustery 30° F Day would feel just as cold as a calm day with 0° F temperatures[4]. The Brazos County planning area, including all participating entities, has never experienced a blizzard. Based on nineteen (19) previous occurrences recorded from 1997 through 2023, it has been subject to winter storm watches, warnings, freezing rain, sleet, snow, and wind chill, including the winter storm Uri.

The average number of cold days is similar for the entire planning area, including all participating entities. Therefore, the intensity or extent of a winter storm incident to be mitigated

for the area ranges from mild to extreme according to the definitions in Table: 8.2. The entire Brazos County planning area can expect anywhere between 0.1 to 4.0 inches of ice and snow during a winter storm event and temperatures between 20 and 50 degrees with winds ranging from 0 to 20 mph[3].

Previous Occurrences

The Great Texas Freeze of February 2021 killed far more people in the Lone Star State than Hurricane Harvey did in 2017. According to the final report from the Texas Department of State Health Services[5], released in December 2021, 246 deaths were attributed to the Great Texas Freeze (Winter Storm Uri), spread out across seventy-seven (77) of the state's counties[5].

Among the 244 that had state residency information available, 229 of the deceased were Texas residents and fifteen (15) lived in other states or countries but were in Texas when they were killed. Hurricane Harvey killed eighty-nine (89) people, that means the Great Texas Freeze killed nearly three times more people than Harvey, the nation's second-costliest weather disaster behind only Hurricane Katrina in 2005[4].

NOAA[4] estimated the historic cold snap in 2021 was a $25.6 billion disaster, more than doubling the inflation-adjusted cost of the "Storm of the Century" in March 1993. Figure: 9.1, shows the weather across the nation.

From January 1997 through February 2022, Brazos County experienced 19 winter storm events. A complete list of winter storm events, as sourced from the Brazos County HMAP (2019-2024)[6] in Table: 9.4.

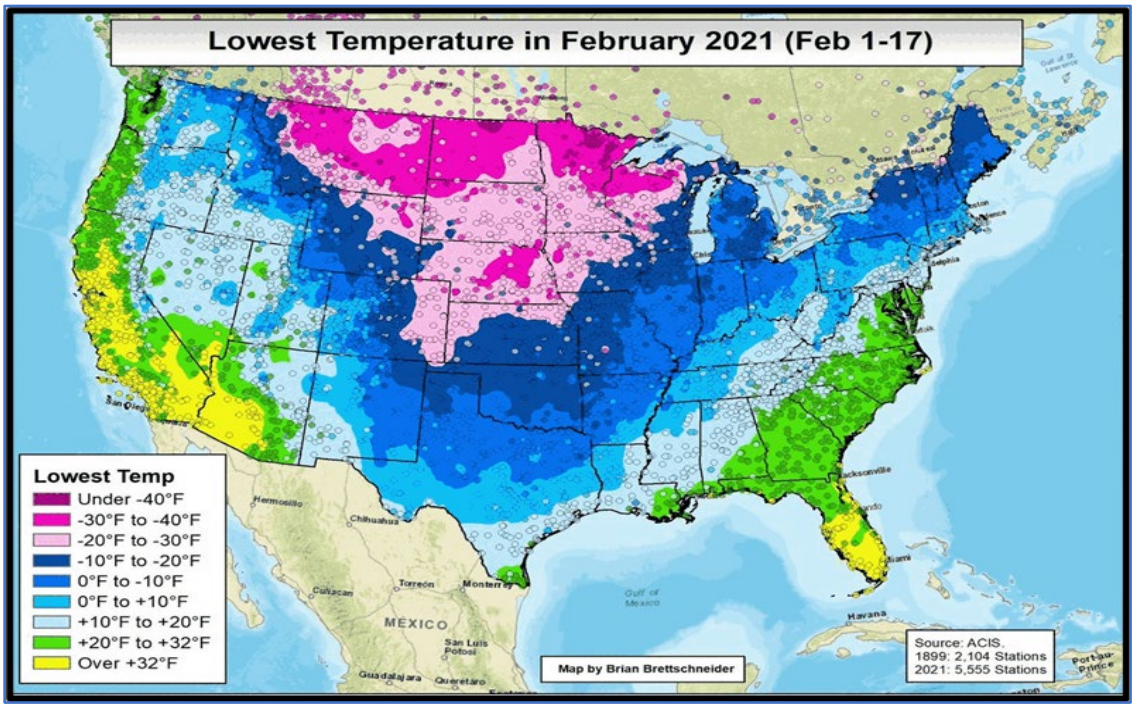


Figure: 9.1 – Historic Severe Winter Weather Source: NOAA[4]

Type	Location	Date(S)	Deaths	Injuries	Property Damage	Crop Damage
General, Ice	Countywide	01/12/1997	0	0	0	0
General	Countywide	12/23/1998	0	0	$75k	0
General, Ice	Countywide	12/13/2000	0	0	$1m	0
Ice Storm	Countywide	12/07/2005	1	2	$70k	0
Ice Storm	Countywide	01/16/2007	0	0	$1k	0
Ice Storm	Countywide	02/04/2011	0	0	0	0
General, Ice	Countywide	12/07/2013	0	0	0	0
General, Ice	Countywide	01/28/2014	0	0	0	0
General, Ice	Countywide	02/06/2014	0	0	$50k	0
General, Ice	Countywide	3/2-3/2014	0	0	0	0
Snow	Countywide	12/07/2017	0	0	0	0
General	Countywide	01/10/2021	0	0	0	0
General	Countywide	02/13/2021	0	0	0	0
Cold, Wind	Countywide	02/15/2021	0	0	$108k	0
Ice	Countywide	02/17/2021	0	0	0	0
Ice	Countywide	02/03/2022	0	0	0	0

Table: 9.4 – Severe Winter Weather Events Source: Brazos County HMAP (2019-2024)[6]

Future Probability

Winter weather impacts continue to increase in severity with climate change as warmer global air temperatures generate conditions more favorable for extreme precipitation events and destabilize the polar vortex pattern[3].

The expected El Niño[7] has emerged and should gradually strengthen into the winter. El Niño is a natural climate phenomenon marked by warmer-than-average sea surface temperatures in the Pacific Ocean. Typically, El Niño[7] conditions result in wetter-than-average conditions from southern California to along the Gulf Coast and drier-than-average conditions in the Pacific Northwest, (see Figure: 9.2). We also expect a warm Atlantic Multidecadal Oscillation (AMO) and cool Pacific Decadal Oscillation (PDO). Also important are the equatorial stratospheric winds involved in the Quasi-Biennial Oscillation, or QBO[7].

El Niño is characterized by unusually warm ocean temperatures in the Equatorial Pacific. El Niño is an oscillation of the ocean-atmosphere system in the tropical Pacific having important consequences for weather around the globe[7].

El Niño events also disrupt global atmospheric circulation. Global atmospheric circulation is the large-scale movement of air that helps distribute thermal energy (heat) across the surface of Earth. The eastward movement of oceanic and atmospheric heat sources causes unusually severe winter weather at the higher latitudes of North and South America[7].

Among these consequences are increased rainfall across the southern tier of the U.S. and in Peru, which has caused destructive flooding and drought[7]. Figure: 9.2 shows the extent of the effects of El Nino on Texas and surrounding areas.

Under certain combinations of meteorological conditions, the polar vortex can be displaced from the North Pole, which could open the door for cold blasts to hit southern Canada and the central and eastern United States during this upcoming winter[7].

In the U.S., winter temperatures are warmer than normal in the Southeast, and cooler than normal in the Northwest[7]. Global climate La Niña[7] impacts tend to be opposite those of El Niño[7] impacts. In the tropics, ocean temperature variations in La Niña[7] tend to be opposite those of El Niño[7]. At higher latitudes, El Niño[7] and La Niña[7] are among a few factors that influence climate. However, the impacts of El Niño[7] and La Niña[7] at these latitudes are most clearly seen in wintertime. In the continental U.S., during El Niño[7] years, temperatures in the winter are warmer than normal in the North Central States, and cooler than normal in the Southeast and the Southwest. During a La Niña[7] year, (see Figure: 9.3), winter temperatures are warmer than normal in the Southeast and cooler than normal in the Northwest[7].

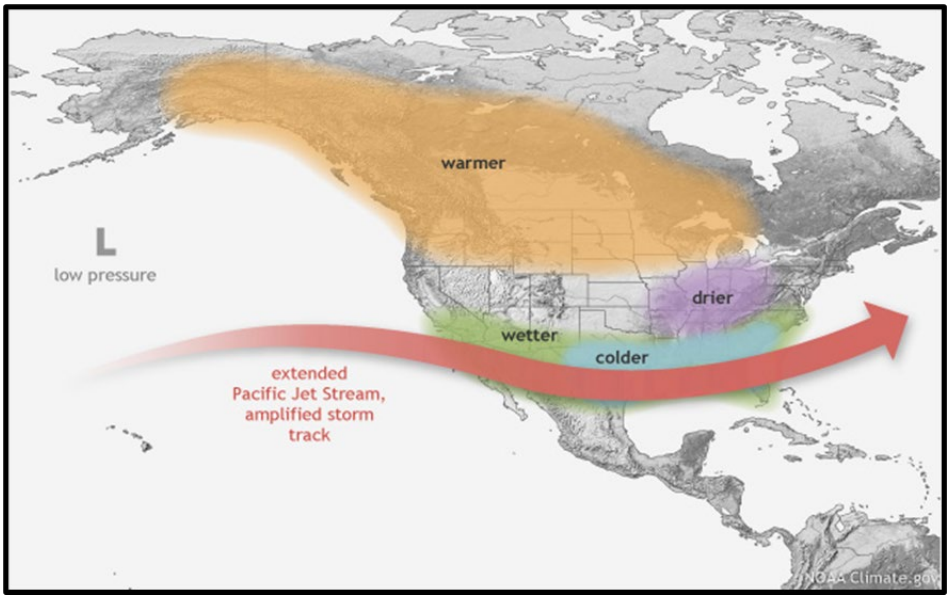


Figure 9.2 - El Nino Weather Patterns Source: NOAA[7]

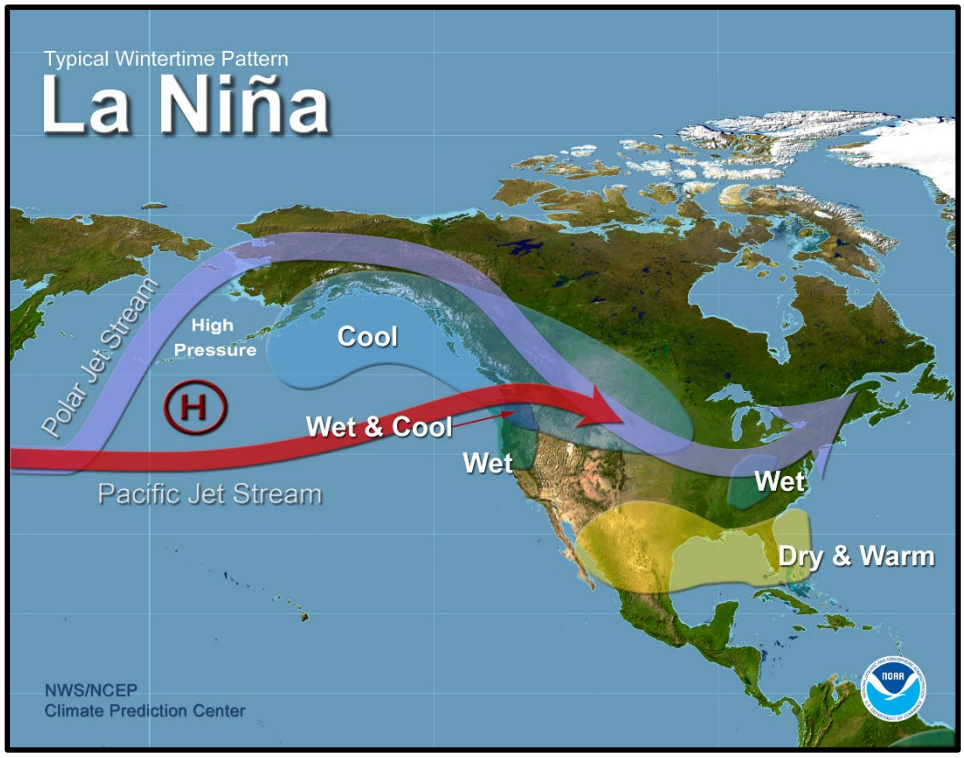


Figure: 9.3 – La Nina Weather Patterns Source: NOAA[7]

Climate Change

Temperatures are "warming" during all seasons. In many regions, winters are warming faster than any other season. Climate Central[8] reports that winters across the contiguous United States have warmed by an average of nearly 3°F over the last half of the century[8]. Extreme precipitation events appear to be increasing in frequency in Texas, and more broadly across other parts of the U.S. Consequently, the increasing temperatures that lead to increase evaporation and thus increased precipitation, can also be expected to lead to increased snowfall as well." Additionally, research suggests that with increases in average global temperatures and average arctic temperatures, the jet stream may also change, slowing down and growing wavers[8]. Changes in the jet stream may allow extremely cold arctic air to advance farther south than usual in the winter months and may affect areas that are not accustomed to low temperatures for longer periods of time[10]. Though on average winters are predicted to be shorter and warmer, many areas are predicted to continue to experience significant cold weather over time[9].

Potential Damages and Losses

During periods of extreme cold and freezing temperatures, water pipes can freeze and crack, and ice can build up on power lines, causing them to break under the weight or causing tree limbs to fall on the lines. These events can disrupt electric service for long periods.

An economic impact may occur due to increased consumption of heating fuel and utilities, which can lead to energy shortages and higher prices. House fires and resulting deaths tend to occur more frequently from increased and improper use of alternate heating sources. Fires during

winter storms also present a greater danger because water supplies may freeze and impede firefighting efforts.

All populations, buildings, critical facilities, infrastructure, and equipment in the entire Brazos County planning area, including all participating entities, are vulnerable to severe winter events; for example, which may freeze and impede potential firefighting efforts and affect medical capabilities, such as dialysis.

Extreme winter weather can cause significant problems in the planning area including, but not limited to, the following:

- Ice accumulation on trees and power lines.
- Hazardous road conditions.
- Dangerous ambient and wind chill temperatures.

People and animals are subject to health risks from extended exposure to cold air. Elderly people are at greater risk of death from hypothermia during these events, especially in the rural areas of the county where populations are sparse, icy roads may impede travel, and there are fewer neighbors to check in on the elderly[12].

According to the U.S. Center for Disease Control[10], every year hypothermia kills about 600 Americans, half of whom are 65 years of age or older. In addition, populations living below the poverty level may not be able to afford to run heat on a regular basis[10]. According to the Census Bureau[11], Brazos County currently has 10.3% of the population over 65 and 22.6% living in poverty. Poverty is defined as not having enough money to meet basic needs including food, clothing, and shelter[11].

The annualized expected property losses due to extreme winter weather in Brazos County were calculated using the statistical risk assessment methodology. According to the data from this assessment, potential annualized losses in the planning area are $4,428.50.

Extent

The location of winter storms in Brazos County and the participating entities can impact the entire planning area. The extent of winter storms in Brazos County and the participating entities can extend from something as minor as winter weather advisory's or as major as freezing temperatures with sleet, snow, and wind chill. The maximum extent of winter storms for Brazos County and the participating entities includes low temperatures below 32 degrees, freezing rain and sleet, and/or snow amounts up to 6-10 inches[6].

The frequency of occurrence of winter storms in Brazos County and the participating entities is unlikely, with an event probable in the next ten years. The severity of impact of winter storms is generally minor[6]. Winter storms can cause injuries and completely shut down facilities for more than one week and cause more than ten percent of affected properties to be destroyed or suffer major damage[6]. A heavy accumulation of ice can topple power and telephone lines, television towers, and trees. Highways become impossible to travel on, and even stepping outdoors can be

an extremely risky undertaking. Utility disruptions from winter storms can severely impact the delivery of services. Water pipes can freeze and crack in sub-freezing temperatures. These events can disrupt electric service for long periods. Warning time for winter storms is generally 6 to 12 hours[6].

Assessment of Impacts

The greatest risk from a winter storm hazard is to public health and safety. Potential impacts for the planning area may include:

- Vulnerable populations, particularly the elderly, infants, and the homeless, can face serious or life-threatening health problems from exposure to extreme cold including hypothermia and frostbite.
- Loss of electric power or other heat source can result in increased potential for fire injuries or hazardous gas inhalation because residents burn candles for light or use fires or generators to stay warm.
- Response personnel, including utility workers, public works personnel, debris removal staff, tow truck operators, and other first responders, are subject to injury or illness resulting from exposure to extreme cold temperatures.
- Response personnel would be required to travel in potentially hazardous conditions, elevating the life safety risk due to accidents and potential contact with downed power lines.
- Operations or service delivery may experience impacts from electricity blackouts or rolling brown outs, due to winter storms.
- Power outages are possible throughout the planning area due to downed trees and power lines and/or rolling blackouts.
- Critical facilities without emergency backup power may not be operational during power outages.
- Emergency response and service operations may be impacted by limitations on access and mobility if roadways are closed, unsafe, or obstructed.
- Hazardous road conditions will likely lead to increases in automobile accidents, further straining emergency response capabilities.
- Depending on the severity and scale of damage caused by ice and snow events, damage to power transmission and distribution infrastructure can require days or weeks to repair.
- A winter storm event could lead to tree, shrub, and plant damage or death.
- Severe cold and ice could significantly damage agricultural crops.
- Schools may be forced to shut early due to treacherous driving conditions.
- Exposed water pipes may be damaged by severe or late season winter storms at both residential and commercial structures, causing significant damages.

The impact of severe winter weather increases as the population grows. More people may be exposed to extreme cold temperatures, experience power outages, etc.

The economic and financial impacts of winter weather on the community will depend on the scale of the event, what is damaged, and how quickly repairs to critical components of the economy can be implemented.

The level of preparedness and pre-event planning done by businesses and citizens will also contribute to the overall economic and financial conditions in the aftermath of a winter storm event.

References – Section 9

1. *National Oceanic and Atmospheric Administration. Severe Winter Weather. https://www.nssl.noaa.gov/education/svrwx101/winter/types/*
2. *Brazos Valley Council of Governments. Main Page. https://www.bvcog.org/*
3. *National Weather Service. Winter Weather Terminology. https://www.weather.gov/bgm/WinterTerms*
4. *National Oceanic and Atmospheric Administration. Winter Storm Severity Index. https://www.wpc.ncep.noaa.gov/wwd/wssi/wssi.php*
5. *Texas Department of State Health Services. Health and Human Services. https://www.dshs.texas.gov/*
6. *Brazos County HMAP (2019-2024). Main Page. https://bcdem.org/emergency/plans*
7. *National Oceanic and Atmospheric Administration. El Nino and La Nina. https://www.noaa.gov/education/resource-collections/weather-atmosphere/el-nino*
8. *Climate Central. The Case of the Shifting Snow. https://www.climatecentral.org/report/report-the-case-of-the-shifting-snow*
9. *The Climate Reality Project. Winter Weather and the Climate Crisis: Explained. https://www.climaterealityproject.org/blog/winter-weather-and-climate-crisis-explained*
10. *Centers for Disease Control and Prevention. Prevent Hypothermia and Frostbite. https://www.cdc.gov/disasters/winter/staysafe/hypothermia.html*
11. *US Census Bureau. Poverty. https://www.census.gov/topics/income-poverty/poverty.html*

This page intentionally left blank.

Section 10 – Tornado

Hazardous Description

Tornadoes are among the most violent storms on the planet. A tornado is a rapidly rotating column of air extending between, and in contact with, a cloud and the surface of the earth. The most violent tornadoes are capable of tremendous destruction and have wind speeds of 250 miles per hour or more. In extreme cases, winds may approach 300 miles per hour. Damage paths can be more than one mile wide and 50 miles long[2].

The most powerful tornadoes are produced by "Supercell Thunderstorms." These thunderstorms are created when horizontal wind shears (winds moving in different directions at different altitudes) begin to rotate the storm. This horizontal rotation can be tilted vertically by violent updrafts, and the rotation radius can shrink, forming a vertical column of very quickly swirling air. This rotating air can eventually reach the ground, forming a tornado[2].

Hazardous Areas

Tornado season in Texas falls during the *April, May, and June* months, though it's not unheard of to see twisters make landfall throughout the entire year[2].

Tornadoes do not have any specific geographic boundary and can occur throughout the Brazos County planning area uniformly. It is assumed that the entire Brazos County planning area, including all participating entities are uniformly exposed to tornado activity. The entire Brazos County planning area is in Wind Zone III[3] (Figure: 10.1), where tornado winds can be as high as 250 mph.

QUICK FACTS

Enhanced Fujita Scale

EF-0 (Gale)

Winds 65-85 mph

Damage to trees and signs.

EF-1 (Moderate)

Winds 86-110 mph

Damage to roofs; mobile homes pushed off foundations; cars pushed off roads.

EF-2 (Significant)

Winds 111-135 mph

Considerable damage; roofs torn off; mobile homes and large trees destroyed; boxcars pushed over; projectiles generated.

EF-3 (Severe)

Winds 136-165 mph

Roofs and walls torn off homes; trains overturned; trees uprooted.

EF-4 (Devastating)

Winds 166-200 mph

Homes leveled; structures and cars thrown distances.

EF-5 (Incredible)

Winds over 200 mph

Homes disintegrated; large projectiles generated; steel-reinforced concrete badly damaged.

Source: National Oceanic & Atmospheric Administration (NOAA)[1]

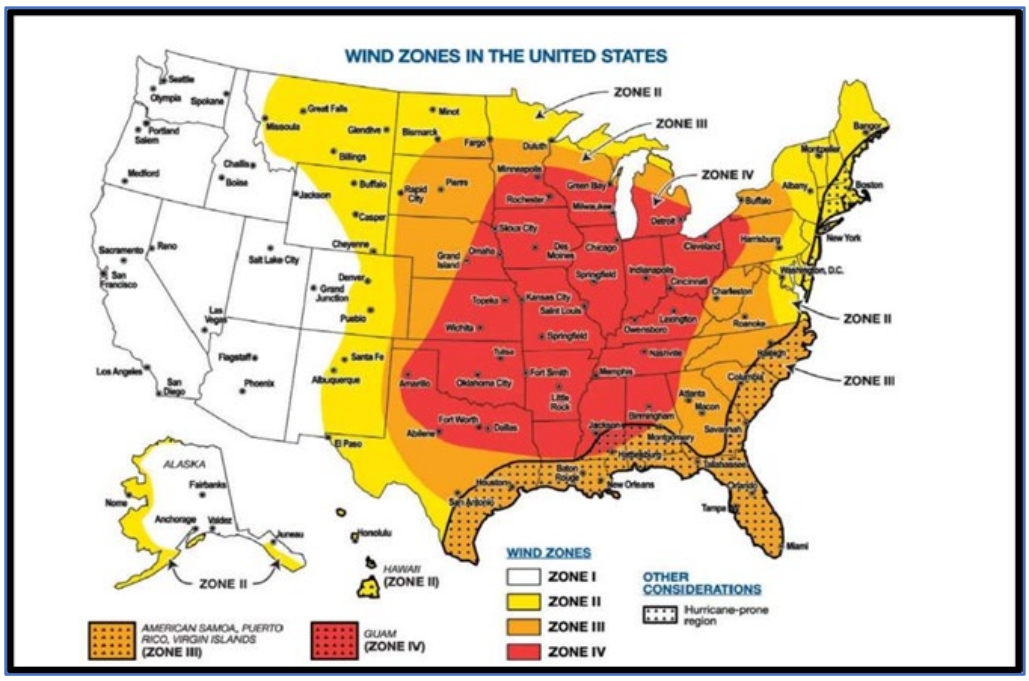


Figure: 10.1 – Wind Zone Designations in The US Source: FEMA[3]

The destruction caused by tornadoes ranges from light to inconceivable, depending on the intensity, size, and duration of the storm. Typically, tornadoes cause the greatest damage to structures of light construction, such as residential homes (particularly manufactured and mobile homes).

The Enhanced Fujita Tornado Scale (EF Scale)[4]

The Enhanced Fujita Scale or EF Scale[4], (see Table: 10.1), which became operational on February 1, 2007, is used to assign a tornado a 'rating' based on estimated wind speeds and related damage. When tornado-related damage is surveyed, it is compared to a list of Damage Indicators (DIs) and Degrees of Damage (DoD) (see Table: 10.2) which helps estimate better the range of wind speeds the tornado likely produced. From that, a rating (from EF0 to EF5) is assigned.

Once the indicator is selected, the team will then assign a degree of damage to the structure or object. The tornado evaluator will then make a judgement of the wind speeds that could have caused that specific damage, which will decide the official EF rating of the tornado[4].

The EF Scale was revised from the original Fujita Scale to reflect better examinations of tornado damage surveys so as to align wind speeds more closely with associated storm damage[4].

Tornado magnitudes prior to 2005 were determined using the traditional version of the Fujita Scale. Since February 2007, the Fujita Scale has been replaced by the Enhanced Fujita Scale[4] (Table: 10.1), which retains the same basic design and six strength categories as the previous scale. The newer scale reflects more refined assessments of tornado damage surveys, standardization, and damage consideration to a wider range of structures.

Scale	Wind speed		Relative frequency	Potential damage	
	mph	km/h			
EF0	65–85	105–137	53.5%	Minor damage. Peels surface off some roofs; some damage to gutters or siding; branches broken off trees; shallow-rooted trees pushed over. Confirmed tornadoes with no reported damage (i.e., those that remain in open fields) are always rated EF0.	
EF1	86–110	138–178	31.6%	Moderate damage. Roofs severely stripped; mobile homes overturned or badly damaged; loss of exterior doors; windows and other glass broken.	
EF2	111–135	179–218	10.7%	Considerable damage. Roofs torn off well-constructed houses; foundations of frame homes shifted; mobile homes completely destroyed; large trees snapped or uprooted; light-object missiles generated; cars lifted off ground.	
EF3	136–165	219–266	3.4%	Severe damage. Entire stories of well-constructed houses destroyed; severe damage to large buildings such as shopping malls; trains overturned; trees debarked; heavy cars lifted off the ground and thrown; structures with weak foundations blown away some distance.	
EF4	166–200	267–322	0.7%	Extreme damage to near-total destruction. Well-constructed houses and whole frame houses completely leveled; cars thrown and small missiles generated.	
EF5	>200	>322	<0.1%	Massive Damage. Strong frame houses leveled off foundations and swept away; steel-reinforced concrete structures critically damaged; high-rise buildings have severe structural deformation. Incredible phenomena will occur.	

Table: 10.1 - Enhanced Fujita Scale Source: NWS[4]

Enhanced F Scale Damage Indicators

NUMBER (Details Linked)	DAMAGE INDICATOR	ABBREVIATION
1	Small barns, farm outbuildings	SBO
2	One- or two-family residences	FR12
3	Single-wide mobile home (MHSW)	MHSW
4	Double-wide mobile home	MHDW
5	Apt, condo, townhouse (3 stories or less)	ACT
6	Motel	M
7	Masonry apt. or motel	MAM
8	Small retail bldg. (fast food)	SRB
9	Small professional (doctor office, branch bank)	SPB
10	Strip mall	SM
11	Large shopping mall	LSM
12	Large, isolated ("big box") retail bldg.	LIRB
13	Automobile showroom	ASR
14	Automotive service building	ASB
15	School - 1-story elementary (interior or exterior halls)	ES
16	School - jr. or sr. high school	JHSH
17	Low-rise (1-4 story) bldg.	LRB
18	Mid-rise (5-20 story) bldg.	MRB
19	High-rise (over 20 stories)	HRB
20	Institutional bldg. (hospital, govt. or university)	IB
21	Metal building system	MBS
22	Service station canopy	SSC
23	Warehouse (tilt-up walls or heavy timber)	WHB
24	Transmission line tower	TLT
25	Free-standing tower	FST
26	Free standing pole (light, flag, luminary)	FSP
27	Tree - hardwood	TH
28	Tree - softwood	TS

Table: 10.2 – Enhanced Fujita Scale Damage Indicators Source: NWS[4]

Both the Fujita Scale and Enhanced Fujita Scale[4] should be referenced in reviewing previous occurrences since tornado events prior to 2007 will follow the original Fujita Scale. The largest magnitude reported within the planning area is an F4 on the Fujita Scale, a “Devastating

Tornado." Based on the planning area's location in Wind Zone III[3], the planning area could experience anywhere from an EF0 to EF5 depending on the wind speed.

The events in Brazos County have been between EF0 and EF3[4]. However, the range of intensity that the Brazos County planning area, including all participating entities, would be expected to mitigate is a tornado event that would be a low to incredible risk, an EF0 to EF5[4].

Previous Occurrences

Only reported tornadoes were factored into the risk assessment. It is likely that a high number of occurrences have gone unreported over the past 69 years.

The reported frequency of a tornado occurrence in the planning area is less than 1% per year, though one event may cause millions of dollars in damage[1]. Tornadoes can cause deaths, the temporary or permanent loss of critical facilities, and the destruction of property.

From December 1953 through March 2022, Brazos County experienced twenty-nine (29) tornadic events with the most severe tornado ranked F-3 in 1956. A complete list of tornado events, as sourced from NOAA[1], is in Table: 10.3.

***Note that, prior to 2007 and the establishment of the Enhanced Fujita Scale, the original Fujita Scale was used to mark the magnitude of tornadoes.

Magnitude	Date	Time	Deaths	Injuries	Property Damage	Crop Damage
F2	12/02/1953	1530	0	0	$25k	0
F2	04/30/1954	0730	0	0	0	0
F3	04/05/1956	1515	0	0	$250k	0
F0	03/31/1957	1610	0	0	$3k	0
F0	05/20/1960	0615	0	0	0	0
F0	05/17/1965	1456	0	0	0	0
F1	02/10/1981	0245	0	1	$25k	0
F2	11/19/1983	0910	0	0	$2.5m	0
F0	04/27/1990	1758	0	0	0	0
F0	05/13/1994	1525	0	0	0	0
F0	05/08/1995	0230	0	0	$60k	0
F0	01/21/1998	1644	0	0	$35k	0
F1	10/17/1998	1540	0	0	$20k	0
F1	10/12/2001	1150	0	0	$60k	0
F0	12/23/2002	1120	0	0	$5k	0
F0	06/13/2003	1500	0	0	$1k	0
F1	10/05/2003	1705	0	1	$750k	0
F0	10/05/2003	1730	0	0	$3k	0
F0	02/24/2004	2110	0	0	$25k	0
F0	03/17/2004	0040	0	0	$3k	0
F1	05/13/2004	0545	0	0	$515k	0
F1	12/29/2006	1523	0	3	$2.8m	0
EF0	04/28/2009	1441	0	0	0	0
EF1	05/26/2016	1130	0	0	$7m	0
EF0	08/26/2017	0705	0	0	0	0
EF2	04/24/2019	1548	0	0	$400k	0
EF0	05/08/2019	1321	0	0	0	0
EF1	03/21/2022	2005	0	0	$100k	0

Table: 10.3 – Tornadic Activity with Damage Assessments (1953-2022) Source: NOAA[1]

Future Probability

Tornadic storms can occur at any time of year and at any time of day, but they are typically more common in the spring months during the late afternoon and evening hours. A smaller, high frequency period can emerge in the fall during the brief transition between the warm and cold seasons.

According to historical records, Brazos County, including all participating entities, can experience a tornado touchdown approximately once every two to three years. This frequency supports a likely probability of future events for Brazos County, including all participating entities.

In 2022, Texas ranked second in the number of tornadoes at 160 events, beat only by Louisiana's number of incidents at 184[5].

Due to climate change, rising concentrations of greenhouse gases tend to increase humidity, and thus, atmospheric instability, which would encourage tornadoes. But wind shear is likely to decrease, which would discourage tornado formations. Research is ongoing to learn whether tornadoes will be frequent in the future[6].

Climate Change

The Fourth National Climate Assessment[7] summarizes the complicated relationship between tornados and climate change: "Some types of extreme weather (e.g., rainfall and extreme heat) can be directly attributed to climate change. Other types of extreme weather, such as tornados, are also exhibiting changes that may be linked to climate change, but scientific understanding isn't detailed enough to project direction and magnitude of future change." In other words, we still have a lot to learn about how climate change might affect tornados[8]. There is increasing evidence linking global warming to changes in severe weather that give rise to tornados[8]. Observational data indicate detectable increases in tornado risk over the past few decades. There are several factors that contribute to tornados and tornado outbreaks in the last decade, which are influenced by climate change[8].

Potential Damages and Losses

Because tornadoes often cross jurisdictional boundaries, all existing and future buildings, facilities, and populations in the entire Brazos County planning area, including all participating entities, are exposed to this hazard, and could potentially be impacted. The damage caused by a tornado is typically a result of high wind velocity, wind-blown debris, lightning, and large hail.

The average tornado moves from southwest to northeast, but tornadoes have been known to move in any direction[9]. Consequently, the vulnerability of humans, animals, and property is difficult to evaluate since tornadoes form at different strengths, in random locations, and create relatively narrow paths of destruction[9]. Although tornadoes strike at random, making all buildings vulnerable, three types of structures are more likely to suffer damage[9]:

- Manufactured and mobile homes.
- Homes on peer and beam (more susceptible to lift).
- Buildings with large spans, such as shopping malls, gymnasiums, and factories.

Tornadoes can cause a significant threat to people as they could be struck by flying debris, falling trees/branches, utility lines, and poles. Blocked roads could prevent first responders to respond to calls. Tornadoes commonly cause power outages which could cause health and safety risks to residents and visitors, as well as to patients in hospitals[9].

The Brazos County planning area features multiple mobile or manufactured home parks throughout the planning area, including all participation entities. These parks are typically more vulnerable to tornado events than typical site-built structures. In addition, manufactured and mobile homes are located sporadically throughout the planning area including all participating entities and unincorporated areas of the county which would also be more vulnerable.

The portable buildings used at various locations would be more vulnerable to tornado events than typical site-built structures and could potentially pose a greater risk for wind-blown debris. In addition, some of the planning areas feature roof top air conditioning units that would be vulnerable to high winds and flying debris.

The US Census[10] data indicates a total of 5,910 manufactured and mobile homes located in the Brazos County planning area, including all participating entities and unincorporated areas of the county. These structures would typically be built to lower or less stringent construction standards than newer construction and may be more susceptible to damage during significant tornado events[11].

RV and RV Parks

The National Weather Service warns that RVs offer very little protection from tornadoes[9]. They suggest that you abandon your RV and seek shelter underground, in a concrete structure, or in a ditch[9]. Not only can the RV be damaged by flying debris but can flip and the occupants can become trapped[9].

The annualized expected property losses due to tornadoes in the planning area were calculated using the statistical risk assessment methodology[12]. Table: 10.4 below identifies these losses by planning entity:

Planning Entity	Potential Annualized Loss
Unincorporated*	$570,920
City of Bryan	$1,283,912
City of College Station	$1,879,980
City of Kurten	$6,331
Total	$3,741,143

Table: 10.4 – Annualized Expected Loss to Property Source: Brazos County Tax Assessor's Office[12]

Extent

The destruction caused by tornadoes ranges from light to heavy damage. But the destruction comes from flying debris, wind factors, water damage, and hail damage. We have added the Beaufort Wind Scale, which measures the extent and magnitude of a thunderstorm/wind event that precedes and often follows a tornado. Table: 10.5 describes the different intensities of wind in terms of speed and the World Meteorological Organization (WMO) Classification of storm effects, from calm to violent and destructive.

Beaufort Number	Description	Wind speed	Wave height	Sea conditions	Land conditions	
0	Calm	< 1 knot < 1 mph < 2 km/h	0 ft 0 m	Sea like a mirror	Smoke rises vertically	
1	Light air	1–3 knots 1–3 mph 2–5 km/h	0–1 ft 0–0.3 m	Ripples	Direction shown by smoke drift	
2	Light breeze	4–6 knots 4–7 mph 6–11 km/h	1–2 ft 0.3–0.6 m	Small wavelets	Wind felt on face	
3	Gentle breeze	7–10 knots 8–12 mph 12–19 km/h	2–4 ft 0.6–1.2 m	Large wavelets	Leaves and small twigs in constant motion	
4	Moderate breeze	11–16 knots 13–18 mph 20–28 km/h	3.5–6 ft 1–2 m	Small waves	Raises dust and loose paper	
5	Fresh breeze	17–21 knots 19–24 mph 29–38 km/h	6–10 ft 2–3 m	Moderate waves	Small trees and leafs begin to sway	
6	Strong breeze	22–27 knots 25–31 mph 39–49 km/h	9–13 ft 3–4 m	Large waves	Large branches in motion	
7	High wind, moderate gale, near gale	28–33 knots 32–38 mph 50–61 km/h	13–19 ft 4–5.5 m	Sea heaps up	Whole trees in motion	
8	Gale, fresh gale	34–40 knots 39–46 mph 62–74 km/h	18–25 ft 5.5–7.5 m	Moderately high waves	Twigs break off trees	
9	Strong/severe gale	41–47 knots 47–54 mph 75–88 km/h	23–32 ft 7–10 m	High waves	Slight structural damage	
10	Storm, whole gale	48–55 knots 55–63 mph 89–102 km/h	29–41 ft 9–12.5 m	Very high waves	Trees uprooted, considerable structural damage	
11	Violent storm	56–63 knots 64–72 mph 103–117 km/h	37–52 ft 11.5–16 m	Exceptionally high waves	Widespread damage	
12	Hurricane force	≥ 64 knots ≥ 73 mph ≥ 118 km/h	≥ 46 ft ≥ 14 m	Exceptionally high waves, sea is completely white	Devastation	

Table: 10.5 – Beaufort Wind Scale Source: NWS[9]

Assessment of Impacts

Tornadoes have the potential to pose a significant risk to the population and can create dangerous situations. Often, providing and preserving public health and safety is difficult. Impacts to the planning area can include:

- Individuals exposed to the storm can be struck by flying debris, falling limbs, or downed trees causing serious injury or death.
- Structures can be damaged or crushed by falling trees, which can result in physical harm to the occupants.
- Manufactured and mobile homes may suffer substantial damage as they would be more vulnerable than typical site-built structures.
- Significant debris and downed trees can result in emergency response vehicles being unable to access areas of the community.
- Downed power lines may result in roadways being unsafe for use, which may prevent first responders from answering calls for assistance or rescue.
- Tornadoes often result in widespread power outages increasing the risk to more vulnerable portions of the population who rely on power for health and/or life safety.
- Extended power outages can result in an increase in structure fires and/or carbon monoxide poisoning as individuals attempt to cook or heat their home with alternate, unsafe cooking or heating devices, such as grills or incorrect use of generators.
- Tornadoes can destroy or make residential structures uninhabitable, requiring shelter or relocation of residents in the aftermath of the event.
- First responders must enter the damage area shortly after the tornado passes to begin rescue operations and to organize cleanup and assessments efforts, therefore they are exposed to downed power lines, unstable and unusual debris, hazardous materials, and generally unsafe conditions, elevating the risk of injury to first responders and potentially diminishing emergency response capabilities.
- Emergency operations and services may be significantly impacted due to damaged facilities, loss of communications, and damaged emergency vehicles and equipment.
- City or county departments may be damaged or destroyed, delaying response and recovery efforts for the entire community.
- Private sector entities that the city and its residents rely on, such as utility providers, financial institutions, and medical care providers may not be fully operational and may require assistance until full services can be restored.
- Economic disruption negatively impacts the programs and services provided by the community due to short- and long-term loss in revenue.
- Damage to infrastructure may slow economic recovery since repairs may be extensive and lengthy.
- Some businesses not directly damaged by the tornado may be negatively impacted while roads and utilities are being restored, further slowing economic recovery.
- When the community is affected by significant property damage, it is anticipated that funding would be required for infrastructure repair and restoration, temporary services and facilities, overtime pay for responders, and normal day-to-day operating expenses.

- Displaced residents may not be able to immediately return to work, furthering economic recovery.
- Residential structures destroyed by a tornado may not be rebuilt for years, reducing the tax base for the community.
- Large or intense tornadoes may result in a dramatic population fluctuation, as people are unable to return to their homes or jobs and must seek shelter and/or work outside of the affected area.
- Businesses that are uninsured or underinsured may have difficulty reopening, which results in a net loss of jobs for the community and a potential increase in the unemployment rate.
- Recreation activities may be unavailable, and tourism can be unappealing for years following a large tornado, devastating local businesses.

The growing population increases exposure to tornadoes. More development increases the potential for more debris. Critical infrastructure increases with the growing population; therefore, the tornado exposure for critical infrastructure increases.

The economic and financial impacts of a tornado event on the community will depend on the scale of the event, what is damaged, costs of repair or replacement, lost business days in impacted areas, and how quickly repairs to critical components of the economy can be implemented.

The level of preparedness and pre-event planning done by government, businesses, and citizens will contribute to the overall economic and financial conditions in the aftermath of a tornado event.

References – Section 10

1. *National Oceanic and Atmospheric Administration. Tornadoes. https://www.noaa.gov/education/resource-collections/weather-atmosphere/tornadoes*
2. *National Weather Service. Tornado Definitions. https://www.weather.gov/phi/TornadoDefinition*
3. *Federal Emergency Management Agency. Understanding Hazards. https://www.fema.gov/pdf/library/ism2_s1.pdf*
4. *National Weather Service. The Enhanced Fujita Scale. https://www.weather.gov/oun/efscale*
5. *Policy Genius. Texas Home Insurance rates on The Rise. https://www.policygenius.com/homeowners-insurance/why-texas-home-insurance-rates-are-rising/*
6. *US Environmental Protection Agency. Climate. https://www.epa.gov/sites/default/files/2016-09/documents/climate-change-tx.pdf*
7. *National Climate Assessment. Main Page. https://nca2014.globalchange.gov/*
8. *Global Change. Fourth National Climate Assessment. https://nca2018.globalchange.gov/*
9. *National Weather Service. Weather-Thunderstorms, Tornadoes, Lightening. https://www.weather.gov/media/owlie/ttl6-10.pdf*
10. *US Census Bureau. Brazos County. https://www.census.gov/quickfacts/fact/table/brazoscountytexas/PST045222*
11. *City Data. Brazos County. https://www.city-data.com/county/Brazos_County-TX.html*
12. *Brazos County Tax Assessors Office. Main Page. https://www.brazoscountytx.gov/138/Tax-Assessors-Office*

This page intentionally left blank.

Section 11 – Hail

Hazard Description

Hailstorm incidents are a potentially damaging outgrowth of severe thunderstorms. During the developmental stages of a hailstorm, ice crystals form within a low-pressure front due to the rapid rising of warm air into the upper atmosphere, and the subsequent cooling of the air mass[2].

Frozen droplets gradually accumulate in the atmosphere into ice crystals until they fall as precipitation that is round or irregularly shaped masses of ice typically greater than 0.75 inches in diameter. The size of hailstones is a direct result of the size and severity of the storm[2].

High velocity updraft winds are required to keep hail in suspension in thunderclouds. The strength of the updraft is a by-product of heating on the Earth's surface. Higher temperature gradients above the Earth's surface result in increased suspension time and hailstone size[2].

Hazardous Areas

Hailstorms are an extension of severe thunderstorms that could potentially cause severe damage. As a result, they are not confined to any specific geographic location and can vary greatly in size, location, intensity, and duration. Therefore, the Brazos County planning area, including all participating entities, are equally at risk to the hazard of hail.

Most hailstorms occur during *March, April, May, and September*. Hail causes damage to automobiles, windows, roofs, crops, and animals[2].

The National Weather Service (NWS)[3] classifies a storm as "severe" if there is hail three-quarters of an inch in diameter (approximately the size of a penny) or greater, based on radar intensity or as seen by observers[3].

The intensity category of a hailstorm depends on hail size and the potential damage it could cause, as depicted in the National Centers for Environmental Information (NCEI) Intensity Scale in Table: 11.1.

QUICK FACTS

What is hail?

Hail is a form of precipitation consisting of solid ice that forms inside thunderstorm updrafts. Hail can damage aircraft, homes, businesses, and cars, and can be deadly to livestock and people.

How does hail form?

Hailstones are formed when raindrops are carried upward by thunderstorm updrafts into extremely cold areas of the atmosphere and freeze.

Hailstones then grow by colliding with liquid water drops that freeze onto the hailstone's surface.

How does hail fall to the ground?

It falls to the ground when the frozen water becomes too heavy to stay in the clouds.

Where can I find data on hailstorms?

The National Climatic Data Center is the official archive for all U.S. weather events.

Source: National Climatic Data Center[1]

Size Code	Intensity Category	Size (Diameter Inches)	Descriptive Term	Typical Damage
H0	Hard Hail	Up to 0.33	Pea	No damage.
H1	Potentially Damaging	0.33 – 0.60	Marble	Slight damage to plants and crops.
H2	Potentially Damaging	0.60 – 0.80	Dime	Significant damage to plants and crops.
H3	Severe	0.80 – 1.20	Nickel	Severe damage to plants and crops.
H4	Severe	1.2 – 1.6	Quarter	Widespread glass and auto damage.
H5	Destructive	1.6 – 2.0	Half Dollar	Widespread destruction of glass, roofs, and the risk of injuries.
H6	Destructive	2.0 – 2.4	Ping Pong Ball	Aircraft bodywork dented and brick walls pitted.
H7	Very Destructive	2.4 – 3.0	Golf Ball	Severe roof damage and risk of serious injuries.
H8	Very Destructive	3.0 – 3.5	Hen Egg	Severe damage to all structures.
H9	Super Hailstorms	3.5 – 4.0	Tennis Ball	Extensive structural damage could cause fatal injuries.
H10	Super Hailstorms	4.0 +	Baseball	Extensive structural damage could cause fatal injuries.

Table: 11.1 – Hail Intensity and Magnitude Scale Source: NOAA[4]

The intensity scale[4] in Table: 11.1, ranges from H0 to H10, with increments of intensity or damage potential in relation to hail size (distribution and maximum), texture, fall speed, speed of storm translation, and strength of the accompanying wind[4].

Based on available data regarding the previous occurrences for the area, the Brazos County planning area, including all participating entities, could experience hailstorms ranging from an H0 to an H10[4].

Previous Occurrences

Historical evidence shown in Table: 11.2, demonstrates that the planning area is vulnerable to hail events overall, which typically result from severe thunderstorm activity. Historical events with reported damage, injuries, or fatalities are shown in Table: 11.2. A total of sixty-six (66) reported historical hail events impacted the Brazos County planning area between 2005 through 2022 (summary Table: 11.2). Including a significant hail event(s) that occurred on 05/07/2020 and 04/08/2021. These events were reported to NCEI[4] and NOAA[1] databases and may not represent all hail events to have occurred during the past 17 years. Only those events for the Brazos County planning area with latitude and longitude available were plotted.

Future Probability

Based on available records for Brazos County, a probability of three to four events per year may occur. According to NOAA[1] and storm events data, this frequency supports a highly likely probability of future incidents for the Brazos County planning area including all participating entities. Figure: 11.1, shows that 46% of the time the County will experience hail.

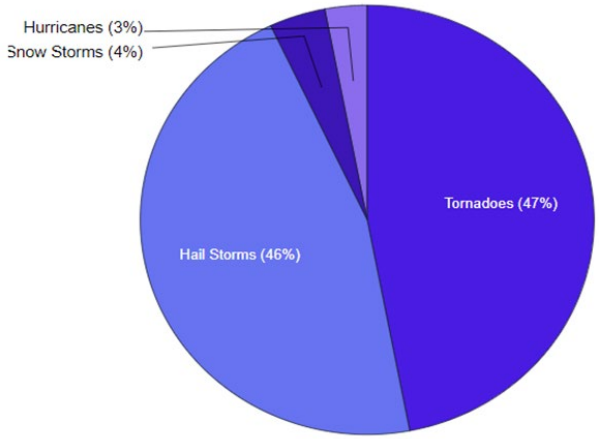


Figure 11.1 – Distribution of Storm Incidents in Brazos County Source: Augurisk.com[5]

Climate Change

Predictions about the effects of climate changes on hail, including event frequency, spatial distribution, and intensity (e.g., hail size of kinetic energy) are limited and uncertain. Research suggests that climate change is expected to result in conditions that increase the potential for severe thunderstorms in the U.S., broadly. However, the resulting changes to specific storm-related events are not well-understood. Some predictive models predict fewer hail events broadly across the U.S., these predictive models also simultaneously predict an increase in the Brazos County Hazard Mitigation Plan 2024. Proactive mitigation for a Disaster-Resilient Future 56 (a mitigation roadmap that provide practical advice and resources to those involved in disaster risk reduction (DRR)) mean hail size, suggesting fewer small hail events but more frequent large hail events[6]. However, regional conditions that may affect the likelihood of hail production vary and regionally specific, precise predictions are not well-understood[6]. However, most predictions

appear to suggest that the most likely future trend is an increase in the proportion of hail events consisting of large hail[6]. Large hail tends to produce greater and more significant economic damage, suggesting that planning for a future environment in which hail events and hail damage are likely to increase to some extent is reasonably well supported[6].

Potential Damages and Losses

Damage from hail approaches 1 billion dollars in the U.S. each year. Most of the time, crops sustain the most damage during an incident. Even relatively small hail can shred plants to ribbons in a matter of minutes. Vehicles, roofs of buildings and homes, and landscaping are also damaged by hail[7].

Utility systems on roofs at school districts and critical facilities are vulnerable and could be damaged. Hail could cause a significant threat to people and animals as they could be struck by hail and falling trees and branches. Outdoor student activities and events may elevate the risk to students and faculty when a hailstorm strikes with little warning. Hail events during school hours could elevate the risk to students and faculty due to broken windows and flying debris. Portable buildings utilized by campuses within the school district would be more vulnerable to hail events than the typical site-built structures. In addition, outdoor equipment would be more vulnerable including air conditioning units, and athletic fields equipped with operational infrastructure. Windows at all structures would be vulnerable and shattered glass may cause injury to students and faculty[7].

The Brazos County planning area features manufactured and mobile home parks throughout the planning area. These parks are typically more vulnerable to hail events than typical site-built structures. In addition, manufactured and mobile homes are located sporadically throughout the planning area including all participating entities, which would also be more vulnerable. The US Census data indicates a total of 5,910 manufactured and mobile homes located in the Brazos County planning area including all participating entities[8].

Hail has been known to cause injury to humans and livestock and occasionally has been fatal. Overall, approximate annual loss estimates of $38,953. Losses were adjusted to account for inflation and calculated through a non-linear regression of historical data.

Based on historic loss and damages, the impact of hail damages on the Brazos County planning area, including all participating entities can be considered “Limited” with the exception of 2020 and 2021, severity of impact meaning injuries and illness can be treated with first aid, county area facilities are shut down for 24 hours or less, and less than ten percent of property destroyed or with major damage.

Extent

Hailstorms are generally localized, and their impact is considered limited since the injuries they cause are generally treatable with first aid, they shut down critical facilities and services for 24 hours or less, and less than ten percent of affected properties are destroyed or suffer major

damage[9]. The frequency of occurrence of hail in Brazos County and participating entities is likely, with an event highly likely in the next three years[9].

Warning time for a hailstorm is generally minimal or no warning. The National Weather Service classifies a storm as severe if hail of 1 inch in diameter (approximately the size of a quarter) or greater is imminent based on radar intensities or observed by a spotter or other people[9].

The extent of hail in Brazos County and participating entities can range from 1/4 of an inch up to 4.5 inches, based on information from the National Weather Service.

Assessment of Impacts

Hail events have the potential to pose a significant risk to people and can create dangerous situations. Impacts to the planning area can include:

- Hail may create hazardous road conditions during and immediately following an event, delaying first responders from providing for or preserving public health and safety.
- Individuals and first responders who are exposed to the storm may be struck by hail, falling branches, or downed trees resulting in injuries or possible fatalities.
- Large hail incidents will likely cause extensive roof damage to residential and business structures along with siding damage and broken windows, creating a spike in insurance claims and a rise in premiums.
- Automobile damage may be extensive depending on the size of the hail and length of the storm.
- Hail events can result in power outages over widespread areas increasing the risk to more vulnerable portions of the population who rely on power for health and/or life safety.
- Extended power outage can result in an increase in structure fires and/or carbon monoxide poisoning, as individuals attempt to cook or heat their home with alternate, unsafe cooking or heating devices, such as grills and the incorrect use of generators.
- First responders are exposed to downed power lines, damaged structures, hazardous spills, and debris that often accompany hail events, elevating the risk of injury to first responders and potentially diminishing emergency response capabilities.
- Downed power lines and large debris, such as downed tree limbs, can result in the inability of emergency response vehicles to access areas of the community.
- Hazardous road conditions may prevent critical staff from reporting for duty, limiting response capabilities.
- Economic disruption negatively impacts the programs and services provided by the community due to short- and long-term loss in revenue.
- Some businesses not directly damaged by the hail event may be negatively impacted while roads are cleared and utilities are being restored, further slowing economic recovery.

- Businesses that are more reliant on utility infrastructure than others may suffer greater damage without a backup power source.
- Hazardous road conditions will likely lead to increases in automobile accidents, further straining emergency response capabilities.
- Depending on the severity and scale of damage caused by large hail events, damage to power transmission and distribution infrastructure can require days or weeks to repair.
- A significant hail event could significantly damage agricultural crops, resulting in extensive economic losses for the community and surrounding area.
- Hail events may injure or kill livestock and wildlife.
- A large hail event could impact the accessibility of recreational areas and parks due to extended power outages or debris clogged access roads.

The growing population increases exposure to hail. More development increases the potential for more debris. Critical infrastructure increases with the growing population; therefore, the hail exposure for critical infrastructure increases.

The economic and financial impacts of hail will depend entirely on the scale of the event, what is damaged, and how quickly repairs to critical components of the economy can be implemented.

The level of preparedness and pre-event planning conducted by the community, local businesses, and citizens will contribute to the overall economic and financial conditions in the aftermath of any hail event.

References – Section 11

1. *National Oceanic and Atmospheric Administration. Climate Data Online. https://www.ncei.noaa.gov/cdo-web/*
2. *National Oceanic and Atmospheric Administration. Severe Storm – Hail. https://www.nssl.noaa.gov/education/svrwx101/hail/*
3. *National Weather Service. Storm Reports. https://www.weather.gov/bgm/helpStormReports*
4. *National Centers for Environmental Information. Strom Data. https://www.ncdc.noaa.gov/stormevents/faq.jsp*
5. *Augurisk. Brazos County. https://www.augurisk.com/risk/state/texas/brazos-county/48041*
6. *Brimelow, J., Burrows, W., & Hanesiak, J. (2017). The changing hail threat over North America in response to anthropogenic climate change. Nature Climate Change, 7(7), 516-522.*
7. *Archer County Hazard Mitigation Plan. 2019 Draft. https://www.co.archer.tx.us/upload/page/1357/Draft%20Archer%20County%20HMAP%20June%202019.pdf*
8. *City Data. Brazos County. https://www.city-data.com/county/Brazos_County-TX.html*
9. *The Tornado and Storm Research Organization. The TORRO Hailstorm Intensity Scale. Hail Size and Diameter. https://www.torro.org.uk/research/hail/hscale.*

This page intentionally left blank.

Section 12 – Thunderstorms and Wind

Hazard Descriptions

Thunderstorms create extreme wind events which includes straight line winds. Wind is the horizontal motion of the air past a given point, beginning with differences in air pressures. Pressure that is higher at one place than another sets up a force pushing from the high toward the low pressure: the greater the difference in pressures, the stronger the force. The distance between the area of high pressure and the area of low pressure also determines how fast the moving air accelerates[1].

Thunderstorms are created when heat and moisture near the Earth's surface are transported to the upper levels of the atmosphere. By-products of this process are the clouds, precipitation, and wind that become the thunderstorm[1].

According to the National Weather Service (NWS)[2], a thunderstorm occurs when thunder accompanies rainfall. Radar observers use the intensity of radar echoes to distinguish between rain showers and thunderstorms[2].

Straight line winds are responsible for most thunderstorm wind damages. One type of straight-line wind, the downburst, is a small area of rapidly descending air beneath a thunderstorm. A downburst can cause damage equivalent to a strong tornado and make air travel extremely hazardous[2].

Hazardous Areas

Thunderstorms and wind events can develop in any geographic location and are considered a common occurrence in Texas.

Therefore, a thunderstorm wind event could occur at any location within Brazos County's planning area, including all participating entities as these storms develop randomly and are not confined to any geographic area within the County. It is assumed that the entire Brazos County planning area is uniformly exposed to the threat of thunderstorms winds.

The Beaufort Wind Scale[3]

In the early 19th century, naval officers made regular weather observations, but there was no standard scale, so they could be very subjective – one man's "stiff breeze" might be another's "soft breeze". Beaufort succeeded in standardizing the scale[3].

The Beaufort Scale[3] is an empirical measure that relates wind speed to observed conditions at sea or on land. The full name is the Beaufort Wind Scale[3].

QUICK FACTS

Anatomy of a Thunderstorm

Moisture – forms the clouds and rain.

Unstable Air – warm air that rises rapidly.

Lift – fronts, sea breezes and elevations lift air to help form the thunderstorm.

Thunderstorm

A thunderstorm, also known as an electrical storm or a lightning storm, is a storm characterized by the presence of lightning and its acoustic effect on the Earth's atmosphere, known as thunder. Relatively weak thunderstorms are sometimes called thunder showers.

The typical thunderstorm is 15 miles in diameter and lasts an average of 30 minutes.

Lightening occurs in all thunderstorms.

The number one killer in a thunderstorm is flash flooding.

Straight line winds can exceed 100 mph and a downburst can cause damage equivalent to a tornado.

Source: National Weather Service[2]

Table: 12.1, shows the Beaufort Scale[3] with speeds in knots, miles per hour and kilometers per hour. Please note that these are *mean speeds*, usually averaged over 10 minutes by convention, and do not capture the speed of wind gusts[3].

The wind speeds shown in the table below and that you hear quoted in weather or news reports are always measured at 10 meters or 0.00321371 miles above the ground using meteorological instruments. They do not reflect the wind speeds that you would feel on the ground. At 2 meters or 0.00124274 miles, wind speed may be only 50-70% of these figures[3].

Force	Speed		Description	Specifications for use at sea Specifications for use on land
	(mph)	(knots)		
0	0-1	0-1	Calm	Sea like a mirror. Calm; smoke rises vertically.
1	1-3	1-3	Light Air	Ripples with the appearance of scales are formed, but without foam crests. Direction of wind shown by smoke drift, but not by wind vanes.
2	4-7	4-6	Light Breeze	Small wavelets, still short, but more pronounced. Crests have a glassy appearance and do not break. Wind felt on face; leaves rustle; ordinary vanes moved by wind.
3	8-12	7-10	Gentle Breeze	Large wavelets. Crests begin to break. Foam of glassy appearance. Perhaps scattered white horses. Leaves and small twigs in constant motion; wind extends light flag.
4	13-18	11-16	Moderate Breeze	Small waves, becoming larger; fairly frequent white horses. Raises dust and loose paper; small branches are moved.
5	19-24	17-21	Fresh Breeze	Moderate waves, taking a more pronounced long form; many white horses are formed. Small trees in leaf begin to sway; crested wavelets form on inland waters.
6	25-31	22-27	Strong Breeze	Large waves begin to form; the white foam crests are more extensive everywhere. Large branches in motion; whistling heard in telegraph wires; umbrellas used with difficulty.
7	32-38	28-33	Near Gale	Sea heaps up and white foam from breaking waves begins to be blown in streaks along the direction of the wind. Whole trees in motion; inconvenience felt when walking against the wind.
8	39-46	34-40	Gale	Moderately high waves of greater length; edges of crests begin to break into spindrift. The foam is blown in well-marked streaks along the direction of the wind. Breaks twigs off trees; generally impedes progress.

9	47-54	41-47	Severe Gale	High waves. Dense streaks of foam along the direction of the wind. Crests of waves begin to topple, tumble and roll over. Spray may affect visibility Slight structural damage occurs (chimney-pots and slates removed)
10	55-63	48-55	Storm	Very high waves with long overhanging crests. The resulting foam, in great patches, is blown in dense white streaks along the direction of the wind. On the whole the surface of the sea takes on a white appearance. The tumbling of the sea becomes heavy and shock-like. Visibility affected. Seldom experienced inland; trees uprooted; considerable structural damage occurs.
11	64-72	56-63	Violent Storm	Exceptionally high waves (small and medium-size ships might be for a time lost to view behind the waves). The sea is completely covered with long white patches of foam lying along the direction of the wind. Everywhere the edges of the wave crests are blown into froth. Visibility affected. Very rarely experienced; accompanied by wide-spread damage.
12	72-83	64-71	Hurricane	The air is filled with foam and spray. Sea completely white with driving spray; visibility very seriously affected. see *Saffir-Simpson Hurricane Scale*

Table: 12.1 – Beaufort Wind Scale Source: National Weather Service[3]

Previous Occurrences

There is no reliable, long-term record of severe thunderstorms or the severe weather they produce: tornadoes, hail, and strong winds. Reporting methods and magnitude scales have changed over time for tornadoes and hail events[4]. Maps of the historic distribution of tornadoes, hail, and strong winds make it clear that no corner of the state is immune to severe thunderstorms[4]. Not only is the climate data record for severe thunderstorms poor, but severe thunderstorms are also too small to be simulated directly by present-day climate models[4]. Therefore, when assessing trends in severe thunderstorms, it is necessary to consider indirect indicators of severe thunderstorm frequency and intensity such as wind shear and convective instability, both of which favor severe storms[4]. This results in an overall increase in the number of days capable of producing severe thunderstorms[4].

Regarding the specific hazards of thunderstorms, lightning occurs most often during the months of *May and June*[4], due to climate change these months may vary. Severe wind is most prevalent during the summer months from disorganized storm systems. Warmer temperatures are likely to lead to less hail overall, particularly during the summer, but increases in available thunderstorm energy may lead to an increase of the risk of very large hail in springtime[4].

From February 2009 through May 2017, Brazos County has experienced twenty (20) reported thunderstorms and wind incidents listed on Table: 12.2.

Location	Date	Time	Wind Speed	Deaths	Injuries	Property Damage	Crop Damage
BC	02/10/2009	2325	52 knots	0	0	$8k	0
K	03/31/2009	0445	50 knots	0	0	$3k	0
COB, K	05/03/2009	0454-0500	55 knots	0	0	$5k	0
COCS	07/19/2009	1800	56 knots	0	0	$5k	0
COB	02/01/2011	0440	52 knots	0	0	$1k	0
COB	05/12/2011	1030	58 knots	0	0	0	0
K	06/06/2011	1735	52 knots	0	0	$1k	0
COB	08/24/2011	1829	52 knots	0	0	0	0
COB	01/09/2012	0412	52 knots	0	0	$3k	0
COB, COCS	01/25/2012	0715-0724	55 knots	0	0	$21k	0
COB	02/03/2012	1938	65 knots	0	0	$5k	0
COB	08/07/2012	1645	50 knots	0	0	0	0
COCS	10/13/2013	0158	52 knots	0	0	$15k	0
COB	05/23/2015	2230	55 knots	0	0	0	0
COB, COCS	08/25/2015	1115-1128	59 knots	0	0	0	0
COB	04/27/2016	0136	60 knots	0	0	0	0
BC	01/02/2017	0635	52 knots	0	0	0	0
BC	03/27/2017	0120	51 knots	0	0	0	$1k
BC	05/21/2017	0008	60 knots	0	0	0	0
COB, BC	05/28/2017	1853	53 knots	0	0	0	0

Table 12.2 – Thunderstorm and Wind Incidents in Brazos County (2009-2017) Source: Brazos County HMAP (2019-2024)[5]

*** The term "knot", in reference to currents, is defined as one nautical mile per hour and is used to measure speed. A nautical mile is slightly more than a standard mile.

Future Probability

As temperatures increase, the amount of energy available to fuel these storms will increase as temperature and low-level moisture increase[4]. Even though shear will likely decrease as the temperature gradient from the poles to the equator weakens, the increase in the Convective Available Potential Energy (CAPE) outweighs any decrease in low level shear[4].

Most thunderstorm winds occur during the months of *March, April, May, and September*[4]. Based on available records of historic events, there are 143 recorded wind events in Brazos County[6]. This frequency supports a probability of one to two events every year. Even though the intensity of thunderstorm wind events is not always damaging for the Brazos County planning area, the frequency of occurrence for a thunderstorm wind event is highly likely. This means that an event is probable within the next year for the Brazos County planning area, including all participating entities.

If an exceedingly rare windstorm (a 1-in-3,000-year storm event) occurred today, it could cause wind gusts of up to 134 mph in Brazos County. A storm of this severity has a 1% chance of occurring at least once over the next 30 years[6]. In 30 years, an event of this same likelihood would show increased wind gusts of up to 145 mph due to a changing environment[6].

Climate Change

Severe winds are associated with severe storm conditions. Predictions about trends in severe storm likelihood and severity are typically made at broader spatial scales than the planning area, or even the region. Broad predictive efforts indicate that severe storms are likely to increase in

severity globally and in the U.S. due to climate change. However, predictions also indicate that frequency of strong storms may decrease. Some predictions indicate a shift in storm loci (location of updrafts/downdrafts, strength of storm top divergence), such that strong storms that affect the Central and South-Central U.S. may become less frequent as they become more frequent in Eastern and North-Eastern North America[7]. Other climate models consistently project environmental changes that would predict an increase in the frequency and intensity of severe thunderstorms (a category that combines tornados, hail, and winds), especially over regions that are currently prone to these hazards such as the Southern and Eastern U.S[8]. However, the confidence intervals and predictive power of many of these models are relatively low[9]. Predictions specifically about wind are also varied. Some research points to a "global stilling," meaning a reduction in mean winds globally. Other research suggests evidence for trends of increasing wind speeds globally[10]. While other research predicts decline in wind speed for many regions as the climate warms, a shift in high wind regions moving poleward, increases winds and wind speeds in specific locations, for example due to increases in hurricane severity in some regions[11]. The Intergovernmental Panel on Climate Change (IPCC)[12] currently forecasts that on average, worldwide annual wind speeds are expected to drop by up to 10%. Predictions of future severe wind patterns largely rely on predictions of changes to, or increases in, thunderstorm storm frequency or severity, and are thus saddled with the same uncertainty and limits to predictive power. Given the varied and uncertain predictions regarding storm frequency, severity, and resulting effects on severe wind event frequency and severity, planners should act with the expectation that severe storm and wind conditions are likely to be similar, if slightly lower or slightly higher, in frequency and severity in the future[12]. For the planning area, a reasonable baseline for planning purposes would be approximately 3 to 6 significant thunderstorms per year, several of which may be accompanied by significant wind conditions.

Also associated with thunderstorms and wind, is lightening, lightning is correlated with severe storm conditions but ultimately is caused by hyper-local, transitory conditions, identifying patterns, and generating predictions are difficult to conduct at a local scale. Broad predictive efforts indicate that lightning strikes are likely to increase nationwide due to climate change[13]. Predictions of future lightning frequency largely rely on predictions of changes to, or increases in, thunderstorm storm frequency and severity, as well as the trend that lightning is more likely to occur in warmer conditions, on average. Areas with predicted increases in thunderstorm frequency or severity, and/or where temperatures are predicted to increase, can reasonably expect that lightning frequency will remain the same or increase[14]. Spatial and temporal changes to lightning occurrence and severity may be expected to result in higher risk of sequelae such as wildfires[15]. Research indicating recent, short-term changes to lightning strike density (i.e., comparing 2022 to the average rates for 2015 to 2021) nationwide show that during 2022, in Texas, strike density was down compared to the prior 6-year average. In Vaisala 's annual lightning report executive summary (Vagasky 2022)[16], it was noted that: Texas remains the United States lightning count leader: The Lone Star State continued its run as the number one state for lightning with 27,696,688 total lightning events in 2022[16]. While it secured the top spot, its total count dropped significantly from the 41 million events recorded in 2021[16]. Texas faced its most severe drought since 2011, with more than a quarter of the state experiencing exceptional drought conditions in mid-August[16]. Lightning strikes during droughts can lead to wildland fires and dwelling fires. However, locally specific future predictions regarding changes

to lightning frequency or location are not well understood and limited data exist to make locally specific predictions of such changes[16].

Potential Damages and Losses

Vulnerability is difficult to evaluate since thunderstorm wind events can occur at different strength levels, in random locations, and can create relatively narrow paths of destruction. Due to the randomness of these events, all existing and future structures and facilities in the Brazos County planning area, including all participating entities, could potentially be impacted and remain vulnerable to possible injury and property loss from strong winds.

Trees, power lines and poles, signage, manufactured and mobile housing, radio towers, concrete block walls, storage barns, windows, garbage receptacles, brick facades, and vehicles, unless reinforced, are vulnerable to thunderstorm wind events[17]. More severe damage involves windborne debris; in some instances, patio furniture and other lawn items have been reported to have been blown around by wind and, very commonly, debris from damaged structures in turn have caused damage to other buildings not directly impacted by the event[17]. In numerous instances roofs have been reported as having been torn from buildings. The portable buildings used at various locations would be more vulnerable to thunderstorm wind events than typical site-built structures and could potentially pose a greater risk for wind-blown debris[17]. In addition, some structures feature roof top air conditioning units that would be vulnerable to high winds flying debris[17]. These structures would also be more vulnerable. These units would also pose the additional threat of contributing to flying debris, causing additional damage to structures[17].

A thunderstorm wind incident can also result in traffic disruptions, injuries and in rare cases, fatalities. An average forty-nine (49) deaths and hundreds more injuries occur around the U.S. annually. An estimated 100,000 thunderstorms occur nationwide each year. The southeast Texas area averages 50 to 60 days with thunderstorms per year. Brazos County had one fatality in 2021and numerous injuries reported from secondary causes related to thunderstorms and wind[19]. Impact of thunderstorm wind events experienced in the entire Brazos County planning area would be “Minor,” and injuries and illnesses would be treatable with first aid, ten percent or more of property damaged or destroyed, and facilities would be shut down for up to one week[19].

Overall, the average loss estimate (in 2019 dollars) is $3,107,325, having an approximate annual loss estimate of $48,552.

Extent

The extent of thunderstorm types in Brazos County and participating entities can be classified as a T-4 Heavy Thunderstorm[2], as described in the Thunderstorm Criteria Scale below.

THUNDERSTORM TYPES	Rainfall Rate/hr	MAX WIND GUST	HAIL SIZE	PEAK TORNADO Possibility	LIGHTNING FREQUENCY (5 min Intervals)	Darkness Factor	STORM IMPACT
T-1 – Weak thunderstorms or Thundershowers	.03-.10	< 25 MPH	None	None	Only a few strikes during the storm.	Slightly Dark. Sunlight may be seen under the storm.	1. No damage. 2. Gusty winds at times.
T-2 – Moderate Thunderstorms.	.10"-.25"	25-40 MPH	None	None	Occasional 1-10	Moderately Dark. Heavy downpours may cause the need for car lights.	1. Heavy downpours. 2. Occasional lightning. 3. Gusty winds. 4. Very little damage. 5. Small tree branches may break 6. Lawn furniture moved around
T-3 – Heavy Thunderstorms 1. Singular or lines of storms.	.25"-.55"	40-57 MPH	1/4 " to ¾"	EF0	Occasional to Frequent 10-20	Dark. Car lights used. Visibility low in heavy rains. Cars may pull off the road.	1. Minor Damage. 2. Downpours that produce some flooding on streets. 3. Frequent lightning could cause house fires. 4. Hail occurs within the downpours. 5. Small branches are broken. 6. Shingles are blown off roofs.
T-4 – Intense Thunderstorms 1. Weaker supercells 2. Bow Echos or lines of Storms	.55" – 1.25"	58 to 70 MPH	1" to 1.5"	EF0 to EF2	Frequent 20-30	Very Dark. Car lights used. Some street lights come on..	1. Moderate Damage. 2. Heavy rains can cause flooding to streams and creeks. Roadway flooding. 3. Hail can cause dents on cars and cause crop damage. 3. Wind damage to trees and buildings. 4. Tornado damage. 5. Power outages
T-5 – Extreme Thunderstorms 1. Supercells with familty of tornadoes. 2. Derecho Windstorms	1.25" – 4"	Over 70 Mph	Over 1.5" to 4"	EF3 to EF5	Frequent to Continuous. > 30	Pitch Black, Street Lights come on. House lights maybe used	1. Severe Damage to Trees and Property. Damage is widespread. 2. Flooding rains. 3. Damaging hail. 4. Damaging wind gusts to trees and buildings. 5. Tornadoes F3-F5 or family of tornadoes can occur. Tornadoes can cause total devastation. 6. Widespread power outages.

Table: 12.3 – Thunderstorm Criteria Scale Source: National Weather Service [2]

The extent of high winds in Brazos County and the participating entities can be classified as a Beaufort Number 11, based on the Beaufort Wind Scale in Table 12.1[3], from historical data (2009-2017).

Assessment of Impacts

Thunderstorm wind events have the potential to pose a significant risk to people and can create dangerous and difficult situations for public health and safety officials. Impacts to the planning area can include:

- Individuals exposed to the storm can be struck by flying debris, falling limbs, or downed trees causing serious injury or death.
- Structures can be damaged or crushed by falling trees, which can result in physical harm to the occupants.
- Significant debris and downed trees can result in emergency response vehicles being unable to access areas of the community.
- Downed power lines may result in roadways being unsafe for use, which may prevent first responders from answering calls for assistance or rescue.
- During exceptionally heavy wind events, first responders may be prevented from responding to calls, as the winds may reach a speed at which their vehicles and equipment are unsafe to operate.
- Thunderstorm wind events often result in widespread power outages increasing the risk to more vulnerable portions of the population who rely on power for health and/or life safety.

- Extended power outage often results in an increase in structure fires and carbon monoxide poisoning, as individuals attempt to cook or heat their homes with alternate, unsafe cooking or heating devices, such as grills and incorrect use of generators.
- First responders are exposed to downed power lines, unstable and unusual debris, hazardous materials, and generally unsafe conditions.
- Emergency operations and services may be significantly impacted due to damaged facilities and/or loss of communications.
- Critical staff may be unable to report for duty, limiting response capabilities.
- City or county departments may be damaged, delaying response and recovery efforts for the entire community.
- Private sector entities that the community and its residents rely on, such as utility providers, financial institutions, and medical care providers may not be fully operational and may require assistance from neighboring communities until full services can be restored.
- Economic disruption negatively impacts the programs and services provided by the community due to short- and long-term loss in revenue.
- Some businesses not directly damaged by thunderstorm wind events may be negatively impacted while roads are cleared and utilities are being restored, further slowing economic recovery.
- Older structures built to less stringent building codes may suffer greater damage as they are typically more vulnerable to thunderstorm winds.
- Large scale wind events can have significant economic impact on the affected area, as it must now fund expenses such as infrastructure repair and restoration, temporary services and facilities, overtime pay for responders, and normal day-to-day operating expenses.
- Businesses that are more reliant on utility infrastructure than others may suffer greater damage without a backup power source.
- Activities at locations that attract tourism include hiking, camping, boating, and fishing throughout the year. A large thunderstorm wind event could impact recreational activities, placing visitors in imminent danger, potentially requiring emergency services or evacuations.
- Recreational areas and parks may be damaged or inaccessible due to downed trees or debris, causing temporary impacts to area businesses.

The growing population increases exposure to thunderstorms and wind. More development increases the potential for more debris. Critical infrastructure increases with the growing population; therefore, the thunderstorms and wind exposure to critical infrastructure increases.

The economic and financial impacts of thunderstorm winds on the area will depend entirely on the scale of the event, what is damaged, and how quickly repairs to critical components of the economy can be implemented.

The level of preparedness and pre-event planning done by the community, local businesses, and citizens will also contribute to the overall economic and financial conditions in the aftermath of any thunderstorm wind event.

References – Section 12

1. *National Oceanic and Atmospheric Administration. Thunderstorms. https://www.noaa.gov/jetstream/thunderstorms*
2. *National Weather Service. Severe Thunderstorm Safety. https://www.weather.gov/safety/thunderstorm*
3. *National Weather Service. Beaufort Wind Scale. https://www.weather.gov/mfl/beaufort*
4. *Climate Texas. Texas A & M University. https://climatexas.tamu.edu/*
5. *Brazos County HMAP (2019-2024). Main Page. https://bcdem.org/emergency/plans*
6. *Risk Factor. Brazos County. https://riskfactor.com/city/brazos-country-tx/4810090_fsid/wind?utm_source=redfin*
7. *Haberlie, A., Ashley, W., Battisto, C., & Gensini, V. (2022). Thunderstorm activity under intermediate and extreme climate change scenarios. Geophysical Research Letters, 49(14), e2022GL098779.*
8. *Trapp, R., Diffenbaugh, N.., Brooks, H., Baldwin, M., Robinson, E., & Pal, J. (2007). Changes in severe thunderstorm environment frequency during the 21st century caused by anthropogenically enhanced global radiative forcing. Proceedings of the National Academy of Sciences, 104(50), 19719-19723.*
9. *Hayhoe, K., Edmonds, J., Kopp, R., LeGrande, A., Sanderson, B., Wehner, M., & Wuebbles, D. (2017). Climate models, scenarios, and projections.*
10. *Ye, S., Zeng, G., Wu, H., Liang, J., Zhang, C., Dai, J., & Yu, J. (2019). The effects of activated biochar addition on remediation efficiency of co-composting with contaminated wetland soil. Resources, Conservation and Recycling, 140, 278-285.*
11. *Abell, J., Winckler, G., Anderson, R., & Herbert, T. (2021). Poleward and weakened westerlies during Pliocene warmth. Nature, 589(7840), 70-75.*
12. *IPCC. Weather and Climate Extreme Events in the Changing Climate. https://www.ipcc.ch/report/ar6/wg1/downloads/report/IPCC_AR6_WGI_Chapter11.pdf*
13. *Muller, C., & Romps, D. (2018). Acceleration of tropical cyclogenesis by self-aggregation feedback. Proceedings of the National Academy of Sciences, 115(12), 2930-2935.*
14. *Price, C., and D. Rind, (1994) Modeling global lightning distributions in a general circulation model. Mon. Weather Rev., **122**, 1930-1939, doi:10.1175/1520-0493(1994)122<1930:MGLDIA>2.0.CO;2. NASA.*
15. *Nampak, H.; Love, P.; Fox-Hughes, P.; Watson, C.; Aryal, J.; Harris, R.M.B. (2021). Characterizing Spatial and Temporal Variability of Lightning Activity Associated with Wildfire over Tasmania, Australia. Fire (**2021**), 4, 10. https://doi.org/10.3390/fire4010010*
16. *Vaisala. Vaisala Annual Weather Lightening Report, 2022. Vaisala X-weather Annual Lightning Report explores 2022's extremes – from a record-breaking volcano to major snowstorms and exceptional drought. https://www.vaisala.com/en/press-releases/2023-01/vaisala-xweather-annual-lightning-report-explores-2022s-extremes-record-breaking-volcano-major-snowstorms-and-exceptional*
17. *San Antonio. Hazard Mitigation Action Plan. https://www.saoemprepare.com/Portals/16/Files/Plans/planHMAP.pdf?ver=2017-03-01-001439-567*
18. *National Weather Service. Weather. Main Page. https://forecast.weather.gov/MapClick.php?zoneid=TXZ196*
19. *Texas Department of State Health Services. Texas Health and Human Services. Main Page. https://www.dshs.texas.gov/*

This page intentionally left blank.

Section 13 – Dam Failure

Hazard Description

Dams are water storage, control, or diversion structures that impound water upstream in reservoirs. Dam failure can take several forms, including a collapse of or breach in the structure. While most dams have storage volumes small enough that failures have few or no repercussions, dams storing large amounts can cause significant flooding downstream. Dam failures can result from any one or a combination of the following causes[2]:

- Prolonged periods of rainfall and flooding, which cause most failures, such as structural integrity failures.
- Inadequate spillway capacity, resulting in excess overtopping of the embankment.
- Internal erosion caused by embankment or foundation leakage or piping.
- Improper maintenance, including failure to remove trees, repair internal seepage problems, or maintain gates, valves, and other operational components.
- Improper design or use of improper construction materials.
- Failure of upstream dams in the same drainage basin.
- Landslides into reservoirs, which cause surges that result in overtopping.
- High winds, which can cause significant wave action and result in substantial erosion.
- Destructive acts of terrorism.
- Earthquakes, which typically cause longitudinal cracks at the tops of the embankments, lead to structural failure.

Benefits provided by dams include water supplies for drinking; irrigation and industrial uses; flood control; hydroelectric power; recreation; and navigation[2]. At the same time, dams also represent a risk to public safety[2]. Dams require ongoing maintenance, monitoring, safety inspections, and sometimes even rehabilitation to continue safe service[2]. In the event of a dam failure, the energy of the water stored behind the dam can cause rapid and unexpected flooding downstream, resulting in loss of life and substantial property damage[2]. A devastating effect on water supply and power generation might occur as well[2].

The terrorist attacks of September 11, 2001, generated increased focus on protecting the country's infrastructure, including ensuring the safety of dams.

QUICK FACTS

Critical Components

Abutments

Dam abutments are where the dam is structurally tied in with the adjoining valley slopes.

Right and left abutments are described as viewed looking downstream.

Spillways

Are used to help regulate the volume of water in the reservoir. They can also be used to release surplus floodwater that cannot be contained in the reservoir.

Outlet Works

Control the release of water from a reservoir and typically consist of a combination of structures.

Source: FEMA[1]

One major issue with the safety of dams is their age. The average age of America's 84,000 dams is 52 years[3]. According to statistics released in 2009 by the Association of State Dam Safety Officials[4], more than 2,000 dams near population centers are in need of repair[4]. In addition to the continual aging of dams, there have not been significant increases in the number of safety inspectors resulting in haphazard maintenance and inspection[4].

The Association of State Dam Safety Officials[4] estimate that $16 billion will be needed to repair all high- hazard dams, but the total for all state dam-safety budgets is less than $60 million[4]. The current maintenance budget does not match the scale of America's long-term modifications of its watersheds[4]. Additionally, more people are moving into risky areas[4]. As the American population grows, dams that once could have failed without major repercussions are now upstream of cities and development[4].

Hazardous Areas

The State of Texas has 7,413 dams, all regulated by the Texas Commission on Environmental Quality (TCEQ)[5]. The National Dam Safety Review Board (in coordination with FEMA)[6] and the National Inventory of Dams (NID)[7] list a total of thirty-eight dams in or near the Brazos County planning area, including all participating entities. Each of these dams were analyzed individually by location, volume, elevation, and condition (where available) when determining the risk, if any, for each dam.

Each dam site was further analyzed for potential risks utilizing FEMA's National Flood Hazard Layer[8] to map locations and fully understand development near the dam and topographical variations that may increase risk. Most of the dams listed in the planning area were embankments for typically dry detention drainage areas or shored up stream embankments[8]. These types of structures are utilized for flood control and a variety of other purposes and do not pose a dam failure risk[8]. Additionally, dams in the planning area feature such limited storage capacity that they pose no risk to structures, infrastructure, or citizens[8]. Dams that were deemed to pose no past, current, or future risk to the planning area are not profiled in the plan as no loss of life or impact to critical facilities or infrastructure is expected in the event of a breach[8].

Legislation[9] was passed on September of 2013 allowed for some dams to be designated as exempt if they met all the following five criteria[9]:

- Privately owned.
- Less than 500-acre foot maximum capacity.
- Located in a county with a population of less than 350,000 (per census).
- Located outside the city limits.
- Low or significant hazard rating.

While owners are still required to do maintenance on those dams, TCEQ[9] is not required to do inspections on those dams. For those dams that are non-exempt (see Table 13.1), the owners must continue the maintenance of the dams, schedule inspections every 5 years with TCEQ[9], and if they are high and significant hazard dams, they must also produce an emergency action plan[9].

Dam Name	Exemption Status	Latitude/Longitude	Dam Height (Ft.)	Maximum Storage (Acre feet)	Normal Storage (Acre feet)	Available Data
Bryan Utilities Lake Dam	Non-Exempt	30.710067/-96.453721	59	20763	13647	Yes
Carter Lake Dam	Non-Exempt	30.594992/-96.248677	32	2196	481	Data Deficient
Midtown Park Lake Dam	Non-Exempt	30.639827/-96.358982	10	128	42	Yes
CSISD at Anderson St Detention Structure No. 3	Non-Exempt	30.613940/-96.327372	11.7	9	0	Data Deficient
Finfeather Lake Dam	Non-Exempt	30.649868/-96.371041	16.1	300	156	Data Deficient
Lake Arapaho Dam	Non-Exempt	30.510553/-96.250460	37	924	436	Data Deficient
Leisure Lake Dam	Non-Exempt	30.633847/-96.411916	25	322	175	Data Deficient
Nantucket Dam	Non-Exempt	30.543651/-96.243367	20	428	140	Data Deficient
Oakland Lake Dam	Non-Exempt	30.776483/-96.235630	32	550	272	Data Deficient
TAMU Detention Dam No. 8	Non-Exempt	30.621050/-96.333642	8.2	140	0	Yes
Thousand Oaks Dam No. 11	Non-Exempt	30.544471/-96.231595	22	120	58	Data Deficient

Table: 13.1 – Dam Exemption/Non-Exemption Status in Brazos County Source: TCEQ[9]

Dam Classification System[10]

The three classification levels for dams that were adopted are: *low, significant, and high*, listed in order of increasing adverse incremental consequences. The classification levels build on each other, i.e., the higher order classification levels add to the list of consequences for the lower classification levels[10].

This hazard potential classification system should be utilized with the understanding that the failure of any dam or water-retaining structure, no matter how small, could present a danger to downstream life and property. Whenever there is an uncontrolled release of stored water, there is the possibility of someone, regardless of how unexpected, being in its path[10].

A primary purpose of any classification system[10] is to select appropriate design criteria. In other words, design criteria will become more conservative as the potential for loss of life and/or property damage increases. However, postulating every conceivable circumstance that might remotely place a person in the inundation zone whenever a failure may occur should not be the

basis for determining the conservatism in dam design criteria[10].

Table: 13.2, shows the classification system that categorizes dams based on the probable loss of human life and the impacts on economic, environmental, and lifeline interests.

Classification	Loss of Human Life	Economic, Environmental, and Lifeline Losses
A – Low	None Expected	Low and Generally Limited to Owner
B – Significant	None Expected	Yes
C - High	Probable, one or more expected	Yes

Table: 13.2 – Classification of Dams Source: DHS[11] & FERC [12]

A/Low Hazard Potential[11,12]
Dams assigned the low hazard potential classification are those where failure or mis operation results in no probable loss of human life and low economic and/or environmental losses. Losses are principally limited to the owner's property[11,12].

B/Significant Hazard Potential[11,12]
Dams assigned the significant hazard potential classification are those dams where failure or mis-operation results in no probable loss of human life but can cause economic loss, environmental damage, disruption of lifeline facilities, or can impact other concerns. Significant hazard potential classification dams are often located in predominantly rural or agricultural areas but could be in areas with population and significant infrastructure[11,12].

C/High Hazard Potential[12]
Dams assigned the high hazard potential classification are those where failure or mis-operation will probably cause loss of human life[11,12].

Brazos County has a total of thirty-eight (38) dams with the following hazard potential classifications:

- Low: twenty-six (22)
- Significant: five (5)
- High: eleven (11)

For dams with a maximum storage capacity between 10,000 and 100,000 acre-feet, all structures within three miles are at risk of potential dam failure hazards. For dams with a maximum storage capacity of less than 10,000 acre-feet, all structures within one mile are at risk of potential dam failure hazards,[8] currently there are thirty-seven (37) that are under 10,000 acre-feet and one (1) that is between 10,000 and 100,000 acre-feet[10].

The areas at risk in the event of a dam failure are identified in Figure 13.1, below.

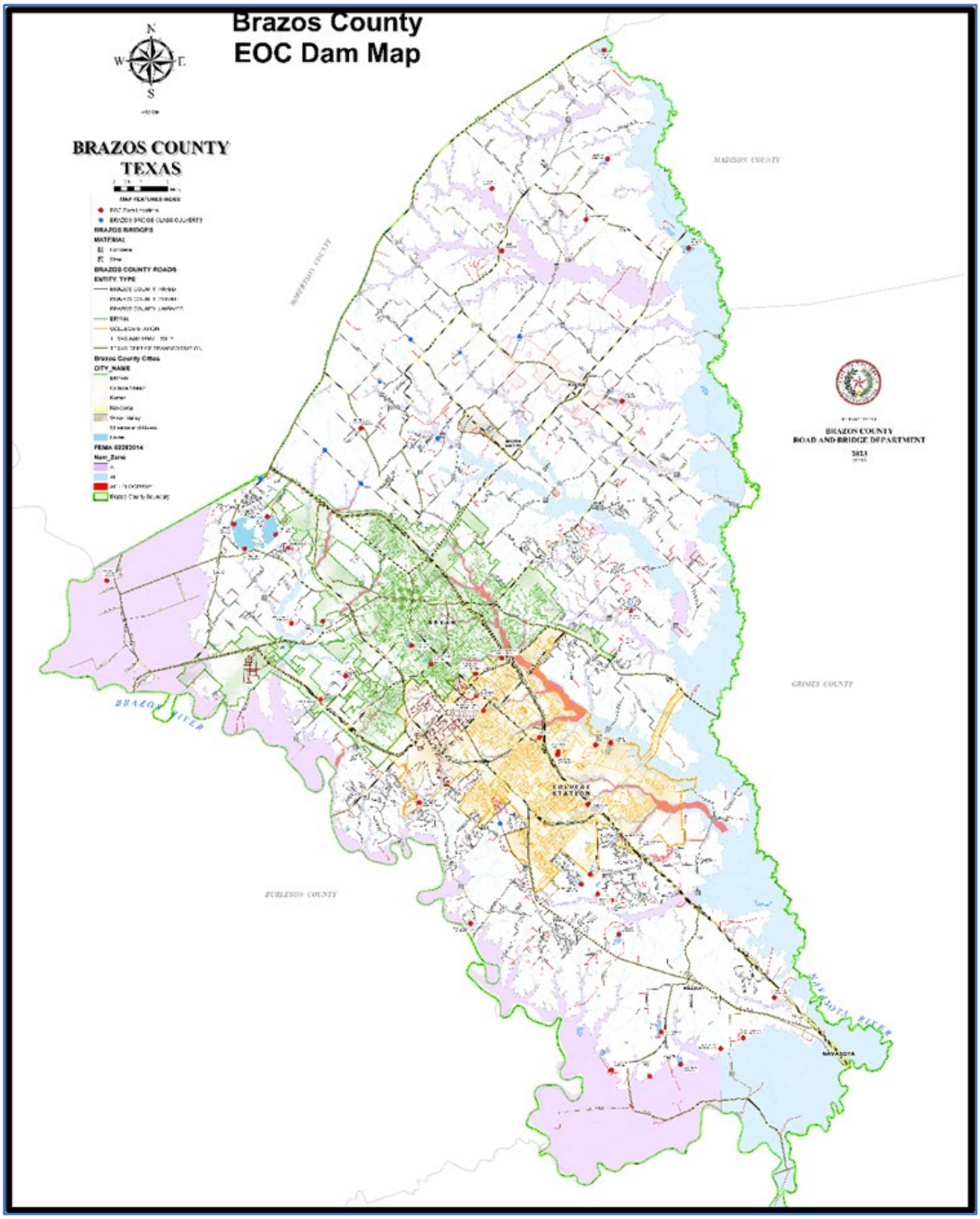


Figure: 13.1 Dam Locations and Surrounding Areas Source: Brazos County Road and Bridge[13]

Previous Occurrences

There are approximately 84,000 dams in the United States today. Catastrophic dam failures have occurred frequently throughout the past century. Between 1918 and 1958, 33 major U.S. dam failures caused 1,680 deaths. From 1959 to 1965, nine major dams failed worldwide. Some of the largest disasters in the U.S. have resulted from dam failures. More than 90 dam incidents, including 23 dam failures, were reported in the past ten years to the National Performance of

Dams Program, which collects and archives information on dam performance from state and federal regulatory agencies and dam owners.

The State of Texas has not experienced loss of life or extensive economic damage due to a dam failure since the first half of the twentieth century. However, there may be many incidents that are not reported and, therefore, the actual number of incidents is likely to be greater.

Brazos County has had two (2) reported dam failures in the planning area[10]:

- 2017 – Clifty Creek Lake (Spillway Breech)
- 2002/2003 – Lake Linda (Dam Breech)

Future Probability

Based on historical occurrences and the changing climate, the soil in Brazos County shrinks and swells frequently causing the shrinkage of settlement leading to instability over time. It is possible for an occurrence; the risk of dam failure is monitored closely. Due to the lack of historical occurrences, the probability of a future event is unlikely for those jurisdictions profiling dam failure as a hazard, meaning an event is possible in the next ten years.

Climate Change

Climate change could affect the safety of all dam structures, including large and small dams and earthen or concrete dams. Specifically, significant changes in a region's climate, such as increased incidence of extreme temperatures and the increased frequency of heavy precipitation, could seriously impact the integrity and viability of dams in Brazos County and its participating entities.

Potential Damages and Losses

There are thirty-eight (38) dams in the Brazos County planning area. The majority of the dams were evaluated in-depth to determine the risk, if any, associated with each dam. It is critical to note that many of the studies on the dams are missing the inundation studies because they are "privately" owned dams and are the responsibility of the owners to conduct.

Flooding is the most prominent effect of dam failure. If the dam failure is extensive, a large amount of water would enter the downstream waterways forcing them out of their banks. There may be significant environmental effects, resulting in flooding that could disperse debris and hazardous materials downstream that can damage local ecosystems. If the event is severe, debris carried downstream can block traffic flow, cause power outages, and disrupt local utilities, such as water and wastewater, which could result in school closures.

Annualized loss-estimates for dam failure are not available; neither is there a breakdown of potential dollar losses for critical facilities, infrastructure and lifelines, or hazardous-materials facilities. If a major dam should fail, however, the severity of impact could be substantial. The extent of a major dam failure in the planning area is a release of several thousand gallons of

water which could affect 695 buildings and over 2,000 individuals; to include critical infrastructure such as roads, railways, farms, livestock, and buildings. The estimated cost of this type of failure could top over $23 million (estimated). Examples of dams within the Brazos County planning area that could cause damage in the millions if breached. (See Figure 13.1)

Extent

Table 13.2 shows a list of the high hazard dams within Brazos County. HAZUS-MH inventory was used to estimate potential exposure, losses, and affected population due to dam failure. It was assumed that dam break happens most likely at the time of maximum capacity and that a downstream quarter-circle buffer (buffers that restrict sediment delivery to channels, inhibit sediment movement along channels, and blankets drape channel or floodplain) proportional to the maximum capacity of dams represents the maximum impact area. There have been no previous occurrences of dam failure at high hazard dams in Brazos County. Dam inundation maps are not currently available.

Dam Name	Hazard	Latitude/Longitude
Bryan Utilities Lake Dam	High	30.710067/-96.453721
Carter Lake Dam	High	30.594992/-96.248677
Midtown Park Lake Dam	High	30.639827/-96.358982
CSISD at Anderson St Detention Structure No. 3	High	30.613940/-96.327372
Finfeather Lake Dam	High	30.649868/-96.371041
Lake Arapaho Dam	High	30.510553/-96.250460
Leisure Lake Dam	High	30.633847/-96.411916
Nantucket Dam	High	30.543651/-96.243367
Oakland Lake Dam	High	30.776483/-96.235630
TAMU Detention Dam No. 8	High	30.621050/-96.333642
Thousand Oaks Dam No. 11	High	30.544471/-96.231595

Table: 13.3 – High Hazard Dams in Brazos County Source: TCEQ[9]

The High Hazard Dams in Brazos County Descriptions

Bryan Utilities Lake Dam

Bryan Utilities Lake Dam, Texas ID TX 01869, is located in central Texas on unnamed tributaries of Thompson's Creek and Peach Creek in the Brazos River Basin in Brazos County, northwest of the City of Bryan.

North Embankment (Power Plant Embankment) - Power Plant Embankment would result in a peak discharge of 5,993 cfs. The resulting flood wave would flow downstream from the embankment through the Power Plant, along Elm Creek and into the Little Brazos River, where it would be attenuated. The Power Plant, several structures and roadways would be flooded.

All roadways that could possibly be flooded should be barricaded off to prevent access into the affected area. These streets include but are not limited to:

- Mumford Road
- Maple Drive
- West OSR
- Allen Road

South Embankment - South Embankment would result in a peak discharge of 186,585 cfs. The resulting flood wave would flow downstream from the embankment along Thompsons Creek and the Brazos River, where it would be attenuated. Numerous structures and roadways would be flooded.

All roadways that could possibly be flooded should be barricaded off to prevent access into the affected area. These streets include but are not limited to:

- FM 1687
- Britten Road
- Burt Road
- Union Pacific Railroad
- SH 21
- Silver Hill Road
- SH 47
- Bush Road
- Leonard Road

East Embankment - East Embankment would result in a peak discharge of 234,014 cfs. The resulting flood wave would flow downstream from the embankment along Thompsons Creek and into the Brazos River, where it would be attenuated. Numerous structures and roadways would be flooded.

All roadways that could possibly be flooded should be barricaded off to prevent access into the affected area. These streets include but are not limited to:

- Unnamed Street (oil service road)
- Sandy Oaks Drive
- Creekside Drive
- FM 1687
- Valley Road
- Union Pacific Railroad
- SH 21
- Silver Hill Road

- SH 47
- Bush Road
- Leonard Road

West Embankment - West Embankment would result in a peak discharge of 288,054 cfs. The resulting flood wave would flow downstream from the embankment along the Little Brazos River and into the Brazos River, where it would be attenuated. Numerous structures and roadways would be flooded.

All roadways that could possibly be flooded should be barricaded off to prevent access into the affected area. These streets include but are not limited to:

- West OSR
- Rye Loop
- Allen Road
- Union Pacific Railroad
- FM 1687
- SH 21 (Road does not get overtopped but will flood in the area)

Official Dam Name: Bryan Utilities Lake Dam **Jurisdiction Affected:** City of Bryan and Brazos County
Latitude: 30.710067 **Longitude: -96.453721**
Stream: Alum Creek
Location: Six miles northwest of the City of Bryan, Brazos County, Texas
Dam Owner: Bryan Texas Utilities
Dam Coordinator: Manager of Production Operations
Type of Dam: Compacted earth fill
Year Constructed: 1975
Dam Height: 59 feet **Dam Length:** 17,500 feet **Crest Width:** 20 feet
Dam Size: Large (3)
Drainage Area: 0 square miles, groundwater is pumped into the lake
Hazard Classification: High
Principal Spillway: Sluice gate

Table: 13.4 Bryan Utilities Lake Dam Information Source: TCEQ9

Carter Lake Dam

The downstream structures that could be affected by a breach of the dam include the four houses adjacent to the spillway as well as five lots in the Williams Creek development, 3 miles downstream. If Carter Lake Dam fails, a flood wave will move east down through the low-lying area along Carter Creek toward William D. Fitch Road and beyond. There are no critical facilities or infrastructure in the inundation area.

Official Dam Name: Carter Creek Dam	**Jurisdiction Affected:** City of College Station
Latitude: 30.594992	**Longitude: -96.248677**
Stream: Unnamed Tributary of Carter Creek	
Location: Six miles southeast of Bryan, TX	
Dam Owner: Carter Lake Homeowners Corporation	
Dam Coordinator: Head of the Dam Committee	
Type of Dam: Compacted earth fill	
Year Constructed: 1966	
Dam Height: 32 feet	**Dam Length:** 1425 feet **Crest Width:** 26 feet
Dam Size: Small	
Drainage Area: 228 acres (0.356 sq. miles)	
Hazard Classification: High	
Principal Spillway: Irregular Earthen	

Table: 13.5 Carter Creek Dam Information Source: TCEQ[9]

Midtown Park Lake Dam (formerly Country Club Lake Dam)

The number businesses that could be impacted by a dam failure is outlined below, along with impacts to numerous roadways in the area. Additionally, Villa Maria and College Avenue are highly trafficked roadways. So, there could be numerous motorists within the inundation area depending on the time of day.

Official Dam Name: Midtown Park Lake Dam	**Jurisdiction Affected:** City of Bryan
Latitude: 30.639827	**Longitude: -96.358982**
Stream: Burton Creek Tributary D	
Location: 2.6 miles southeast of Bryan, TX	
Dam Owner: City of Bryan	
Dam Coordinator: The Operations Manager of the City of Bryan Transportation, Drainage & Environmental Services Department	
Type of Dam: Compacted earth fill	
Year Constructed: 1920/2023	
Dam Height: 8 feet	**Dam Length:** 1860 feet **Crest Width:** 18.9 feet
Dam Size: Small	
Drainage Area: 1.4 square miles	
Hazard Classification: High	
Principal Spillway: Principal: Morning Glory Weir, Auxiliary: Modified Ogee – Concrete, Emergency: Broad Crest, Inlet/Outlet: Natural Creeks	

Table: 13.6 Midtown Park Lake Dam Information Source: City of Bryan[14]

College Station Independent School District (CSISD) at Anderson St Detention Structure No. 3

Multiple residences and roads downstream could be impacted by a failure of the Detention Structure. Roads in the area typically are highly traveled.

The roads impacted are but not limited to:

- Anderson Street
- George Bush Drive
- Holk Street
- Wolf Run

Businesses impacted (but not limited to)

- A & M Consolidated Middle School

Official Dam Name: CSISD at Anderson Street Detention Structure No. 3 Dam **Jurisdiction Affected:** City of College Station		
Latitude: 30.613940	**Longitude: -96.327372**	
Stream: Wolk Pen Creek		
Location: Six miles southeast of Bryan, TX		
Dam Owner: College Station Independent School District (CSISD)		
Dam Coordinator: CSISD Inspector		
Type of Dam: Reinforced concrete		
Year Constructed: Undetermined		
Dam Height: 11.7 feet	**Dam Length:** 90 feet	**Crest Width:** Unk
Dam Size: Small		
Drainage Area: 0.3 square miles		
Hazard Classification: High		
Principal Spillway: V-notch weir		

Table: 13.7 CSISD at Anderson St Detention Structure No. 3 Dam Information Source: TCEQ[9]

Fin-Feather Lake Dam

Finfeather Lake, located upstream of Bryan Municipal Lake, is also a small lake (18.5 acres), which is fed by an unnamed tributary within an industrial area of Bryan, Texas. It is bordered by Fountain Street on the west side and South College Ave on the east side. Most of the impacts from a dam failure would be commercial businesses. Depending on the size of the breach residential homes on the west side could be affected.

Official Dam Name: Fin-Feather Lake Dam	**Jurisdiction Affected:** City of Bryan
Latitude: 30.649868	**Longitude: -96.371041**
Stream: TR-Burton Creek	
Location: Northwest Bryan in Brazos County	
Dam Owner: Union Pacific Railroad Company	
Dam Coordinator: Union Pacific Railroad Company	
Type of Dam: Compacted earth fill	
Year Constructed: 1930	
Dam Height: 16 feet **Dam Length:** 1310 feet	**Crest Width:** Unk
Dam Size: Small	
Drainage Area: 0.4 square miles	
Hazard Classification: High	
Principal Spillway: Uncontrolled	

Table: 13.8 Fin-Feather Lake Dam Information Source: TCEQ

Lake Arapaho Dam

Multiple residences and roads downstream from the dam could be impacted as well as an electrical substation by a dam failure.

The projected inundation area is assumed to be limited to the floodplain area along Peach Creek.

This area is vacant ranch land consisting of wooded areas mixed with open pastureland. Inundation timing and duration is highly dependent on the rate of dam failure.

Official Dam Name: Lake Arapaho Dam **Jurisdiction Affected:** Brazos County and City of College Station	
Latitude: 30.510553	**Longitude: -96.250460**
Stream: Unnamed tributary of Peach Creek	
Location: 2 miles Southwest of the intersection of State Highway 6 and State Highway 40 in College Station in Brazos County, Texas	
Dam Owner: The Villages of Indian Lakes Homeowners' Association (HOA)	
Dam Coordinator: HOA Manager	
Type of Dam: Compacted earth fill	
Year Constructed: 2004	
Dam Height: 37 feet **Dam Length:** 1572 feet	**Crest Width:** Unk
Dam Size: Small	
Drainage Area: 0.61 square miles	
Hazard Classification: High	
Principal Spillway: Uncontrolled, Sluice Gate, Other Controlled	

Table: 13.9 Lake Arapaho Dam Information Source: TCEQ[9]

Leisure Lake Dam

Numerous residential (both permanent construction and mobile homes), an apartment complex, a commercial water well, and several county roads would be impacted by the failure of this dam.

No formal inundation study has been done for this location.

Official Dam Name: Leisure Lake Dam	**Jurisdiction Affected:** City of Bryan
Latitude: 30.633847	**Longitude: -96.411916**
Stream: Tributary of Thompsons Creek	
Location: 4 miles southwest of Bryan off of Cypress Road	
Dam Owner: Leisure Lake Inc.	
Dam Coordinator: Leisure Lake Inc.	
Type of Dam: Compacted earth fill	
Year Constructed: 1964	
Dam Height: 25 feet **Dam Length:** 1220 feet	**Crest Width:** 322.0 feet
Dam Size: Small	
Drainage Area: 0.14 square miles	
Hazard Classification: High	
Principal Spillway: Uncontrolled	

Table: 13.10 Leisure Lake Dam Information Source: TCEQ[9]

Nantucket Dam

Primary impacts from a dam failure at this location would be a major state highway and frontage roads as well as impacts to several county roads and residential structures in the vicinity of the lake.

Official Dam Name: Nantucket Lake Dam	**Jurisdiction Affected:** City of College Station
Latitude: 30.543651	**Longitude: -96.243368**
Stream: Alum Creek	
Location: 1/2 Miles Southeast of College Station	
Dam Owner: Nantucket Preservation Association	
Dam Coordinator: Nantucket Preservation Association	
Type of Dam: Compacted earth fill	
Year Constructed: 1977	
Dam Height: 20 feet **Dam Length:** 900 feet	**Crest Width:** 12 feet
Dam Size: Small	
Drainage Area: 1300 Acres	
Hazard Classification: High	
Principal Spillway: Concrete Lined Channel	

Table:13.11 Nantucket Lake Dam Information Source: TCEQ[9]

Oakland Lake Dam

Several structures (residential and farm use), a wellsite, and possibly one county road could be impacted by the failure of this rural dam.

Official Dam Name: Oakland Lake Dam	**Jurisdiction Affected:** Brazos County
Latitude: 30.543651	**Longitude: -96.243368**
Stream: Allcorn Creek	
Location: Near 5085 North Oakland	
Dam Owner: The Falls Subdivision	
Dam Coordinator: The Falls Subdivision	
Type of Dam: Compacted earth fill	
Year Constructed: 1960	
Dam Height: 32 feet	**Dam Length:** 2387 feet **Crest Width:** Unk
Dam Size: Small	
Drainage Area: 6 square miles	
Hazard Classification: High	
Principal Spillway: Uncontrolled	

Table:13.12 Oakland Lake Dam Information Source: TCEQ[9]

TAMU Detention Dam No. 8

The number of people and structures that could be impacted by a dam failure is Texas Avenue and George Bush Drive which are highly trafficked roadways. So, there could be numerous motorists within the inundation area depending on the time of day[13].

Official Dam Name: TAMU Detention Dam No. 8 **Jurisdiction Affected:** City of College Station and Texas A&M University	
Latitude: 30.621050	**Longitude: -96.333642**
Stream: Unnamed Tributary of Wolf Pen Creek	
Location: Along New Main Dr. from Texas Ave.	
Dam Owner: The Texas A&M University System	
Dam Coordinator: The Texas A&M University System	
Type of Dam: Compacted earth fill	
Year Constructed: 2002	
Dam Height: 8.2 feet	**Dam Length:** 2037 feet **Crest Width:** 20 feet
Dam Size: Small	
Drainage Area: 0.5 square miles	
Hazard Classification: High	
Principal Spillway: Uncontrolled	

Table: 13.13 TAMU Detention Dam No. 8 Information Source: TAMU[15]

Thousand Oaks Dam No. 11

The projected inundation area is assumed to be limited to the floodplain area along Alum Creek. This area is vacant ranch land consisting of wooded areas mixed with open pastureland.

Inundation timing and duration is highly dependent on the rate of dam failure. There are no critical facilities or infrastructure in the inundation area.

Official Dam Name: Thousand Oaks Dam No. 11 **Jurisdiction Affected:** City of College Station
Latitude: 30.544471 **Longitude: -96.231595**
Stream: Alum Creek
Location: 1 mile Southeast of the intersection of State Highway 6 and State Highway 40 in College Station in Brazos County, Texas..
Dam Owner: Animate Habitat, Ltd. (AH)
Dam Coordinator: Animate Habitat, Ltd. (AH)
Type of Dam: Compacted earth fill
Year Constructed: 1930
Dam Height: 22 feet **Dam Length:** 900 feet **Crest Width:** 70 feet
Dam Size: Small
Drainage Area: 0.26 square miles
Hazard Classification: High
Principal Spillway: Uncontrolled

Table: 13.14 Thousand Oaks Dam No. 11 Information Source: TCEQ[9]

Assessment of Impacts

Any individual dam has a very specific area that will be impacted by a catastrophic failure. Dams identified as a high or significant hazard can directly threaten the lives of individuals living or working in the inundation zone below the dam. The impact from any catastrophic failure would be like that of a flash flood. Potential impacts for the planning area include:

- Lives could be lost.
- There could be injuries from impacts with debris carried by the flood.
- Swift-water rescue of individuals trapped by the water puts the immediate responders at risk for their own lives.
- Individuals involved in the cleanup may be at risk from the debris left behind.
- Continuity of operations for any jurisdiction outside the direct impact area could be very limited.
- Roads, bridges highways, and railways could be destroyed.
- Homes and businesses could be damaged or destroyed.
- Emergency services may be temporarily unavailable.
- Potential for the disruption of operations and the delivery of services in the impacted area.
- A large dam with a high head of water could effectively scour the terrain below it for miles, taking out all buildings and other infrastructure.

- Scouring force could erode soil and any buried pipelines.
- Scouring action of a large dam will destroy all vegetation in its path.
- Wildlife and wildlife habitat caught in the flow will likely be destroyed.
- Fish habitat will likely be destroyed.
- Topsoil will erode, slowing the return of natural vegetation.
- The destructive high velocity water flow may include substantial debris and hazardous materials, significantly increasing the risks to life and property in its path.
- Debris and hazardous material deposited downstream may cause further pollution of areas far greater than the inundation zone.
- Destroyed businesses and homes may not be rebuilt, reducing the tax base, and impacting long term economic recovery.
- Historical or cultural resources may be damaged or destroyed.
- Recreational activities and tourism may be temporarily unavailable or unappealing, slowing economic recovery.

The economic and financial impacts of dam failure on the area will depend entirely on the location of the dam, scale of the event, what is damaged, and how quickly repairs to critical components of the economy can be implemented.

The level of preparedness and pre-event planning done by the community, local businesses, and citizens will also contribute to the overall economic and financial conditions in the aftermath of any dam failure event.

References – Section 13

1. *Federal Emergency Management Agency. Dam Awareness. https://www.fema.gov/sites/default/files/2020-08/fact-sheet_dam-awareness.pdf*
2. *Concho Valley Council of Governments. Dam Failure. https://www.cvcog.org/cvcog/docs/Regional_services/Hazard_Mitigation/10.damfailure.v4.public.pdf*
3. *Infrastructure Report Card. America's Infrastructure. https://www.infrastructurereportcard.org/2009/fact-sheet/dams.html*
4. *Association of State Dam Safety Officials. Main Page. https://www.damsafety.org/*
5. *Texas Commission on Environmental Quality. Main Page. https://www.tceq.texas.gov/*
6. *Federal Emergency Management Agency. Dam Safety. https://www.fema.gov/emergency-managers/risk-management/dam-safety*
7. *National inventory of Dams. Dams of the Nation. https://nid.sec.usace.army.mil/#/*
8. *Federal Emergency Management Agency. National Flood Hazard Layer. https://www.fema.gov/flood-maps/national-flood-hazard-layer*
9. *Texas Commission on Environmental Quality. Guidelines for Developing Emergency Action Plan for Dams in Texas. https://www.tceq.texas.gov/downloads/compliance/publications/gi/gi-394.pdf*
10. *Brazos River Authority. Main Page. https://brazos.org/*
11. *Department of Homeland Security. National Infrastructure Protection Plan. Dams Sector. https://www.dhs.gov/xlibrary/assets/nppd/nppd-dams-sector-snapshot-508.pdf*
12. *Federal Energy Regulatory Commission. Federal Guidelines for Dam Safety. Hazard Potential Classification System for Dams. https://www.ferc.gov/sites/default/files/2020-04/fema-333.pdf*
13. *Brazos County Road and Bridge. Main Page. https://www.brazoscountytx.gov/177/Road-Bridge-Department*
14. *City of Bryan. Street and Drainage Services. https://www.bryantx.gov/streets-and-drainage-services/*
15. *Texas A & M University. Department of Engineering. https://engineering.tamu.edu/industrial/index.html*
16. *Google Earth. (2024). Coordinates and Maps of Dams. Brazos County. Earth.google.com*

This page intentionally left blank.

Section 14 – Excessive and Extreme Heat

Hazard Description

Excessive or extreme heat is a prolonged period of excessively or extreme high temperatures and exceptionally humid conditions. Excessive or extreme heat during the summer months is a common occurrence throughout the State of Texas, and Brazos County is no exception. The entire planning area, including all participating entities, typically experiences extended heat waves. A heat wave is an extended period of extreme heat and is often accompanied by high humidity.

Although heat can damage buildings and facilities, it presents a more significant threat to the safety and welfare of citizens. The major human risks associated with severe summer heat include heat cramps; sunburn; dehydration; fatigue; heat exhaustion; and even heat stroke.

The most vulnerable population to heat casualties are children and the elderly or infirmed who frequently live on low fixed incomes and cannot afford to run air-conditioning on a regular basis. This population is sometimes isolated, with no immediate family or friends to look out for their well-being[2].

Hazardous Areas

While there have been no deaths reported from excessive or extreme heat in the planning area, there is no specific geographic scope to the extreme heat hazard. Excessive or extreme heat could occur anywhere within the Brazos County planning area, including all participating entities.

The magnitude or intensity of an excessive or extreme heat incident is measured according to temperature in relation to the percentage of humidity[3]. (See Table: 14.1) According to the National Oceanic Atmospheric Administration[3], this relationship is referred to as the "Heat Index" and is depicted in Table: 14.2[3]. This index[3] measures how hot it feels outside when humidity is combined with high temperatures (See Table: 14.1)[3]. Located below is a chart that shows the heat indices and the possible heat disorders that could affect all populations within the planning area[3]. (Table: 14.3)

QUICK FACTS

Hyperthermia

A group of heat illnesses like heat exhaustion and heat stroke.

Heat Cramps

Painful muscle spasms that occur due to dehydration and loss of nutrients from excessive sweating.

Heat Exhaustion

The body's response to an excessive loss of water and salt, usually through excessive sweating.

Heat Stroke

It occurs when the body can no longer control its temperature: the body's temperature rises rapidly, the sweating mechanism fails, and the body is unable to cool down.

Dehydration

Occurs when you use or lose more fluid than you take in, and your body doesn't have enough water and other fluids to carry out its normal functions.

Sunburn

A radiation burns to the skin caused by too much exposure to the sun's ultraviolet (UV) rays or artificial sources such as tanning beds.

Source: Texas Department of State Health Services (DSHS)[1]

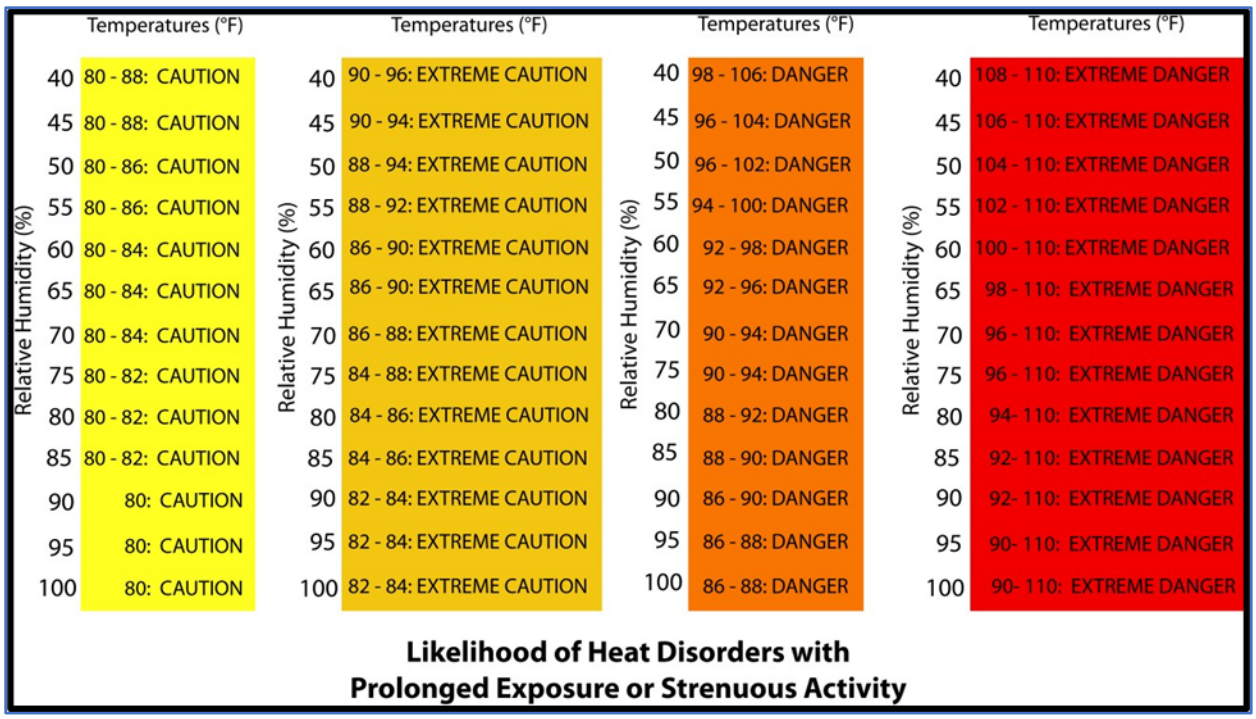


Table: 14.1 – Humidity and Temperature Likelihood of Heat Disorders Source: NOAA[3]

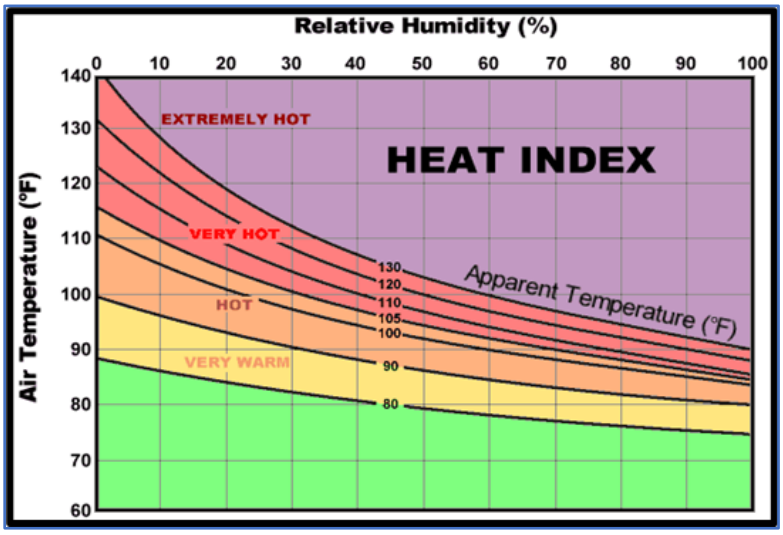


Table: 14.2 – Heat Index Source: NOAA[3]

Heat Index/Apparent Temperature (°F)	Possible Heat Disorders for People in High Risk Groups
130°F or Higher	Heat/Sunstroke HIGHLY LIKELY with continued exposure
105°F - 130°F	Sunstroke, heat cramps, or heat exhaustion LIKELY, and heatstroke POSSIBLE with prolonged exposure and/or physical activity
90°F - 105°F	Sunstroke, heat cramps, or heat exhaustion POSSIBLE with prolonged exposure and/or physical activity
80°F - 90°F	Fatigue POSSIBLE with prolonged exposure and/or physical activity

Table: 14.3 – Heat Index/Temperature and Heat Disorders Source: NOAA[3]

Previous Occurrences

Every summer, the hazard of heat-related illness becomes a significant public health issue throughout much of the US. Mortality from all causes increases during heat waves, and extreme or excessive heat is an important contributing factor to deaths from other causes, particularly among the elderly and children. To date there have been no excessive or extreme heat casualties in Brazos County. Table: 14.4, depicts historical occurrences of mortality from heat from 2000-2020 from the Texas Department of State Health Services[1] database, where 279 people (Texas) died due to heat related causes. This figure shows resident and non-resident deaths.

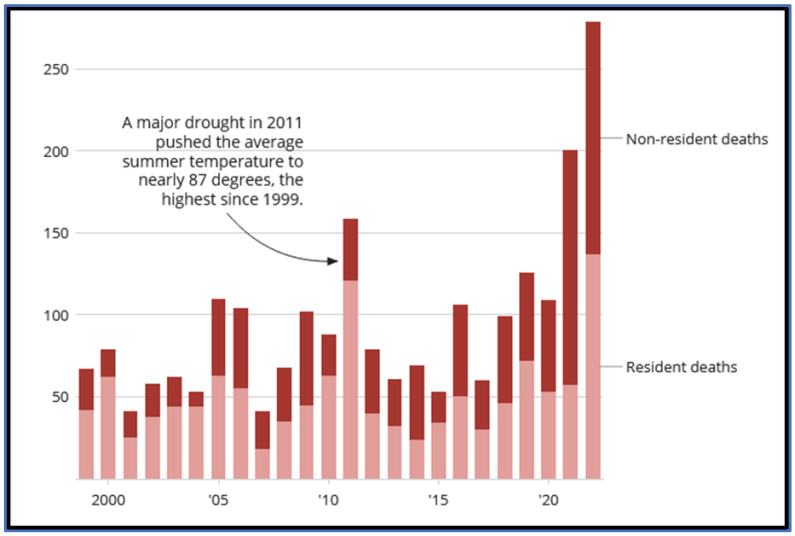


Table: 14.4 – Historical Deaths Related to Heat (Texas)
Source: Texas Department of State Health Services[1] Database

Future Probability

Average high temperatures for the planning area through the summer months indicate a probability of one event or more every year. This frequency supports a highly likely probability of future incidents.

The United States sees an average of 702 deaths per year from the effects of extreme or excessive heat with 67,512 emergency room visits, and 9,235 hospitalizations[4].

A hot day in Brazos County is considered to be any day above a “feels like” temperature of 110ºF. Brazos County is expected to experience 7 hot days this year. Due to a changing climate/environment, Brazos County will experience 14 days above 110ºF in 30 years[5].

One of the resulting effects of heat is the increase in energy usage that occurs as homes and businesses try to keep cool indoors. Based on heat projections for this year in Brazos County it is estimated that the use of air conditioning would cause an increase in energy consumption on 289 days annually.

This risk may become even more pronounced in 30 years, as the number of cooling days is expected to increase to 302 days per year. This increase in need for cooling is expected to increase Brazos County’s electricity usage for cooling purposes by 8.80%.

Heat risks are changing because of climate/environment change. A changing climate/environment means higher average temperatures and increased humidity, which has a compounding effect on heat indices that make risky heat events possible. As the global temperature rises, it can be important to understand what factors contribute to heat risk.

Historical data and climate models lead to similar conclusions[6]. If recent trends continue, as expected, a middle-of-the-road estimate of the overall rate of temperature increase in Texas would be about 0.6 °F per decade[6]. This means that average Texas temperatures in 2036 should be expected to be about 1.6 °F warmer than the 2000-2018 average and 3.0 °F warmer than the 1950-1999 average[6]. This would make a typical year around 2036 warmer than all, but the absolute warmest year experienced in Texas during 1895-2018[6].

Our climate is changing because the earth is warming. In Texas, a good benchmark for excessive or extreme heat is the number of 100+ °F days each year[6]. The number of 100-degree days is closely related to the average summertime temperature[6]. At rural and semi-urban index stations, where 2000-2018 July-August average temperatures average around 83 °F, there are typically about 12 days per year that reach or exceed 100 °F[6]. If summertime temperatures rise at a similar rate as the projected annual Texas average, the typical number of 100-degree days would nearly double, to about 21 per year, by 2036[6].

Figure: 14.1 shows the daily temperature for the current season verses historical data to show that there have been higher than usual temperatures in the Brazos County planning area and that temperatures are expected to rise[7]. People have increased the amount of carbon dioxide in the air by 40 percent since the late 1700s[7]. Other heat-trapping greenhouse gases are also increasing[7]. These gases have warmed the surface and lowered the atmosphere of our planet by about one degree during the last 50 years[7].

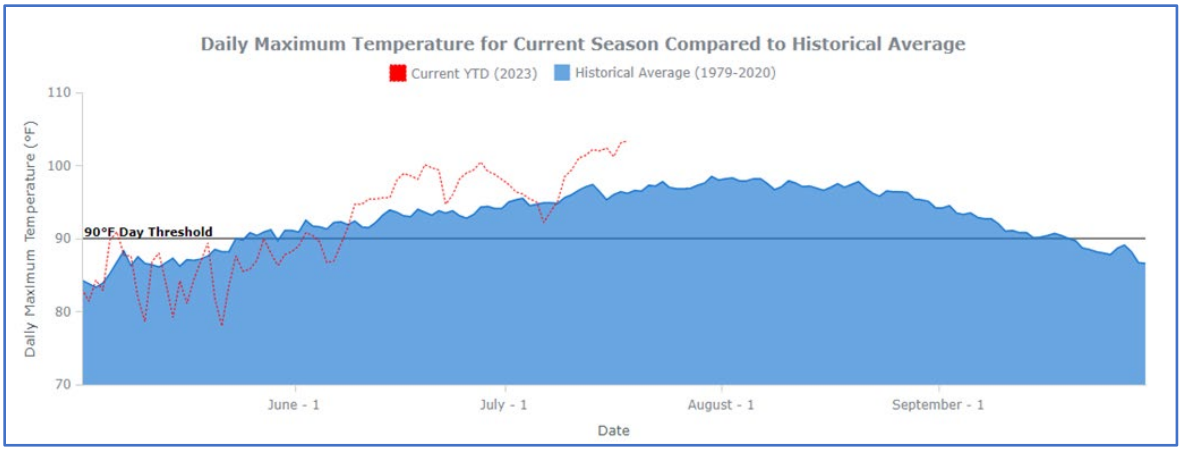


Figure: 14.1 – Historical Average Temperatures (1979-2023) Source: EPA[7]

Climate Change

As previously mentioned, climate change may increase the frequency or intensity of hazards over time. The U.S. Climate Resilience Toolkit, Climate Explorer[8] provides projected climate conditions for counties across the United States. Projections for two long-term climate scenarios were calculated for temperature. One scenario describes a future in which humans stop increasing harmful emissions by 2040 and then continue to reduce emissions through the end of the century (Lower Emissions)[8]. The second scenario describes a future in which harmful emissions continue to increase through the end of the century (Higher Emissions)[8]. The data show that emissions could impact climate, specifically excessive or extreme heat, in Brazos County and its participating entities over the next 80 years causing the number of 100°F days per year to steadily increase over time[8].

Potential Damages and Losses

There is no defined geographic boundary for excessive or extreme heat events. While the entire Brazos County planning area, including all participating entities, is exposed to excessive or extreme temperatures, existing buildings, infrastructure, and critical facilities are not likely to sustain significant damage from excessive or extreme heat incidents. Therefore, any estimated property losses associated with the excessive or extreme heat hazard are anticipated to be minimal across the area.

Excessive or extreme temperatures do, however, present a significant threat to life and safety for the population of the County as a whole. Heat casualties, for example, are typically caused by a lack of adequate air-conditioning or heat exhaustion. The most vulnerable population to heat casualties are the elderly, children, or infirmed who frequently live on low or fixed incomes and

cannot afford to run air-conditioning on a regular basis. This population is sometimes isolated, with no immediate family or friends to look out for their well-being.

In addition, populations living below the poverty level are unable to run air-conditioning on a regular basis and are limited in their ability to seek medical treatment[9]. Another segment of the population at risk are those whose jobs consist of strenuous labor outdoors[9]. Additionally, livestock and crops can become stressed, decreasing in quality or in production, during times of extreme heat[9].

Students in the planning area are also susceptible as sporting events and practices are often held outside during early fall or late spring when temperatures are at the highest[9]. Approximately thirty faculty or staff work outdoors for portions of the school day[9]. The planning area includes several athletic fields that may have ongoing athletic activities that would need to be closely monitored during excessive or extreme heat incidents[9].

Excessive or extremely high temperatures can have significant secondary impacts, leading to droughts, water shortages, increased fire danger, and prompt excessive demands for energy[10]. The possibility of rolling blackouts increases with unseasonably high temperatures in what is a normally mild month with low power demands[10].

Typically, more than 12 hours of warning time would be given before the onset of an excessive or extreme heat incident[10]. Only minor property damage would result[10]. The potential impact of excessive or extreme summer heat is considered "Minor" as injuries and/or illnesses do not result in permanent disability for the Brazos County planning area, including all participating entities.

In terms of vulnerability to structures, the impact from excessive or extreme heat would be negligible[01]. It is possible that critical facilities and infrastructure could be shut down for 24 hours or more, if cooling units are running constantly, leading to a temporary power outage[10]. Less than ten percent of residential and commercial property could be damaged if excessive or extreme heat incidents lead to structure fires[10].

The potential impact of excessive or extreme heat for the entire Brazos County planning area can be considered "Minor," resulting in few injuries and minimal disruption to the quality of life.

A potential dollar loss estimate for extreme or excessive heat is not available currently.

Extent

Texas is known for its long hot summers. These conditions can pose problems for those not accustomed to the climate or who are outside for prolonged periods of time. A prolonged period of dangerous excessive heat is expected within about 24 hours. The combination of hot temperatures and high humidity will create a dangerous situation in which heat related illnesses are likely[14]. The National Weather Service has updated the heat advisory criteria for southeast Texas for 2024[14]. A heat advisory will be issued when the heat index rises to 108 or when the temperature reaches 103[14]. Unlike 2023, these criteria only need to be met or forecasted for one day for the advisory to go into effect[14]. A new advisory named "Excessive Heat Warning" has

been added to the list for 2024. It will be issued when the temperature reaches 105 or the heat index reaches 113[14].

Excessive heat can pose a threat even to individuals and communities that are accustomed to high temperatures. Heat disorders can occur when victims are overexposed to heat or have over-exercised for their age and physical condition. Heat kills by pushing the body beyond its limits. Under normal conditions an internal thermostat produces perspiration that evaporates and cools the body. In excessive heat and high humidity, however, evaporation is slowed, and the body must work extra hard to maintain a normal temperature.

Excessive heat kills more people nationally than any other natural disaster. According to the Center for Climatic Research at the University of Delaware, an average of 1,500 American people die every year from the effects of excessive heat[11].

Elderly residents, young children, those who are overweight, and people suffering from serious illnesses are especially prone to heat-related problems. Excessive heat disorders include sunburn, heat cramps, heat exhaustion, and heat stroke. Heat stroke is a severe medical emergency[12].

According to the National Aeronautical and Space Administration, recent years have seen record-breaking temperatures. NASA[13] analysis confirms 2023 as warmest year on record; 2002 was the second- warmest year on record; and 2001 was the third-warmest year on record. But due to climate change, The United States has warmed by about 1.5°F since 1895, with most of the rise occurring since 1970. Figure: 14.2, shows a map of the earth and the global surface temperature anomalies or how much warmer or cooler each region of the planet was compared to the average from 1951 to 1980. Normal temperatures are shown in white, higher-than-normal temperatures in red and orange, and lower-than-normal temperatures in blue[13].

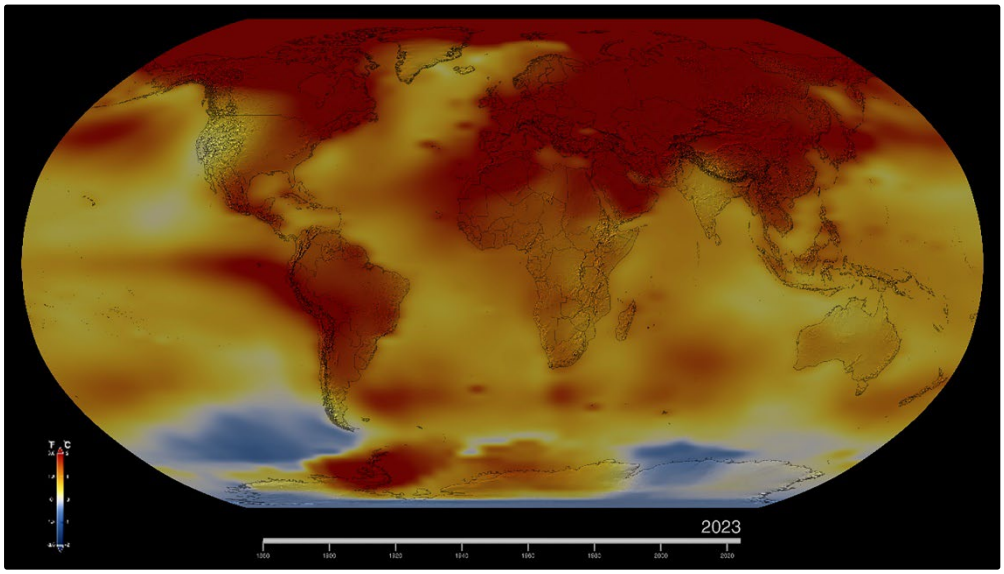


Figure: 14.2 - Global Surface Temperature Anomalies (2023) Source: NASA[13]

If the world continues to increase emissions of carbon pollution, the country could see 5°F to 10°F of additional warming by the end of the century. Increases in extreme heat could cause a dramatic rise in illnesses and deaths by the end of the century[4].

Assessment of Impacts

The greatest risk from excessive or extreme heat is to public health and safety. Potential impacts to the community may include:

- Vulnerable populations, particularly the elderly, infants, and children can face serious or life-threatening health problems from exposure to excessive or extreme heat including hyperthermia, heat cramps, heat exhaustion, and heat stroke (or sunstroke).
- Response personnel, including utility workers, public works personnel, and any other professions where individuals are required to work outside, are more subject to excessive or extreme heat related illnesses since their exposure would typically be greater.
- High energy demand periods can outpace the supply of energy, potentially creating the need for rolling brownouts which would elevate the risk of illness to vulnerable residents.
- Highways, roads, and infrastructure may be damaged by excessive or extreme heat causing asphalt roads to soften and concrete roads to shift or buckle, as well as infrastructure damages through shifting and shrinking of the clay soil, throughout the planning area.
- Vehicles, engines, and cooling systems typically run harder during excessive or extreme heat incidents resulting in increases in mechanical failures.
- Excessive or extreme heat events during times of drought can exacerbate the environmental impacts associated with drought, decreasing water and air quality and further degrading wildlife habitat.
- Excessive or extreme heat increases ground-level ozone (smog), increasing the risk of respiratory illnesses.
- Food suppliers can anticipate an increase in food costs due to increases in production costs and crop and livestock losses.
- Fisheries may be negatively impacted by extreme heat, suffering damage to fish habitats (either natural or man-made) and a loss of fish and/or other aquatic organisms due to decreased water flows or availability.
- Negatively impacted water suppliers may face increased costs resulting from the transport of water resources or development of supplemental water resources.
- Outdoor activities such as fishing, boating, and camping activities may see an increase in injury or illness during excessive or extreme heat incident.

The impact of excessive heat increases as the population grows. More people may be exposed to extreme hot temperatures, further increasing energy demand, etc.

The economic and financial impacts of excessive or extreme heat on the community will depend on the duration of the incident, demand for energy, drought associated with excessive or extreme heat, and many other factors.

The level of preparedness and the amount of planning done by the jurisdiction, local businesses, and citizens will impact the overall economic and financial conditions before, during, and after an excessive or extreme heat incident.

References – Section 14

1. *Texas Department of State Health Services. Health and Human Services. https://www.dshs.texas.gov/*
2. *Heat. Who is Most at Risk to Extreme Heat. https://www.heat.gov/pages/who-is-at-risk-to-extreme-heat*
3. *National Oceanic and Atmospheric Administration. Extreme Heat: A Resource Guide. https://www.noaa.gov/media-advisory/extreme-heat-media-resource-guide*
4. *Centers for Disease Control and Prevention. Extreme Heat. https://www.cdc.gov/disasters/extremeheat/index.html*
5. *Risk Factor. Brazos County. https://riskfactor.com/county/brazos-county-tx/48041_fsid/heat*
6. *Climate Texas. Texas A & M University. Main Page. https://climatexas.tamu.edu/*
7. *Environmental Protection Agency. Extreme Heat. https://www.epa.gov/natural-disasters/extreme-heat*
8. *US Climate Change Resilience Toolkit. Climate Explorer. https://toolkit.climate.gov/tool/climate-explorer-0*
9. *Substance Abuse and Mental Health Services Administration. How Disasters Affect People of Low Socioeconomic Status. https://www.samhsa.gov/sites/default/files/dtac/srb-low-ses_2.pdf*
10. *San Antonio Hazard Mitigation Action Plan. 2019. https://www.saoemprepare.com/Portals/16/Files/Plans/planHMAP.pdf?ver=2017-03-01-001439-567*
11. *The University of Delaware. (2024) Earth, Ocean, & Environment. https://www.udel.edu/academics/colleges/ceoe/research/*
12. *Federal Emergency Management Agency. (2024). Extreme Heat. https://community.fema.gov/ProtectiveActions/s/article/Extreme-Heat.*
13. *National Aeronautical and Space Administration. (2023). Extreme Heat. https://www.nasa.gov/news-release/nasa-analysis-confirms-2023-as-warmest-year-on-record/.*
14. *The National Weather Service. (2015) NWS changes criteria for issuing a Heat Advisory for SE Texas. https://abc13.com/heat-advisory-explanation-david-tillman-weather/851269/.*

This page intentionally left blank.

Section 15 – Infectious Diseases

Hazard Description

An infectious disease is a clinically evident disease resulting from the presence of pathogenic microbial agents. According to FEMA, infectious diseases are a major threat around the world, killing millions globally each year. Transmission of an infectious disease may occur through one or more means including physical contact with infected individuals. These infecting agents may also be transmitted through liquids, food, bodily fluids, contaminated objects, airborne inhalation, or through vector-borne dissemination.

There are three classifications of disease impacts: endemic, epidemic, and pandemic. An endemic is always present at a low frequency, such as chicken pox in the United States. An epidemic is a sudden severe outbreak of disease, such as the bubonic plague during Medieval Times. A pandemic is an epidemic that becomes very widespread and affects a whole region, a continent, or the world, for example COVID 19, which is still currently impacting every corner of the world. In recent years, fears of pandemic have risen because the globalized economy and growing population fosters large scale international travel and trade. Growing populations increase vulnerability because more densely populated areas increase the risk of exposure to an infectious disease, allowing the disease to rapidly advance the spread of the infection.

There are many different types of infectious diseases. Due to the rise in certain diseases, Brazos County and its participating entities are working closely with the Brazos County Health District to closely monitor certain diseases that have affected the planning area.

The top ten infectious diseases by the number of deaths in 2021, according to the World Health Organization (WHO)[1] are COVID-19, chronic respiratory diseases, lower respiratory diseases, diarrheal diseases, Tuberculosis, Malaria, HIV/AIDS, Hepatitis, and Measles. (Table 15.1).

QUICK FACTS

Endemic

A disease outbreak is endemic when it is consistently present but limited to a particular region. This makes the disease spread and rates predictable. Malaria, for example, is considered endemic in certain countries and regions.

Epidemic

An unexpected increase in the number of disease cases in a specific geography

Yellow fever, smallpox, measles, and polio are prime examples of epidemics.

An epidemic disease doesn't necessarily have to be contagious.

West Nile fever and the rapid increase in obesity rates are also considered epidemics.

Epidemics can refer to a disease or other specific health-related behavior (e.g., smoking) with rates that are clearly above the expected occurrence in a community or regional area.

Pandemic

The World Health Organization (WHO) declares a pandemic when a disease's growth is exponential.

This means the growth rate skyrockets, and each day cases grow more than the day prior.

In being declared a pandemic, the virus has nothing to do with virology, population immunity, or disease severity.

It means a virus covers a wide area, affecting several countries and populations.

Source: Centers for Disease Control and Prevention (CDC)[12]

Rank	Infectious Diseases	Estimated Global Deaths in 2021
1	COVID-19	7.89 million
2	Chronic Respiratory Diseases	4.41million
3	Lower Respiratory Infections	2.18 million
4	Diarrheal Diseases	1.17 million
5	Tuberculosis	1.16 million
6	Malaria	748,000
7	HIV/AIDS	718,000
8	Meningitis	214,000
9	Hepatitis	71,800
10	Measles	56,000

Table 15.1 – Top Ten Infectious Diseases Source: WHO[1]

While all these diseases are monitored by Brazos County on a regular basis, the primary disease of concern at the time of this planning process was the Coronavirus disease (COVID-19) due to its rapid spread and impact on the global economy. COVID-19 is an infectious disease caused by a recently discovered coronavirus.

Explanation of Diseases

Coronavirus Disease 2019 (COVID 19)[11]

The new name of this disease is coronavirus disease 2019, abbreviated as COVID-19. In COVID-19, 'CO' stands for 'corona,' 'VI' for 'virus,' and 'D' for the disease, which is caused by the caused by SARS-CoV-2, according to the WHO[1]. Most people infected with the COVID-19 virus will experience mild to moderate respiratory illness and recover without requiring special treatment. Older people, and those with underlying medical problems like cardiovascular disease, diabetes, chronic respiratory disease, and cancer are more likely to develop serious illness.

The COVID-19[11] virus spreads primarily through droplets of saliva or discharge from the nose when an infected person coughs or sneezes, so it's important that you also practice respiratory etiquette (for example, by coughing into a flexed elbow). Many months into the COVID-19 pandemic, the coronavirus is still spreading uncontrolled through the country and throughout the world. Public health authorities including the U.S. Centers for Disease Control and Prevention (CDC)[12] and the World Health Organization (WHO)[1] recommend citizens to remain six feet apart, wash hands frequently, disinfect frequently touched surfaces, and wear masks. There is a growing school of evidence that COVID-19[11] cases are transmitted through aerosols (sometimes referred to as airborne).

Like communities around the globe, Brazos County and participating entities have been dramatically impacted by this virus with an average of 782 new confirmed cases and 7 related deaths per day at the peak of the virus surge. The economic impact of the virus has been highly impacted for the planning area. With no immediate relief on the horizon, economic recovery is likely to take years. The COVID-19 infection was declared a pandemic by the World Health

Organization on March 11, 2020. Currently there are three vaccinations that are FDA approved and that the CDC[12] recommends: Pfizer-BioNTech, Moderna, or Novavax, to protect against serious illness from COVID-19. It is recommended that everyone aged 5 years and older should get 1 dose of an updated COVID-19 vaccine to protect against serious illness from COVID-19. Children aged 6 months–4 years need multiple doses of COVID-19 vaccines to be up to date, including at least 1 dose of updated COVID-19 vaccine. People who are moderately or severely immunocompromised may get additional doses of updated COVID-19 vaccine[12].

The CDC contains the latest information and guidance on the COVID-19 pandemic and provides recommendations on protecting citizens and reducing the spread of the disease.

Since March 2020, there have been over 78,000 COVID-19 cases and 453 fatalities reported in Brazos County and its participating entities as of December 5, 2023[19]. Most individuals infected with COVID-19 did not require hospitalization. While the length of symptoms is still being studied, most patients experience symptoms for a few days to one week but can be infectious for up to ten days, even after symptoms have subsided.

Human Immunodeficiency Virus (HIV) and Acquired Immunodeficiency Syndrome (AIDS)[5]

Human immunodeficiency virus (HIV)[5] is spread through bodily fluids such as blood, semen, vaginal fluids, and breast milk. In the United States, HIV is most commonly transmitted from one person to another through unprotected anal or vaginal sex and through sharing needles or other drug paraphernalia. Transmission also can occur through transfusion of blood or its components from infected persons. In addition, a mother can pass HIV to her baby during pregnancy, during labor, or through breastfeeding. HIV infection is diagnosed by testing blood or saliva for antibodies to the virus or by directly testing for the presence of the virus. HIV damages the immune system leading to immunodeficiency; that is, the immune system is deficient in its ability to fight off infectious agents and cancer[5].

Acquired immunodeficiency syndrome (AIDS)[5] is the clinical stage of infection with HIV. The time from HIV infection to the development of AIDS is extremely variable ranging from less than one year to over 15 years. The term most often used for people who are HIV positive is "person living with HIV/AIDS."[5]

The Centers for Disease Control and Prevention[12] estimates that over one million persons, aged 13 years and older, are living with HIV infection. In the United States, gay, bisexual, and other men who have sex with men are considered most at risk of HIV infection[5].

In 2021, there were 100,700 people living with HIV in Texas. Currently, at the time of this information collection there are 256 people in Brazos County infected with HIV[15]. To date, there are no vaccinations or cures for HIV but there are treatments available. The CDC recommends that a person diagnosed with HIV/AIDS start the pills or shots that are FDA approved to help reduce the amount of HIV carried in their blood (viral load). Some of these medications have decreased a patient's viral load so much that the patients viral load has been deem undetectable

or untransmutable; meaning that patient can no longer transmit HIV through sex and reduces the risk of spread from sharing needles[5].

People cannot become infected through ordinary day-to-day contact such as kissing, hugging, shaking hands, or sharing personal objects, food, or water. Symptoms associated with HIV can vary depending on the stage but generally can include[5]:

- Fever
- Headache
- Rash
- Sore throat
- Swollen lymph nodes
- Diarrhea
- Cough

The risk of HIV infection can be reduced by using condoms during sex, getting tested for HIV and other sexually transmitted infections, using harm reduction services for people using intravenous drugs, and administering antiretroviral therapy (ART). There is no cure for HIV infection. Currently, an HIV positive individual must take daily ART[12].

Foodborne Illnesses[17]

Foodborne disease is a term used to describe illnesses resulting from the consumption of contaminated foods. These diseases may be caused by bacteria, viruses, or toxins produced by these organisms. Contamination may occur during food production and preparation via inadequate sanitization, improper food handling, or holding food items at inadequate temperatures[17]. The Centers for Disease Control and Prevention (CDC)[12] estimate that one in six Americans, approximately 48 million people, have a foodborne illness each year.

Additionally, foodborne diseases kill thousands in the United States each year and cause billions of dollars in healthcare-related and industry costs annually[17].

Foodborne disease rates in Brazos County and the participating entities are significantly higher than those reported for Texas. Foodborne diseases are commonly underreported, and only a small proportion of illnesses are confirmed by laboratory testing; as a result, the higher Brazos County and participating entities rates could reflect an increased disease burden, or a higher proportion of diseases identified and reported as compared to Texas overall. Nationally, the price tag in costs of treatment, lost work hours, and premature deaths is estimated at $4.1 billion a year, according to the USDA. To date, there are 996 cases reported[12].

The most common foodborne diseases reported in Brazos County and participating entities, and Texas were Salmonellosis, Campylobacteriosis, and Shigellosis. Other forms of foodborne diseases are Cyclosporiasis, E Coli, which are listed in Table 15.2.

Commonly associated with contaminated food, water, or contact with infected animals, salmonellosis has been associated with many food items and animal exposures over the past few

years. Nationally, salmonellosis is identified more frequently in children which is also the case in Brazos County and participating entities. Salmonella is a leading culprit, with an estimated 1.35 million infections a year[18].

Campylobacteriosis is associated with eating raw or undercooked poultry, raw milk dairy products, contaminated produce and drinking water. In the last 5 years (2018-2022) there have been 282 cases reported in Brazos County and the participating entities[19].

Shigellosis is an illness caused by Shigella bacteria. It is transmitted by hand-to-mouth contact with stool (feces) from a sick person or animal, eating contaminated foods, or drinking contaminated water. Children and people who work in day care facilities are prone to contracting this disease. Other ways of contracting the disease may be through sexual practices or caring for someone who has Shigellosis; or traveling to other countries where the food/water supply is contaminated and unsafe. In the last 5 years (2018-2022) there have been 52 cases reported in Brazos County and the participating entities. These numbers are currently down due to the increase in hand washing and sanitizing due to COVID 19 recommendations[19].

Vector borne Diseases

Malaria[6]

Malaria is a serious and sometimes fatal disease caused by a parasite that commonly infects a certain type of mosquito which feeds on humans. People who get malaria are typically very sick with high fevers, shaking chills, and flu-like illness. Four kinds of malaria parasites infect humans: Plasmodium falciparum, P. vivax, P. ovale, and P. malariae. In addition, P. knowlesi, a type of malaria that naturally infects macaques in Southeast Asia, also infects humans, causing malaria that is transmitted from animal to human ("zoonotic" malaria). P. falciparum is the type of malaria that is most likely to result in severe infections and if not promptly treated, may lead to death. Although malaria can be a deadly disease, illness and death from malaria can usually be prevented[6].

About 2,000 cases of malaria are diagnosed in the United States each year. Most cases in the United States are in travelers and immigrants returning from parts of the world where malaria transmission occurs, including sub-Saharan Africa and South Asia[6]. Currently, as of August 2023, there has been one (1) case of Malaria reported in Texas. Currently, there are no reported cases of Malaria in the planning area.

Early symptoms include:

- Fever
- Headache
- Chills

However, some types of malaria can cause severe illness and death. Symptoms of severe malaria include:

- Extreme tiredness and fatigue
- Impaired consciousness

- Multiple convulsions
- Difficulty breathing
- Dark or bloody urine
- Jaundice
- Abnormal breathing

Infants, children under five, pregnant women, travelers, and people with HIV or AIDS are at higher risk of infection. Malaria infections can be prevented by using mosquito nets, repellants, using window screens and wearing protective clothing. There are also two WHO-recommended vaccines available for those in endemic countries. Multiple medicines can be used to treat Malaria. Treatment is dependent on several factors such as the type of malaria, drug resistance, weight, and age, and whether the individual is pregnant or not[6].

West Nile Virus[20]

West Nile virus infection[20] is the most common vector borne disease in the United States. In nature, the West Nile virus is spread between mosquitos and birds. Infected mosquitos will infect birds while getting a blood meal. Mosquitos can become infected by feeding on infected birds[20].

West Nile virus is primarily transmitted to humans by the bite of an infected mosquito. Transmission also may occur through blood transfusions, organ transplants, and from mother to baby during pregnancy, delivery, or breastfeeding. Most people with a West Nile virus infection experience a fever with headache, body aches, and joint pains. Severe symptoms in some people include encephalitis or meningitis[20].

In 2023, The state of Texas reported 84 cases of the West Nile Virus. Which displays the most cases reported in the United States for 2023[12]. While there were no cases reported in the planning area, there were mosquitoes trapped within the planning area carrying the West Nile Virus[20].

The Health District urged Brazos County and participating entities residents to take four precautions to minimize exposure to mosquitoes carrying WNV[19].

- DEET: Whenever outside, use insect repellents with the active ingredient DEET or other EPA-registered repellents and always follow label instructions[19].

- Dress: Wear long, loose, and light-colored clothing outside[19].

- Drain: Drain or treat all standing water in and around your home or workplace where mosquitoes could lay eggs[19].

- All Day Long: Day, Dusk and Dawn – Limit your time outdoors, mosquitoes are active any time, day, or night[19].

Influenza A (H1N1)[13]

In March 2009, a novel strain of Influenza A (H1N1 or "Swine Flu")[13] virus was detected in Mexico and the United States. The virus has since spread worldwide. The Center for Disease Control and Prevention (CDC) estimates that from April 12, 2009, to April 10, 2020, there were over 60.8 million cases, 274,304 hospitalizations, and 12,469 deaths in the United States due to the H1N1 virus[12].

The most commonly reported symptoms include cough, fever, sore throat, and gastrointestinal symptoms, such as vomiting and diarrhea. Most individuals infected with H1N1 did not require hospitalization and had symptoms that lasted four days. The CDC[12] reports that confirmed flu activity continues to decrease for the 2019-2020 season. Currently there are no reported cases of H1N1 in Texas or the planning area. However, DSHS reports that H1N1 is still a very contagious form of the flu but is currently considered under control[15].

H5N1 Avian Flu (Bird Flu)[21]

H5N1 is a highly pathogenic avian (bird) flu virus[21] that has caused serious outbreaks in domestic poultry in parts of Asia and the Middle East. Highly pathogenic refers to the virus's ability to produce disease. Although H5N1 does not usually infect humans, 861 cases of human infection with avian influenza were reported globally from January 2003 to August 2020[21].

Most human cases of "highly pathogenic" H5N1 virus infection have occurred in people who had recent contact with sick or dead poultry that were infected with H5N1 viruses[21]. About 60% of people infected with the virus died from their illness. Unlike other types of flu, H5N1 usually does not spread between people. The first case of H5N1[21] in Texas was confirmed on April 2, 2022. Currently, there are no reported cases in the planning area[21].

It is rare for humans to be infected with this virus. You cannot get infected with these viruses from properly handled and cooked poultry or eggs[22]. However, flu viruses are constantly changing, and animal flu viruses can change such that they may gain the ability to infect people easily and spread among people, causing a pandemic. Federal and State partners work jointly on additional surveillance and testing in affected areas, following existing avian influenza response plans[22].

Ebola Virus Disease (EVD)[23]

Ebola is a viral hemorrhagic fever disease. Symptoms of Ebola may include fever, severe headache, muscle pain, vomiting, diarrhea, stomach pain, or unexplained bleeding or bruising. Symptoms may appear anywhere from 2 to 21 days after exposure to the virus, although 8 to 10 days is the most common for symptoms to occur[23].

The 2014 - 2016 Ebola outbreak was centered in three countries in West Africa[23]. Ebola does not pose a significant risk to the United States public, however, during this outbreak there were eleven (11) people treated within the US. In 2014, one (1) patient was diagnosed with Ebola in Texas. Currently, there are no known cases of Ebola in the planning area[15].

Respiratory Infections[2]

Respiratory illnesses are common in the fall and winter, with seasonal cases of influenza, strep throat and respiratory syncytial virus, or RSV, and COVID 19. Respiratory tract infections (RTIs)[2] are infections of parts of the body involved in breathing, such as the sinuses, throat, airways, or lungs. Symptoms of an RTI include:

- a cough – you may bring up mucus (phlegm).
- Sneezing.
- a stuffy or runny nose.
- a sore throat.
- Headaches.
- muscle aches.
- breathlessness, tight chest, or wheezing.
- a high temperature.
- feeling generally unwell[2].

**Upper Infections include the Common Cold, Sinusitis, Tonsillitis, and Laryngitis[2].

Upper respiratory tract infections can be defined as self-limited irritation and swelling of the upper airways with associated cough and no signs of pneumonia, in a patient with no other condition that would account for their symptoms, or with no history of chronic obstructive pulmonary disease, emphysema, or chronic bronchitis. Upper respiratory tract infections involve the nose, sinuses, pharynx, larynx, and large airways[2].

**Lower Infections include Bronchitis, Bronchiolitis, Chest Infections, and Pneumonia (lung infections)[2].

Lower respiratory infections are caused by a variety of microbes, including bacteria, viruses, and fungi. Often, a lower respiratory infection can be accompanied by a cold or flu. Lower respiratory infections can occur to anyone, but those most at risk include:

- Smokers.
- Young children.
- Adults over age 65.
- People with respiratory diseases.
- People with weakened immune systems, including those with HIV.
- People who have just had major surgery[2].

Given the highly transmittable behaviors of respiratory illnesses, there has been, to date, a 4.4% rising trend of reported respiratory illnesses and is expected to continue to rise[2]. Currently, Texas and the planning area are at an activity level of “HIGH” (See Figure 15.1)

It is also worth noting that animals may also have respiratory illnesses that may be viral or bacterial. The most common signs are:

- Rapid breathing or continuous panting.
- Long drawn-out breathing.
- Being unable to settle and distress.
- Standing with elbows pointed outwards and the neck extended.
- Exaggerated or abnormal movement of the chest/abdomen while breathing.
- Blue gums.
- Collapse.
- Open mouth breathing (in cats)[2].

and diagnosis is usually based on history, radiographs, and other laboratory tests as indicated. Any animals having signs of a respiratory illness should be seen by a veterinarian[2].

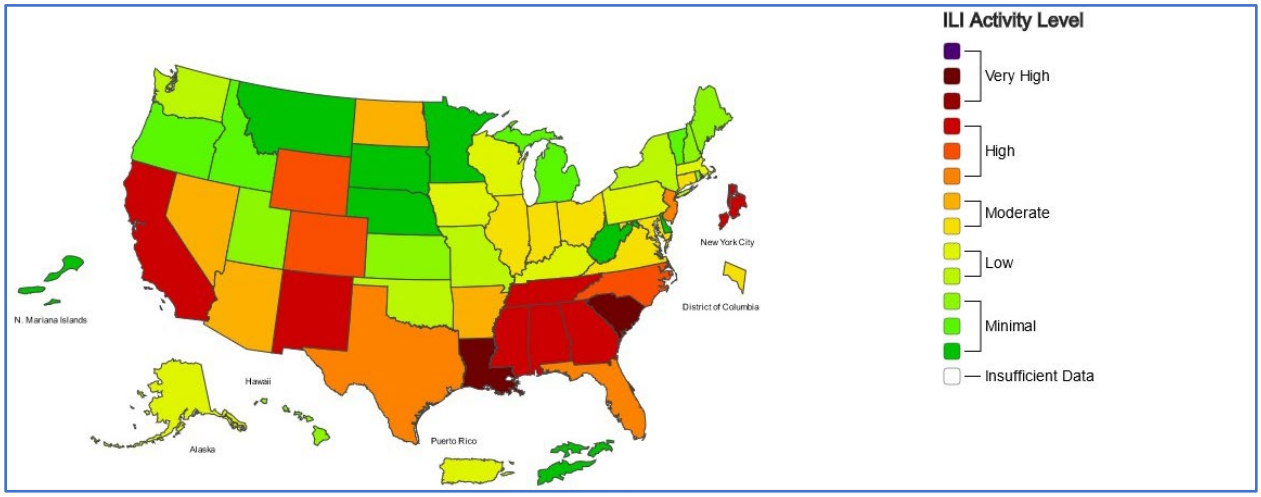


Figure 15.1 – Outpatient Respiratory Illness Activity Map (Reported) Source: CDC[12]

Tuberculosis (TB)[4]

Tuberculosis (TB)[4] is an infectious disease that most often affects the lungs and is caused by a type of bacteria. It spreads through the air when infected people cough, sneeze, or spit. Tuberculosis is preventable and curable. About a quarter of the global population is estimated to have been infected with TB bacteria[4].

- A total of 1.3 million people died from TB in 2022 (including 167 000 people with HIV)[4].

- Worldwide, TB is the second leading infectious killer after COVID-19 (above HIV and AIDS)[4].

- In 2022, an estimated 10.6 million people fell ill with tuberculosis (TB) worldwide, including 5.8 million men, 3.5 million women and 1.3 million children. TB is present in all countries and age groups. TB is curable and preventable[4].

- Multidrug-resistant TB (MDR-TB) remains a public health crisis and a health security threat[4].

- Only about 2 in 5 people with drug resistant TB accessed treatment in 2022[4].

- Global efforts to combat TB have saved an estimated 75 million lives since the year 2000[4].

- United States - $13 billion is needed annually for TB prevention, diagnosis, treatment, and care to achieve the global target agreed at the 2018 United Nations high level-meeting on TB[4].

Common symptoms of TB:

- prolonged cough (sometimes with blood)
- chest pain
- weakness
- fatigue
- weight loss
- fever
- night sweats

The symptoms people get depend on where in the body TB becomes active. While TB usually affects the lungs, it also affects the kidneys, brain, spine, and skin[4].

People with latent TB infection don't feel sick and aren't contagious. Only a small proportion of people who get infected with TB will get TB disease and symptoms. Babies and children are at higher risk[4].

Certain conditions can increase a person's risk for tuberculosis disease:

- diabetes (high blood sugar)
- weakened immune system (for example, HIV or AIDS)
- being malnourished
- tobacco use

Unlike TB infection, when a person gets TB disease, they will have symptoms. These may be mild for many months, so it is easy to spread TB to others without knowing it[4].

In 2022, 7,415 Texans were exposed to TB. Of those exposed, 1,097 people were diagnosed with TB in 2022. Texas ranks #2 among U.S. states with the most TB[15]. The number of cases reported in 2022 represents an increase of 9.9 percent from 2021 when 998 cases were reported[15]. The Texas TB rate in 2021 (most recent data available) was 3.38 cases per 100,000 persons[15]. Texas has a higher TB case rate than the national rate. In 2022, fifty (50) Texans died of TB[15].

Currently, the Brazos County Health District has a Tuberculosis Elimination Clinic that offers testing, treatment, and prevention. Brazos County Health District has identified 1,000,000 cases in the planning area[19].

Diarrheal Diseases[3]

Diarrheal disease[3] is the second leading cause of death in children under five years old and was responsible for the deaths of 370,000 children in 2019. The most severe threat posed by diarrhea is dehydration. During an episode of diarrhea, water and electrolytes including sodium, chloride, potassium, and bicarbonate are lost through liquid stools, vomit, sweat, urine and breathing. A person with diarrhea becomes dehydrated when these losses are not replaced. In addition, diarrhea is a major cause of malnutrition, making the person more susceptible to future bouts of diarrhea and to other diseases[3].

There are three clinical types of diarrheas, each with its specific treatments:

- Acute watery diarrhea, which may last several hours or days, and includes cholera.
- Acute bloody diarrhea, also called dysentery.
- Persistent diarrhea, lasting 14 days or longer[3].

**Causes – *Acute Diarrhea*[3]

Most cases of acute, watery diarrhea are caused by viruses (viral gastroenteritis). The most common ones in children are rotavirus and in adults are norovirus (this is sometimes called "cruise ship diarrhea" due to well publicized epidemics). Bacteria are a common cause of traveler's diarrhea[3].

**Causes – *Chronic Diarrhea*[3]

Chronic diarrhea is classified as fatty or malabsorption, inflammatory or most commonly watery. Chronic bloody diarrhea may be due to inflammatory bowel disease (IBD), which is ulcerative colitis or Crohn's disease. Other less common causes include ischemia of the gut, infections, radiation therapy and colon cancer or polyps. Infections leading to chronic diarrhea are uncommon, apart from parasites[3].

The most common small bowel disease in the U.S. is celiac disease, also called celiac sprue. Crohn's disease can also involve the small bowel. Whipple's disease, tropical sprue, and eosinophilic gastroenteritis are some of the rare conditions that can lead to malabsorption diarrhea[3].

There are many causes of watery diarrhea, including carbohydrate malabsorption such as lactose, sorbitol, and fructose intolerance. Symptoms of abdominal bloating and excessive gas after consuming dairy products suggest lactose intolerance[24]. This condition is more common in African Americans and Asian-Americans[24]. Certain soft drinks, juices, dried fruits, and gums contain sorbitol and fructose, which can lead to watery diarrhea in people with sorbitol and fructose intolerance[24]. Diarrhea is a frequent side effect of antibiotics[24]. Certain other medications such as NSAIDs, antacids, antihypertensives, antibiotics and antiarrhythmics can have side effects leading to diarrhea[24].

Parasitic intestinal infections such as giardiasis can cause chronic diarrhea. Diabetes mellitus may be associated with diarrhea due to nerve damage and bacterial overgrowth; this occurs mainly in patients with long-standing, poorly controlled diabetes[2422].

Irritable bowel syndrome (IBS) is a condition often associated with diarrhea, constipation or more frequently alternating diarrhea and constipation. Other common symptoms are bloating, abdominal pain relieved with defecation and a sense of incomplete evacuation[24].

Recent dietary changes can also lead to acute diarrhea. These include intake of coffee, tea, colas, dietetic foods, gums, or mints that contain poorly absorbable sugars. Acute bloody diarrhea suggests a bacterial cause like Campylobacter, Salmonella or Shigella or Shiga-toxin E. coli. Traveler's diarrhea is common in those who travel to developing countries and results from exposure to bacterial pathogens most commonly enterotoxigenic E. coli. The best method of prevention is to avoid eating and drinking contaminated or raw foods and beverages[24].

Because diarrheal infections/diseases often go unreported or undiagnosed, currently, there is no consolidated number of people in Texas or the planning area to report. But the Brazos County Health District reports there are cases within the area[19].

Measles[7]

Measles[7] infects the respiratory tract and then spreads throughout the body. Symptoms include a high fever, cough, runny nose, and a rash all over the body. Being vaccinated is the best way to prevent getting sick with measles or spreading it to other people. Also called rubeola, measles spreads easily and can be serious and even fatal for small children. While death rates have been falling worldwide as more children receive the measles vaccine, the disease still kills more than 200,000 people a year, mostly children[7]. As a result of high vaccination rates in general, measles hasn't been widespread in the United States in about two decades[7].

Measles signs and symptoms appear around 10 to 14 days after exposure to the virus. Signs and symptoms of measles typically include:

- Fever.
- Dry cough.
- Runny nose.
- Sore throat.
- Inflamed eyes (conjunctivitis).
- Tiny white spots with bluish-white centers on a red background found inside the mouth on the inner lining of the cheek — also called Koplik's spots.
- A skin rash made up of large, flat blotches that often flow into one another[7].

Measles is a highly contagious virus that lives in the nose and throat mucus of an infected person. It can spread to others through coughing and sneezing. If other people breathe the contaminated air or touch the infected surface, then touch their eyes, noses, or mouths, they can become infected. Animals do not get or spread measles[7].

Measles can be prevented with MMR vaccine[7]. The vaccine protects against three diseases: measles, mumps, and rubella. CDC[12] recommends children get two doses of MMR vaccine, starting with the first dose at 12 through 15 months of age, and the second dose at 4 through 6 years of age. Teens and adults should also be up to date on their MMR vaccination. The MMR vaccine is very safe and effective. Two doses of MMR vaccine are about 97% effective at preventing measles; one dose is about 93% effective. Children may also get MMRV vaccine, which protects against measles, mumps, rubella, and varicella (chickenpox)[12].

Prior to vaccine introduction, annual measles incidence peaked at 85,862 in 1958 in Texas. Since the introduction of vaccine, cases have decreased by 99.9 percent in Texas[15]. In 2019, Texas experienced an increase of measles to 23 cases, the highest case count since 2013 (27 cases)15. There are no reported cases of measles in the planning area[19].

Whooping Cough (Pertussis)[8]

Whooping cough (pertussis)[8] is a highly contagious respiratory tract infection. Whooping Cough is not RSV[8]. In many people, it's marked by a severe hacking cough followed by a high-pitched intake of breath that sounds like "whoop." The first symptoms of pertussis may be those of a common cold, including nasal congestion, runny nose, sneezing, red and watery eyes, mild fever, and a dry cough. After about one week to 2 weeks, the dry cough becomes a wet cough that brings up thick, stringy mucus. Many babies with whooping cough don’t cough at all. Instead, it may cause them to turn blue or struggle to breathe. It may seem like a common cold for the entire illness, not just the beginning[8].

Whooping cough, also known as pertussis, is a very contagious respiratory illness caused by a type of bacteria called Bordetella pertussis[8]. The disease is only found in humans.
Whooping cough bacteria attach to the cilia (tiny, hair-like extensions) that line part of the upper respiratory system. The bacteria release toxins (poisons), which damage the cilia and cause airways to swell[8].

The bacteria that cause whooping cough spread easily from person to person through the air. When a person who has whooping cough sneezes or coughs, they can release small particles with bacteria in them. Other people then breathe in the bacteria. It also spreads when people spend a lot of time together or share breathing space, like when you hold a newborn on your chest[8].

Pertussis is known to occur in three to five-year cycles[8]. The last peak year in Texas was 2013 with 3,985 cases, the highest annual case count since 1959. There were 1,765 cases in 2017, and cases have remained relatively stable in 2018 and 2019, with 1,168 and 1,320 reported cases in 2020, respectively[15]. Currently, there are no reported cases of Whooping Cough in the planning area[19].

First symptoms appear 7-10 days after exposure and include:

- Mild fever
- Runny nose
- Cough

Pneumonia is a relatively common complication and seizures and brain disease occur rarely. Most people may be contagious up to 3 weeks after the cough begins. The disease is most dangerous in infants and is a significant cause of death and disease in this age group. Antibiotics are used to treat infections, but the best way to prevent pertussis is through immunization[8].

Hepatitis[16]

Hepatitis[16] is an inflammation of the liver that is caused by a variety of infectious viruses and noninfectious agents leading to a range of health problems, some of which can be fatal. There are five main strains of the hepatitis virus, referred to as types A, B, C, D and E[16]. While they all cause liver disease, they differ in important ways including modes of transmission, severity of the illness, geographical distribution, and prevention methods. In particular, types B and C lead to chronic disease in hundreds of millions of people and together are the most common cause of liver cirrhosis, liver cancer and viral hepatitis-related deaths. An estimated 354 million people worldwide live with hepatitis B or C, and for most, testing and treatment remain beyond reach[16].

**There are five viruses that cause the different forms of viral hepatitis: hepatitis A, B, C, D and E[16].

Hepatitis A is mostly a food-borne illness and can be spread through contaminated water and unwashed food. It is the easiest to transmit, especially in children, but is also the least likely to damage the liver and is usually mild. About 85% of people with hepatitis A recover within three months, and almost all recover within six months. The disease does not become chronic, and there are no long-term health implications[16].

Hepatitis B can be transmitted through exposure to contaminated blood, needles, syringes, or bodily fluids and from mother to baby. It is a chronic disorder and in some cases may lead to long-term liver damage, liver cancer and cirrhosis of the liver after many years of carrying the virus[16].

There are two types of hepatitis B infections:

- Acute infection. When a person is first infected with hepatitis B, it is called an acute infection. Symptoms range from no symptoms to liver failure. Usually, adults recover from this and have no further problems[16].

- Chronic infection. If the virus remains in the blood for more than six months, then it is considered a chronic infection. While most adults do not develop chronic hepatitis B, infants and young children are less able to rid their bodies of the virus and may develop chronic hepatitis B as a result[16].

Acute hepatitis B usually resolves on its own without intervention. Treatment for chronic hepatitis B includes medications to suppress the virus and reduce the risk of long-term medical complications[16].

Hepatitis C is only transmitted through infected blood or from mother to newborn during childbirth. It too can lead to liver cancer and cirrhosis in the long term[16].

Hepatitis C may develop without any signs or symptoms, or symptoms may be nonspecific and short-lived. There are three phases of hepatitis C, and symptoms may differ depending on the stage. Early in the disease or the first stage, called the prodromal phase, the second stage is the preicteric phase, the third stage is the icteric phase[16].

Often, patients with hepatitis C do not experience any symptoms. Many are diagnosed after routine blood works shows abnormal liver enzymes. Sometimes, patients are tested because of their risk factors, such as exposure to needles or a history of blood transfusions. Thanks to advances in medication options, many patients with hepatitis C can be cured. Your hepatologist or infectious disease expert will determine treatment based on your virus type[16].

Hepatitis D is only found in people who are also infected with hepatitis B. The hepatitis D virus (HDV) is an RNA virus discovered in 1977 that is structurally unrelated to the hepatitis A, B or C virus. HDV causes a unique infection that requires the assistance of viral particles from hepatitis B virus (HBV) to replicate and infect other hepatocytes. Its clinical course is varied and ranges from acute self-limited infection to acute fulminant liver failure. Chronic liver infection can lead to end-stage liver disease and associated complications. HDV infection occurs more commonly among adults than children[16]. Treatment consists primarily of support. Liver transplantation is indicated in patients with fulminant liver failure[16]. Fulminant is the severe of sudden onset of a disease or a symptom[16].

Hepatitis E, also called enteric hepatitis (enteric means related to the intestines), is similar to hepatitis A, and more prevalent in Asia and Africa. It is also transmitted through the fecal-oral route. It is generally not fatal, though it is more serious in women during pregnancy and can cause fetal complications. Most patients with hepatitis E recover completely[16]. Hepatitis A and E usually resolve after a period of four to eight weeks of illness. They do not cause chronic hepatitis, and usually no special treatment is necessary[16].

In 2018, 88 cases of hepatitis A were reported in Texas, the lowest total count so far. In 2019 that number rose to 160 cases and in 2020 rose to 223 cases, largely due to an outbreak[15].

Over the past 10 years, the reported incidence of acute hepatitis B has continued to decline, from 394 cases in 2010 to 50 cases in 2020. Adults ages 18 and older have consistently made up many acute hepatitis B cases in Texas[15].

There are currently 387,395 Texans (1.79%) that are infected with the hepatitis C virus. County prevalence varied from 1.25% to 2.63%, with higher rates concentrated along the US–Mexico border. However, most cases of infection were located near major Texas cities[15].

Tetanus[9]

Tetanus[9] is a disease of the nervous system caused by toxins released by the Clostridium tetani bacteria. The tetanus bacterium enters the body through a break in the skin. Tetanus may follow

elective surgery, burns, deep puncture wounds, crush wounds, otitis media (ear infections), dental infection, animal bites, abortion, and pregnancy. Tetanus is not transmitted from person to person[9].

Tetanus[9] mainly affects the neck and abdomen. Tetanus is also known as "lockjaw" because it often causes a person's neck and jaw muscles to lock, making it hard to open the mouth or swallow. It also can cause breathing problems, severe muscle spasms, and seizure-like movements. Complete recovery can take months. If left untreated, tetanus can be fatal. Tetanus is not transmitted from one person to another. A person with tetanus is not infectious to others[9].

Tetanus[9] is rare in Texas, with only a total of (11) cases from 2015 through 2019. However, people who have never been vaccinated, or who have not had a booster in recent years, are at highest risk for tetanus. The Brazos County Health Department has clinics for onsite testing and currently track the infections or outbreaks within the planning area[19].

Symptoms can include:

- Jaw cramping or inability to open the mouth.
- Muscle spasms often in the back, abdomen, or extremities.
- Sudden painful muscle spasms often triggered by sudden noises.
- Trouble swallowing.
- Seizures.
- Headaches.
- Fever and sweating.
- Changes in blood pressure or fast heart rate

Tetanus[9] requires treatment in a medical facility, often in a referral hospital. However, people who recover from tetanus do not have natural immunity and can be infected again and therefore need to be immunized. Tetanus can be prevented through immunization with tetanus-toxoid-containing vaccines[9].

Rabies[10]

Rabies[10] is a preventable viral disease most often transmitted through the bite of a rabid animal. The rabies virus infects the central nervous system of mammals, ultimately causing disease in the brain and death. Many rabies cases reported to the Centers for Disease Control and Prevention (CDC) each year occur in wild animals like bats, raccoons, skunks, and foxes, although any mammal can get rabies[10].

Rabies is a viral zoonotic disease that causes progressive and fatal inflammation of the brain and spinal cord. Clinically, it has two forms:

- Furious rabies – characterized by hyperactivity and hallucinations[10].
- Paralytic rabies – characterized by paralysis and coma[10].

Although in most cases fatal, once clinical signs appear, rabies is entirely avoidable; vaccines, medicines and technologies have long been available to prevent death from rabies. Nevertheless,

rabies still kills tens of thousands of people each year. Of these cases, approximately 99% are acquired from the bite of an infected dog[10].

Rabies is one of the neglected tropical diseases (NTD) that predominantly affects already marginalized, poor and vulnerable populations. Although effective human vaccines and immunoglobulins exist for rabies, these are often not readily available or accessible to those in need. Managing a rabies exposure, where the average cost of rabies post-exposure prophylaxis (PEP) is currently estimated at an average of $108.00, can be a catastrophic financial burden[10].

After a rabies exposure, the rabies virus must travel to the brain before it can cause symptoms. The time between exposure and appearance of symptoms is the incubation period. It may last for weeks to months. The incubation period may vary based on the location of the exposure site (how far away it is from the brain), the type of rabies virus, and any existing immunity[10].

The first symptoms of rabies may be like the flu, including weakness or discomfort, fever, or headache. There also may be discomfort, prickling, or an itching sensation at the site of the bite. These symptoms may last for days[10].

Symptoms then progress to cerebral dysfunction, anxiety, confusion, and agitation. As the disease progresses, the person may experience delirium, abnormal behavior, hallucinations, hydrophobia (fear of water), and insomnia. The acute period of disease typically ends after 2 to 10 days. Once clinical signs of rabies appear, the disease is nearly always fatal, and treatment is typically supportive. Less than 20 cases of human survival from clinical rabies have been documented. Only a few survivors had no history of pre- or postexposure prophylaxis[10].

The signs, symptoms, and outcome of rabies in animals can vary. Symptoms in animals are often like those in humans. These include early nonspecific symptoms, acute neurologic symptoms, and ultimately death[10].

While rabies can be present in any animal, the following have been confirmed in Texas[15]. (See Figure 15.2)

- Bat
- Bovine (Cow)
- Cat
- Dog
- Equine (Horse)
- Fox
- Goat
- Racoon
- Skunk

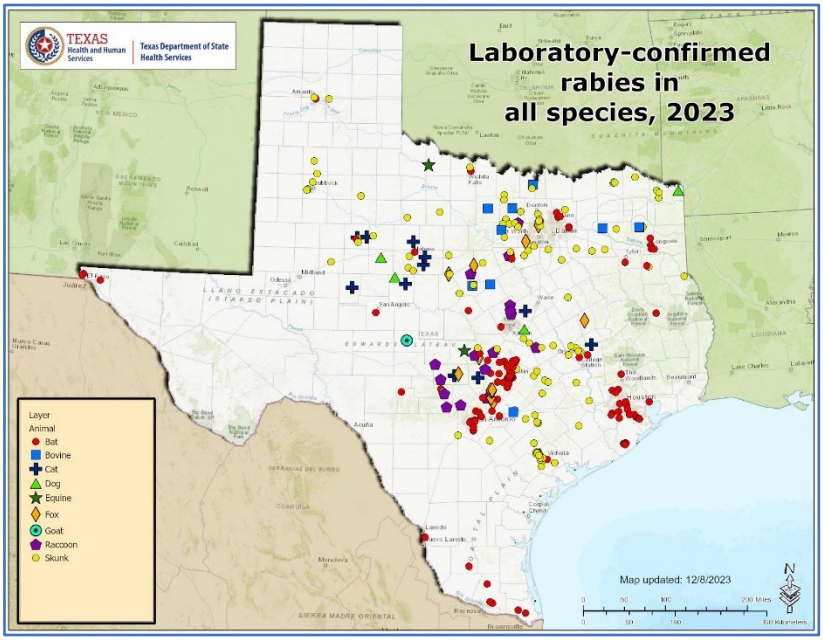


Figure: 15.2 – Laboratory Rabies (all species) Texas Source: DSHS[15]

Know When to Wash Your Hands[12]

You can help yourself and your loved ones stay healthy by washing your hands often, especially during these key times when you are likely to get and spread germs:

- Before, during, and after preparing food.
- Before and after eating food.
- Before and after caring for someone at home who is sick with vomiting or diarrhea.
- Before and after treating a cut or wound.
- After using the toilet.
- After changing diapers or cleaning up a child who has used the toilet.
- After blowing your nose, coughing, or sneezing.
- After touching an animal, animal feed, or animal waste.
- After handling pet food or pet treats.
- After touching garbage.

If soap and water are not readily available, use hand sanitizer with at least 60% alcohol to clean your hands.

Improving Ventilation and Spending Time Outdoors[12]

- Bringing in as much outdoor air as possible—for example, opening windows.
- Increasing air filtration in your heating, ventilation, and air conditioning (HVAC) system, such as by changing filters frequently and using filters that are properly fitted and provide higher filtration.

- Using portable high-efficiency particulate air (HEPA) cleaners.
- Turning on exhaust fans and using other fans to improve air flow.
- Turning your thermostat to the "ON" position instead of "AUTO" to ensure your HVAC system provides continuous airflow and filtration.

Moving Indoor Activities Outdoors[12]

You are less likely to be infected with COVID-19 or other respiratory illnesses during outdoor activities because virus particles do not build up in the air outdoors as much as they do indoors. If you see a spike or rise in hospital admissions in your area, consider increasing the number of group activities you move outside.

Increasing Space and Distance[12]

Small particles that people breathe out can contain virus particles. The closer you are to a greater number of people, the more likely you are to be exposed to the virus that causes COVID-19 or other respiratory illnesses. To avoid this possible exposure, you may want to avoid crowded areas, or keep distance between yourself and others. These actions also protect people who are at high risk for getting very sick from COVID-19 or other respiratory illnesses, in settings where there are multiple risks for exposure.

Wearing Masks or Respirators[12]

Masks are made to contain droplets and particles that you breathe, cough, or sneeze out. A variety of masks are available. Some masks provide a higher level of protection than others. Respirators (for example, N95) are made to protect you by fitting closely on the face to filter out particles, including the virus that causes COVID-19 and many other respiratory illnesses. They can also block droplets and particles you breathe, cough, or sneeze out so you do not spread them to others. Respirators (for example, N95) provide higher protection than masks.

When wearing a mask or respirator (for example, N95), it is most important to choose one that you can wear correctly, that fits closely to your face over your mouth and nose, that provides good protection, and that is comfortable for you.

Get Tested[12]

Get tested if you have any symptoms. A test tells you if you are infected with a virus/disease. Also let your doctor know if you have been traveling out of state or country. If you think you have been exposed to a virus/disease and do not have symptoms, you should get tested after your expected exposure.

Following Recommendations for What to Do If You Have Been Exposed[12]

If you were exposed to someone with a virus/disease, you may have been infected. Follow CDC's recommendations for what to do if you were exposed. This includes wearing a high-

quality mask when indoors around others (including inside your home) for 10 days, testing, and monitoring yourself for symptoms.

Staying Home When You Have Suspected or Confirmed COVID-19 or a respiratory illness[12]

If you have any illness, you can spread it to others, even if you do not have symptoms. If you have symptoms, get tested and stay home until you have your results. If you have tested positive (even without symptoms), follow CDC's or your physician's recommendations. These recommendations include staying home and away from others for at least 5 days (possibly more, depending on how the virus/disease affects you) and wearing a high-quality mask when indoors around others for a period.

Hazardous Areas

Pandemics are random and only a few happen every century. The impacts from an infectious disease event can affect all areas of the world; therefore, all areas are vulnerable, as evidenced by the current COVID-19 pandemic. Globalization has made it increasingly difficult to contain localized outbreaks as infected or exposed people travel across the world in a matter of hours. Third world countries have fewer resources to fight disease and may be more vulnerable than more industrialized nations. In the United States, the public health system works at the federal, state, and local levels to monitor diseases, plan, and prepare for outbreaks, and prevent epidemics where possible.

There is no distinct geographic boundary to infectious disease; therefore, it can occur throughout the Brazos County planning area.

Extent

The severity of a pandemic virus can be evaluated from the perspective of the individual who has been infected; or from the population level, how many complications and deaths might be expected as a whole. The most common measure of severity for a pandemic virus event is the case-fatality rate (CFR) as depicted in Figure 15.3. The severity of the pandemic is measured in Category 1 through 5 based on the number of fatalities.

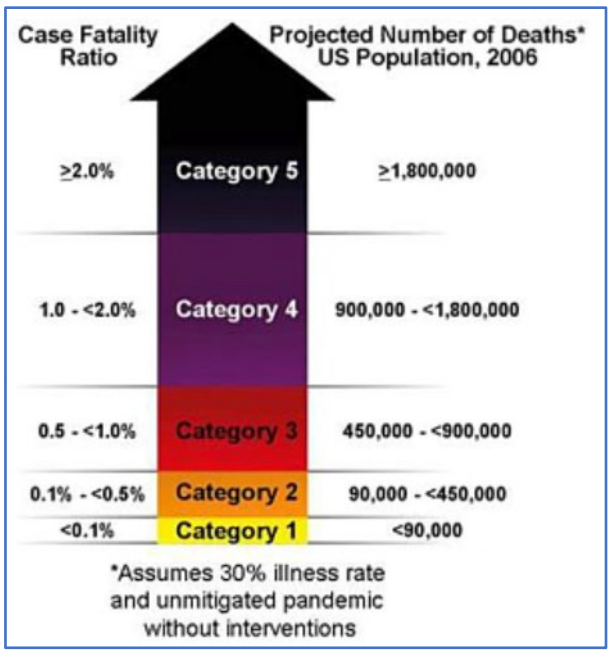


Figure: 15.3 – Case Fatality Rate for Severity
Source: CDC[12]

The magnitude of a pandemic event is identified in terms of warning levels based on population. Figure 15.4 illustrates the various warning levels for pandemic based on the transmission level. NOTE: The COVID-19 pandemic warning level reached Phase 6.

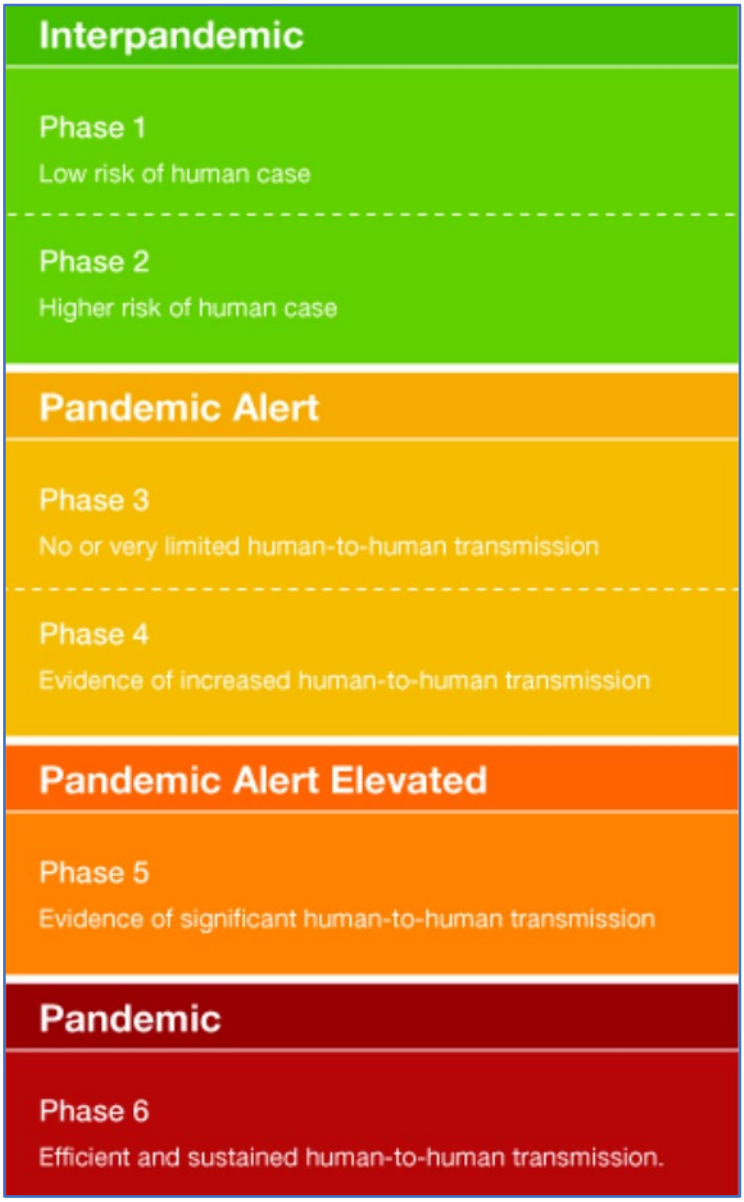


Figure: 15.4 Warning Levels for Pandemic(s)
Source:WHO[1]

Previous Occurrences

The Brazos County Health District has compiled a report on infectious disease from 2015-2023. The number of cases and rates are included in Table:15.2. On average, (175) cases of infectious disease whose transmission could be enhanced during disasters are reported annually[19].

Infectious Disease	2015	2016	2017	2018	2019	2020	2021	2022
Campylobacteriosis	32	44	71	42	99	34	59	48
Chickenpox (varicella)	3	9	7	0	1	0	2	0
Cryptosporidiosis	5	9	15	12	19	5	10	7
Cyclosporiasis	0	1	1	4	3	9	7	5
E. coli (Shiga Toxin-producing)	9	9	15	11	21	7	5	13
Legionellosis	1	1	2	3	0	0	2	1
Malaria	0	0	0	1	3	0	0	2
Mumps	0	1	8	3	1	0	0	0
Pertussis	3	1	1	5	4	0	0	0
Salmonellosis	55	53	66	55	62	22	46	38
Shigellosis	162	18	11	20	17	9	3	3
Strep pneumoniae	4	8	8	9	15	2	3	7
Vibrio infection parahaemolyticus	0	2	1	0	2	1	0	0

Table: 15.2 – Cases and Rate Per Disease Source: BCHD[19]

Pathogenic event hazards are common. In 2014, a popular local restaurant was found to be the source of a Salmonella cluster. Over 30 cases were confirmed for a rare Ohio strain of Salmonella and four food samples collected at the restaurant also tested positive.
In 2022, a global outbreak of mpox was detected. Symptoms of the virus include fever, chills, swollen lymph nodes, back/joint/muscle pain, and a rash that eventually scabs over and falls off.

There were seven known cases of mpox in Brazos County and its planning area. Mpox is an infectious virus called monkeypox[25]. Experts now prefer to call it mpox to avoid associations with monkeys or the idea that it does not affect people. It was first discovered in 1958 among monkeys used for research in a Danish laboratory[25]. Mpox illnesses, including severe infections, continue to occur across the United States[25]. CDC recommends people with the sexual risk factors for mpox get vaccinated now if they have not already received two doses of JYNNEOS vaccine. Those at risk include (but are not limited to) men who have sex with men (MSM) who have more than one sexual partner and those who have sex with them, regardless of gender. CDC does not currently recommend more than two vaccine doses[25].

People with mpox[25] often get a rash that may be located on hands, feet, chest, face, or mouth or near the genitals, including penis, testicles, labia, and vagina, and anus. The incubation period is 3-17 days. During this time, a person does not have symptoms and may feel fine.

- The rash will go through several stages, including scabs, before healing[25].
- The rash can initially look like pimples or blisters and may be painful or itchy[25].

Mpox symptoms usually start within 3 weeks of exposure to the virus. If someone has flu-like symptoms, they will usually develop a rash 1-4 days later. A person with mpox can spread it to others from the time symptoms start until the rash has fully healed and a fresh layer of skin has formed[25].

Future Probability of Events

Epidemics and pandemics have occurred in human and animal populations for thousands of years. As humans began to gather and congregate in urban areas, the potential for pandemics and epidemics increased. As trade routes became established and contact with other cities became more frequent, the potential for transmission of illnesses increased. As trade routes became established and contact with other cities became more frequent, the potential for transmission of illnesses increased. In modern society, the ease of global travel has created a situation where viruses and bacteria can spread quickly from one continent to another.

Historical evidence shows that the population of Brazos County and the participating entities are vulnerable to disease outbreaks, and the probability of future infectious disease or pandemic events is possible. Local public health officials maintain surveillance in hopes of identifying disease prominence and containing potential threats before they become epidemics. Given the impact of the COVID-19 pandemic on Brazos County and its participating entities, the probability of a subsequent infectious disease epidemic or pandemic in the area is "occasional" and an event has the probability of occurring once every five years.

There is risk of introduction, and endemic transmission, of infectious diseases (both transmitted and vector-borne) from around the world due to climate change. Therefore, climate change is anticipated to increase the probability of infectious disease events.

Infectious Disease and Climate Change

Increasing global temperatures due to climate change is contributing to the spread of infectious diseases. Climate change can directly impact infectious disease emergence and re-emergence through effects on pathogen survival, vector survival and reproduction, and their animal reservoirs (i.e., hosts). For example, Aedes genus mosquitoes, which can transmit viruses such as Dengue, Zika, and Chikungunya, have been found farther North than previously known. Milder winters, warmer summers, and fewer days of frost make it easier for infectious diseases to expand to new geographic areas and subsequently increase the number of people at risk.

Additionally, climate change-related extreme whether events create circumstances where infectious microorganisms can flourish and cause novel diseases to emerge. Climate change has forced some animal species into new habitats as their natural habitats disappear, increasing opportunities for contact between humans and animals that can potentially spread zoonotic diseases (Ebola, Lassa, rabies, etc).

Potential Damages and Losses

Estimated potential losses to the built environment are difficult to calculate because infectious disease causes little damage to the built environment and generally losses are experienced through public health response and medical costs, and lost wages of patients. Therefore, it is assumed that all buildings and facilities are exposed to disease but would experience negligible damage in the occurrence of an outbreak event. For example, upkeep and maintenance of

buildings and facilities would fall behind due to the high absenteeism of employees or the closing of facilities.

Critical infrastructure services, such as emergency services, utility services, water services and telecommunications can be limited by an infectious disease event. With the COVID-19 pandemic, most of the people affected have mild illness and do not require hospitalization. People at the highest risk for developing complications from COVID-19 include adults 60 years of age and older. In addition, people who have medical conditions, such as heart disease; chronic lung disease; blood, endocrine, kidney, liver, or metabolic disorders; obesity, or a weakened immune system can experience a worsening of existing conditions if they contract the COVID-19 (See Figure 15.5).

The current COVID-19 pandemic has demonstrated that the response costs to the public health sector for an outbreak, the economic impact, and the impact to health for the Brazos County planning area, is "Substantial." We experienced (453) deaths, and area facilities were shut down for at least four weeks. Currently, there are expectations that COVID – 19 or another disease could occur again.

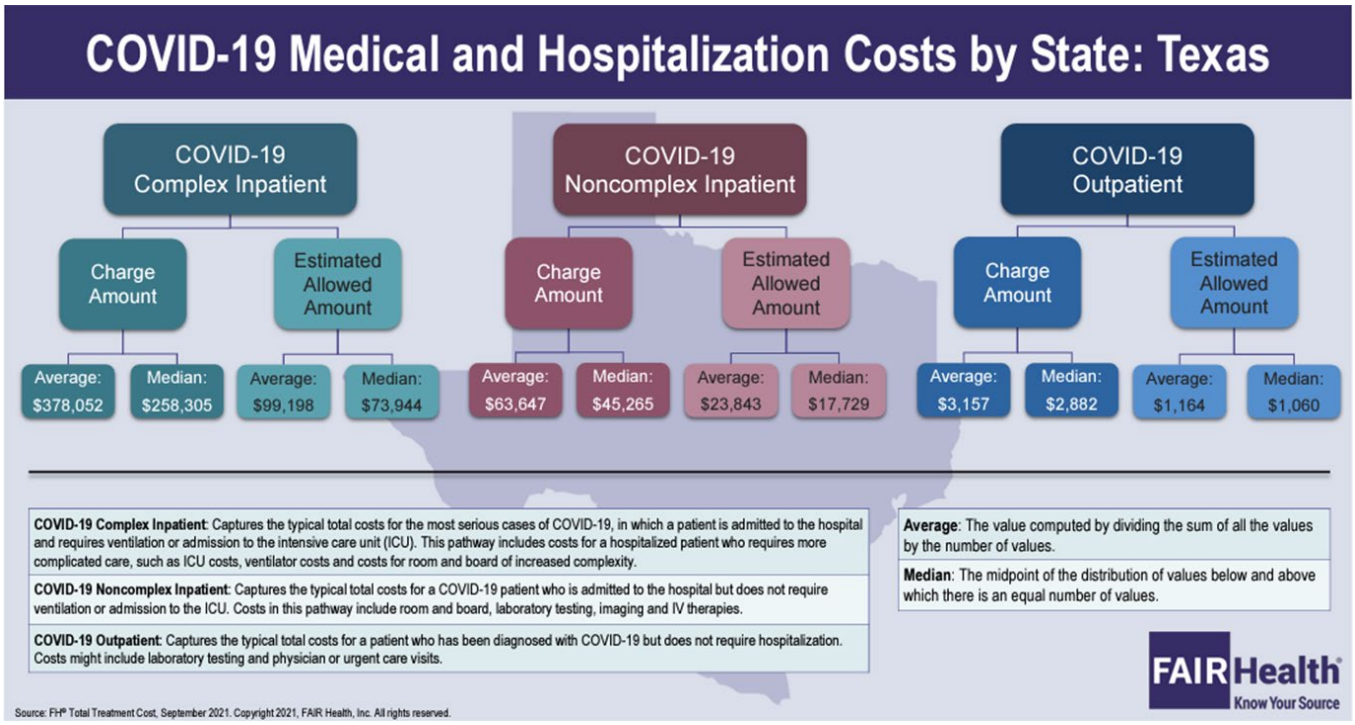


Figure: 15.5 – Covid 19 – Cost by State Source: FairHealth.org[26]

The Brazos County and the planning area executed a mandatory shutdown of non-essential businesses as a direct result of COVID-19. Larger gatherings of people were limited to 50 and below and at times to 10 and below. The impacts of COVID-19, the mandatory shutdown, large gathering limits, ISD closures and pervasive unemployment led to multiple secondary impacts. Figure: 15.6, provides an overview of secondary impacts of COVID-19 in the United States. Currently there are no mandates or restrictions in place for COVID-19 in the planning area.

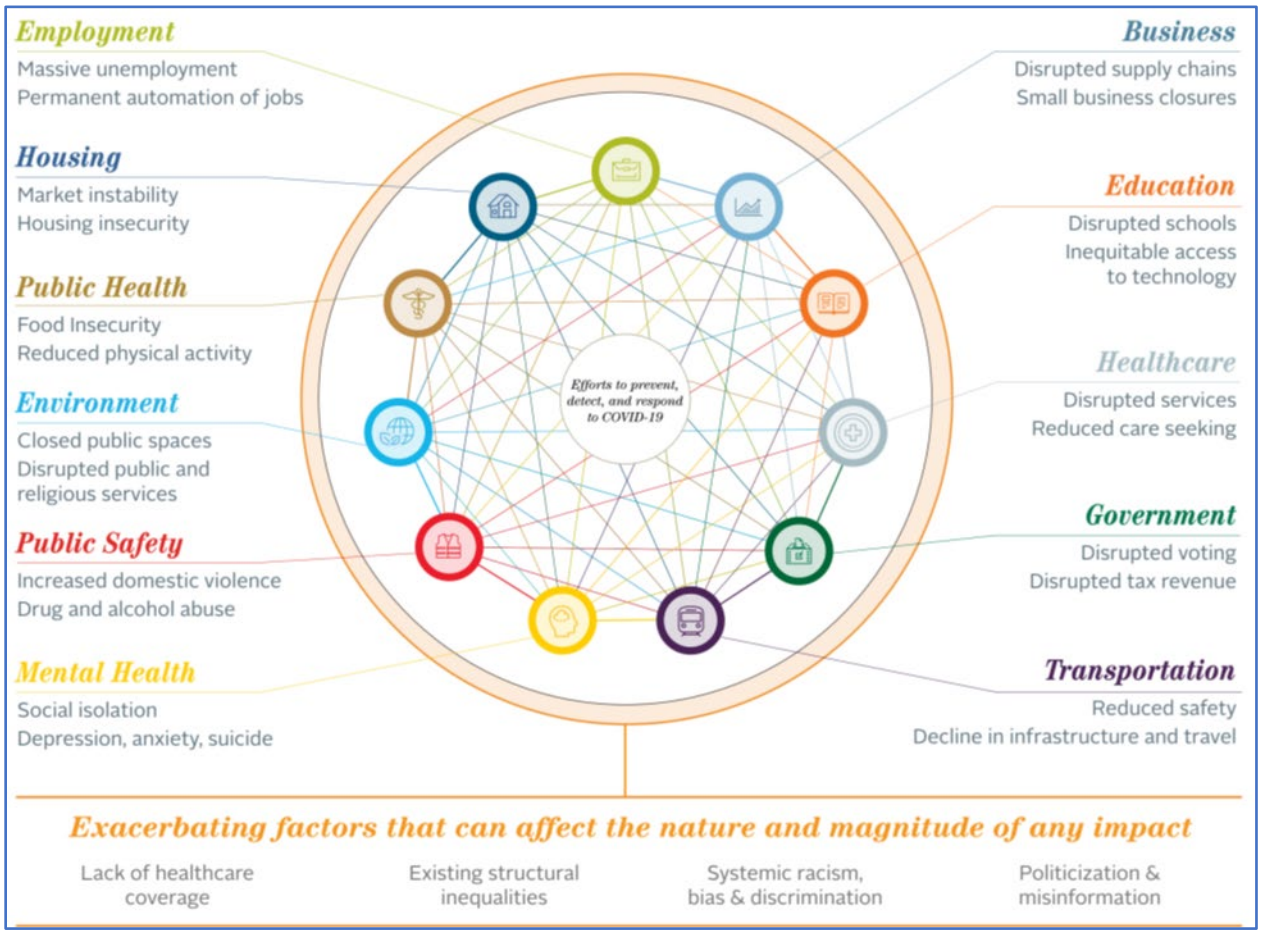


Figure: 15.6 – Secondary Impacts of the COVID 19 Pandemic in the US Source: WHO[1]

Extent

The extent of infectious diseases is continuous, it is very difficult to determine when or where a disease may occur. There are many factors involved in the emergence of new infectious diseases or the re-emergence of "old" infectious diseases. Some result from natural processes such as the evolution of pathogens over time, but many are a result of human behavior and practices.

To enhance the protection of the communities with Brazos County and its participating entities, syndromic surveillance is used. Texas Syndromic Surveillance (TxS2)[15] is the statewide syndromic surveillance system hosted by the Texas Department of State Health Services (DSHS) for use by Local Health Departments (LHDs), DSHS Public Health Regions, DSHS central office, and data providers (hospitals, free standing emergency centers, and urgent care centers,

for example) for enhanced surveillance of emerging public health conditions or threats. Syndromic surveillance[15] utilizes trend analysis to establish a baseline and then uses algorithms to compare the current data to that baseline and issue alerts when aberrations are detected. DSHS has authority to operate TxS2 under Chapter 81 of the Texas Health and Safety Code[15].

Within the last five years, the State of Texas has experienced either transmission or outbreaks of Ebola, Chikungunya, West Nile, and Zika virus infections[27]. Autochthonous transmission (the spread of disease between two individuals in the same place) of neglected parasitic and bacterial diseases (chagas disease, cysticercosis, and toxoplasmosis) has also become increasingly reported[1].

The rise of such emerging and neglected tropical diseases (NTDs) has not occurred by accident but instead reflects rapidly evolving changes and shifts in a "new" Texas. Neglected tropical diseases (NTDs) are a diverse group of conditions caused by a variety of pathogens (including viruses, bacteria, parasites, fungi, and toxins) and associated with devastating health, social and economic consequences[1].

The transmission and resurgent of once thought eradicated diseases, and modern and globalizing forces (economic, political, and technological influences) that include rapid expansions in population together with urbanization and human migrations, altered transportation patterns (such as sea travel and transborder traffic or illegal immigration), climate change, steeply declining vaccination rates (see figure: 15.7), and a new paradigm of poverty known as "blue marble health"[27].

The term "blue marble" is based on a famous Earth photograph taken by astronauts from an Apollo mission, which has since become an important symbol for the health of our planet[28]. The concept of blue marble health emerged as a novel framework for global health in 2013. Succinctly put, today most or at least one-half of the world's neglected diseases occur among the poor living in wealthy countries[28].

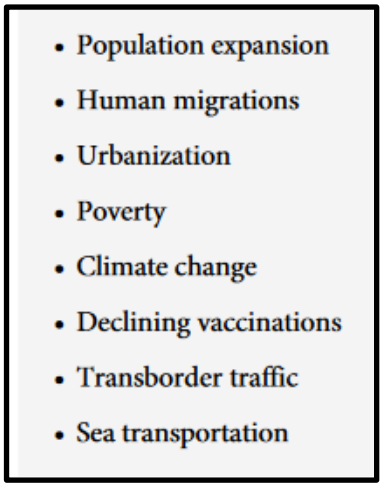


Figure: 15.7 – Major external factors driving emerging and neglected diseases in Texas.
Source: PLOS[27]

Assessment of Impacts

- Infectious disease may be short term or may lead to long-term physical maladies.
- Absenteeism in the workplace may have negative impacts on the overall functioning of society, particularly if prolonged.
- Response personnel are likely to experience the greatest impact and exposure to disease.
- Problems could arise regarding the continuity of operations and delivery of services.
- A large pathogenic event could impact the ability of the local government to maintain operations and deliver services due to staff staying home due to illness or fear of becoming ill.
- Psychological well-being may be affected due to illness, isolation, or the stress of responding to the event.
- It is possible for pathogens to affect not only humans, but their animals as well which may increase stress and financial hardship due to the cost of seeking medical care.

References – Section 15

1. *World Health Organization. Global Health Estimates 2019 Summary Tables: Deaths by Cause, Age, and Sex, by World Bank Income Group, 2000-2019. 2020. https://www.who.int/data/gho/data/themes/mortality-and-global-health-estimates*
2. *Upper Respiratory Infection. Cleveland Clinic. 2021. https://my.clevelandclinic.org/health/articles/4022-upper-respiratory-infection*
3. *World Health Organization. Diarrheal disease. https://www.who.int/news-room/fact-sheets/detail/diarrhoeal-disease. 2017.*
4. *World Health Organization. Tuberculosis. https://www.who.int/news-room/fact-sheets/detail/tuberculosis. 2023.*
5. *World Health Organization. HIV and AIDS. https://www.who.int/news-room/fact-sheets/detail/hiv-aids. 2023.*
6. *World Health Organization. Malaria. https://www.who.int/news-room/fact-sheets/detail/malaria. 2023.*
7. *World Health Organization. Measles. https://www.who.int/news-room/fact-sheets/detail/measles. 2023.*
8. *World Health Organization. Pertussis. https://www.who.int/health-topics/pertussis#tab=tab_1/.*
9. *World Health Organization. Tetanus. https://www.who.int/health-topics/tetanus#tab=tab_1.*
10. *World Health Organization. Rabies. https://www.who.int/news-room/fact-sheets/detail/rabies. 2023.*
11. *Centers for Disease Control and Prevention. https://www.cdc.gov/coronavirus/2019-ncov/prevent-getting-sick/prevention.html. 2023.*
12. *Centers for Disease Control and Prevention. https://www.cdc.gov/media/pdf/mitigationslides.pdf*
13. *Institute of Medicine (US) Forum on Microbial Threats. The Domestic and International Impacts of the 2009-H1N1 Influenza – A Pandemic: Global Challenges, Global Solutions: Workshop Summary. Washington (DC): National Academies Press (US); 2010. PMID: 21413196.*
14. *Putri WCWS, Muscatello DJ, Stockwell MS, Newall AT. Economic burden of seasonal influenza in the United States. Vaccine. 2018 Jun 22;36(27):3960-3966. doi: 10.1016/j.vaccine.2018.05.057. Epub 2018 May 22. PMID: 29801998.*
15. *Department of Health and Human Services. 2023 Statistics- People Living with HIV – Texas Department of Health Services. https://healthdata.dshs.texas.gov/dashboard/diseases/people-living-with-hiv*
16. *World Health Organization. Hepatitis. https://www.who.int/health-topics/hepatitis#tab=tab_1*
17. *World Health Organization. Food Borne Illnesses. https://www.who.int/health-topics/foodborne-diseases#tab=tab_1*
18. *US Department of Agriculture. Cleanliness Helps Food Borne Illness. https://www.fsis.usda.gov/food-safety/safe-food-handling-and-preparation/food-safety-basics/cleanliness-helps-prevent*
19. *Brazos County Health Department. Health District Website Homepage. https://www.brazoscountytx.gov/161/Health-District*
20. *Texas Health and Human Services. Texas Reports First West Nile Case of 2023. https://www.dshs.texas.gov/news-alerts/texas-reports-first-west-nile-case-2023*
21. *Centers for Disease Control and Prevention. Influenza. H5N1 Avian Flu. https://www.cdc.gov/flu/avianflu/avian-flu-summary.htm*
22. *Texas Animal Health Commission. 2022-2023 Highly Pathogenic Avian Influenza. https://www.tahc.texas.gov/emergency/avianinfluenza.html*
23. *Centers for Disease Control and Prevention. Ebola Disease. https://www.cdc.gov/vhf/ebola/index.html*
24. *American College of Gastroenterology. Diarrheal Diseases – Acute and Chronic. https://gi.org/topics/diarrhea-acute-and-chronic/*
25. *World Health Organization. MPOX (Monkeypox). https://www.who.int/news-room/fact-sheets/detail/monkeypox*
26. *Fair Health. Facts and Figures for the Nations' Largest Repository of Data. https://www.fairhealth.org/*
27. *Hotez, A. (2018). The rise of neglected tropical diseases in the "new Texas". PLoS Negl Trop Dis. 2018 Jan 18;12(1):e0005581. doi: 10.1371/journal.pntd.0005581. PMID: 29346369; PMCID: PMC5773009.*
28. *Hotez PJ, Damania A, Naghavi M. Blue Marble Health and the Global Burden of Disease Study. (2013). PLoS Negl Trop Dis. 2016 Oct 27;10(10):e0004744. doi: 10.1371/journal.pntd.0004744. PMID: 27788134; PMCID: PMC5082884.*

This page intentionally left blank.

Section 16 – Mitigation Actions

In the charts that follow, each jurisdiction presents mitigation action projects associated with the hazards listed in this plan. The Short, Medium, and Long designations for Project Length should be understood as 1-3 years, 3-5 years, and 5-10 years or an ongoing project, respectively. "All" in the Jurisdiction section should be understood as Brazos County, TAMU, and the Cities of Bryan, College Station, Kurten, and Wixon Valley.

Flood Mitigation Projects

Jurisdiction	Mitigation Action	Est. Cost	Funding Source(s)	Priority	Project Length	Responsible Department(s)
All	Develop an annual public hazards workshop or expo for all residents to educate them on flooding hazards and the National Flood Insurance Program and to develop methods to mitigate flooding damage to personal property.	$2,000	General Funds Corporate Donations	High	Short 1-3 Years	Emergency Management, Communications/PIO
All	Purchase generators for critical facilities.	Up to $150k per generator	General Funds Grant: Hazard Mitigation Assistance	Medium	Short 1-3 Years	Emergency Management
All	Build, renovate, rehabilitate, and/or convert building(s) for use as emergency shelter(s) to provide a safe environment for individuals and families.	$1m	General Funds Grant: Hazard Mitigation Assistance	Medium	Medium 3-5 Years	Emergency Management
Brazos County	Complete a hydrology study of the watersheds that exist in Brazos County that contribute to flooding during heavy rain incidents.	$25,000	General Funds Grant: Flood Mitigation Assistance	High	Medium 3-5 Years	Emergency Management, BC Road and Bridge
College Station	Mitigate repetitive loss and severe repetitive loss properties to include purchasing and/or elevation of existing structures.	$750k	Grant: Hazard Mitigation Assistance	Medium	Medium 3-5 Years	Planning and Development
College Station	Install early flood warning system(s) to alert the public of roadway closures and collect flood data for use in model calibration and floodplain mapping.	$500k	Drainage Funds Grant: Community Development Block Grant/ Mitigation Funds	Medium	Medium 3-5 Years	Planning and Development
College Station	Conduct flood hazard assessment of the City's watersheds to determine the scale and priority of any necessary floodplain mapping or remapping efforts.	$150k	Drainage Funds Grant: Community Development Block Grant/ Mitigation Funds	High	Medium 3-5 Years	Planning and Development

College Station	Continue to enforce building codes and develop STPs.	$6,000	General Funds	High	Medium 3-5 Years	Community Development
Kurten	Join the National Flood Insurance Program so residents can be eligible for flood insurance.	N/A	General Funds	Medium	Short 1-3 Years	Emergency Management
Wixon Valley	Develop an annual public hazards workshop or expo for all residents to educate them on flooding hazards, National Flodd ins. Program and develop methods to mitigate damage to personal properties from flooding.	$5,000	General Funds and Corporate Donations	Medium	Short Term 1-3 Years	Emergency Management
Wixon Valley	Purchase generators for critical facilities ie, emergency operations and shelter.	Up to $200,000 per generator	General Funds	Medium	Long Term 5-10 Years	Mayor
Wixon Valley	Build, renovate, rehabilitate, or convert a building or buildings for use as emergency shelters for individuals and families.	$5000	General Funds	High	Medium 3-5 Years	City Council
Bryan	Use the potential areas of high-water information (2D models and public information) to inform planning decisions.	$2,000	General Funds	High	Long 5-10 years	Public Works
Bryan	Monitor and update statistical rainfall numbers as soon as available.	$2,000	General Funds	High	Short 1-3 Years	Public Works
Bryan	Coordinate open space opportunities with flood control needs for new developments and repetitive loss areas.	$2,000	General Funds	High	Long 5-10 Years	Public Works
Bryan	Perform a detailed review of flood insurance on city-owned properties.	$2,000	General Funds	Medium	Short 1-3 Years	Public Works
Bryan	Protect critical facilities and flood-prone areas from debris by expanding the maintenance program to include trash pickup, including bulk, prior to forecasted large events.	<$400k	General Funds	Medium	Medium 3-5 Years	Public Works
Bryan	Install additional gauges to expand the B-FEWS system.	<$400k	General Funds Grants: Hazard Mitigation Assistance	High	Medium 3-5 Years	Public Works
Bryan	Create a public information campaign to encourage participation in Code Red.	<$50k	General Funds	High	Long 5-10 Years	Emergency Management
Bryan	Explore installing “Street May Flood” signs in critical locations.	<$500k	General Funds	High	Long 5-10 Years	Public Works
Bryan	Work with organizations serving functional and access needs populations that may require special assistance and can tie in with 911 and GIS systems so vulnerable citizens can be checked on, notified, supported, or educated effectively in the event of a disaster.	<$50k	General Funds	. High	Medium 3-5 Years	Emergency Management
Bryan	Develop a Substantial Damage Management plan.	<$50k	General Funds	Medium	Short 1-3 Years	Emergency Management, Public Works, Risk Management
Bryan	Develop, review, and update a Debris Management plan.	<$50k	General Funds	Medium	Short 1-3 Years	Public Works
Bryan	Continue to construct local and regional stormwater detention facilities in flood-prone areas.	<$5m	General Funds/Bonds	High	Long 5-10 Years	Public Works

Bryan	Increase the capacity of existing culverts and bridges on major thoroughfares and single point access subdivisions to allow passage during 100-year flooding event.	>$5m	General Funds/Bonds	High	Long 5-10 Years	Public Works
Bryan	Explore list of roads flooded during 2016/17 rainfalls and research emergency access availability to residents given these conditions.	$2,000	General Funds	High	Short 1-3 Years	Public Works
Bryan	Explore creating a system for development incentives for improving city stormwater infrastructure.	<$50k	General Funds	Low	Long 5-10 Years	Public Works, Development Services
Bryan	Direct mail of FEMA flood protection information to targeted areas of high flood risk.	<$50k	General Funds	Medium	Long 5-10 Years	Public Works
Bryan	Develop paid advertisements through public service announcements to educate the public about flood insurance and risk.	<$50k	General Funds	Medium	Medium 3-5 Years	Public Works, Communication and Marketing
Bryan	Develop and improve communication regarding preparedness and mitigation actions to better inform developers, engineers, builders, and the public about ways to mitigate flood damage.	<$50k	General Funds	Medium	Medium 3-5 Years	Public Works and Communications and Marketing
Bryan	Create educational program(s) for flood risk for schools and youth.	<$50k	General Funds	Low	Long 5-10 Years	Public Works

Drought Mitigation Projects

Jurisdiction	Mitigation Action	Est. Cost	Funding Source(s)	Priority	Project Length	Responsible Department(s)
All	Develop an annual public hazards workshop or expo for all residents to educate them on drought and develop methods to mitigate drought damage to personal property.	$2,000	General Funds Corporate Donations	High	Short 1-3 Years	Emergency Management, Communications/PIO
All	Purchase generators for critical facilities.	Up to $200k per generator	General Funds Grant: Hazard Mitigation Assistance	Medium	Short 1-3 Years	Emergency Management, BISD
All	Create a series of PSAs or outreach for topics such as burn bans, foundation watering how-to's, and water conservation.	$1,000	General Funds	Medium	Medium 3-5 Years	Emergency Management, Communications/PIO
College Station	Monitor water supply.	$5,000	General Funds	High	Long 5-10 Years	Utilities
College Station	Educate residents on water saving techniques	$5,000	General Funds	High	Long 5-10 Years	Utilities
Bryan	Continue social media campaigns to notify public of emergency situations, water conservation, water use efficiency, burn bands, grid stability, and heat-related illnesses.	<$10k	General Funds	High	Long 5-10 Years	Emergency Management, Utilities, Communications and Marketing
Bryan	Develop strong continuity of operations/government plans.	<$100k	General Funds Grant: BRIC	High	Medium 3-5 Years	Emergency Management

Wildland Fire Mitigation Projects

Jurisdiction	Mitigation Action	Est. Cost	Funding Source(s)	Priority	Project Length	Responsible Department(s)
All	Develop an annual public hazards workshop or expo for all residents to educate them on wildfires and the hazards associated and to develop methods to mitigate wildfire damage to personal property. Educate residents about the need for and creation of preparedness kits.	$1,000	General Funds Corporate Donations	High	Short 1-3 Years	Emergency Management, Communications/PIO
All	Purchase generators for critical facilities.	Up to $150k per generator	General Funds Grant: Hazard Mitigation Assistance	Medium	Short 1-3 Years	Emergency Management
All	Build, renovate, rehabilitate, or convert building(s) for use as emergency shelter(s) for individuals and families.	$1m	General Funds Grant: Hazard Mitigation Assistance	High	Medium 3-5 Years	Emergency Management
Brazos County; Kurten; Wixon Valley	Develop a community wildfire protection plan for the unincorporated areas of Brazos County to also include the Cities of Kurten and Wixon Valley.	$10,000	General Funds	Medium	Short 1-3 Years	Emergency Management, Brazos County Firefighter's Association
College Station	Map and assess vulnerability to wildfires.	$5,000	General Funds	Medium	Medium 3-5 Years	Fire Department
College Station	Increase wildfire risk awareness.	$3,000	General Funds	Medium	Medium 3-5 Years	Fire Department
Wixon Valley	Develop an annual public hazards workshop or expo for all residents to educate them on drought and develop methods to mitigate damage to personal properties from drought.	$5,000	General Funds and Corporate Donations	High	Short 1-3 Years	Emergency Management
Wixon Valley	Purchase generators for critical facilities	Up to $200,000 per generator	General Funds	Medium	Long 5-10 Years	Emergency Management
Wixon Valley	Build, renovate, rehabilitate, or convert a building or buildings for use as emergency shelters for individuals and families.	$7 million	General Funds	Medium	Long 5-10 Years	Emergency Management
Bryan	Continue social media campaign to notify public of emergency situations, water conservation, water use efficiency, burn bands, grid stability, and heat-related illnesses.	<$10k	General Funds	High	Long 5-10 Years	Emergency Management, Utilities, Communications and Marketing
Bryan	Provide door flyers containing information on how to prepare for and recover from fire incidents.	<$5,000	General Funds	High	Long 5-10 Years	Fire Department
Bryan	Provide community information on American Red Cross' smoke alarm program.	$2,000	General Funds	High	Long 5-10 Years	Fire Department
Bryan	Maintain a Community Wildfire Protection Plan to include risk analysis and aerial imaging.	$255k	General Funds Grant: CWDG	High	Long 5-10 Years	Fire Department
Bryan	Phase out DJI drones and replace.	>$1m	General Funds Grant: HSGP	High	Medium 3-5 Years	Fire Department, Police Department

Bryan	Provide PSA for homeowners regarding fuel mitigation projects near wooded areas.	<$300k	General Funds Grant: CWDG	High	Medium 3-5 Years	Fire Department, Public Works
Bryan	Purchase a woodchipper for controlled and uncontrolled burning to begin cleanup.	<$10k	General Funds Grant: CWDG	High	Medium 3-5 Years	Fire Department, Utilities
Bryan	Purchase a bulldozer for wildfire cleanup.	>$1m	Grant: CWDG	Medium	Long 5-10 Years	Fire Department
Bryan	Purchase a Type III engine for wildfire response.	<$2m	General Funds Grant: CWDG, AFG	Medium	Long 5-10 Years	Fire Department
Bryan	Host annual controlled burn training for multiple jurisdictions.	<$100k	General Funds Grant: CWDG	High	Long 5-10 Years	Fire Department
Bryan	Develop strong continuity of operations/government plans.	<$100k	General Funds Grant:BRIC	High	Medium 3-5 Years	Emergency Management

Severe Winter Storm Mitigation Projects

Jurisdiction	Mitigation Action	Est. Cost	Funding Source(s)	Priority	Project Length	Responsible Department(s)
All	Develop an annual public hazards workshop or expo for all residents to educate them on winter storms and associated hazards and to develop methods to mitigate winter storm damage to personal property. Educate residents about the need for and creation of preparedness kits.	$2,000	General Funds Corporate Donations	High	Short 1-3 Years	Emergency Management, Communications/PIO
All	Purchase generators for critical facilities.	Up to $150k per generator	General Funds Grant: Hazard Mitigation Assistance	Medium	Short 1-3 Years	Emergency Management
All	Build, renovate, rehabilitate, or convert building(s) for use as emergency shelter(s) for individuals and families.	$1m	General Funds Grant: Hazard Mitigation Assistance	High	Medium 3-5 Years	Emergency Management
College Station	Conduct winter weather risk awareness activities.	$1,000	General Funds	Medium	Long 5-10 Years	Community Development
College Station	Assist vulnerable populations.	$1,000	General Funds	High	Medium 3-5 Years	Community Development
Bryan	Continue social media campaign to notify public of emergency situations.	$5,000	General Funds	High	Long 5-10 Years	Emergency Management, Utilities, Communications and Marketing
Bryan	Harden critical infrastructure and ensure continuity of essential city services.	>$5m	General Funds Grant: BRIC	High	Long 5-10 Years	Emergency Management, Risk management
Bryan	Develop strong continuity of operations/government plans.	<$100k	General Funds	High	Medium 3-5 Years	Emergency Management
Wixon Valley	Build, renovate, rehabilitate, or convert a building or buildings for use as emergency shelters for individuals and families.	$7 million	General Funds	Medium	Long 5-10 years	Emergency Management
Wixon Valley	Purchase generators for critical facilities (What facilities?)	Up to $200k per generator	General Funds	Medium	Long 5-10 Years	Emergency Management

Tornado Mitigation Projects

Jurisdiction	Mitigation Action	Est. Cost	Funding Source(s)	Priority	Project Length	Responsible Department(s)
All	Develop an annual public hazards workshop or expo for all residents to educate them on tornadoes and associated hazards and to develop methods to mitigate tornado damage to personal property. Educate residents about the need for and creation of preparedness kits.	$2,000	General Funds Corporate Donations	High	Short 1-3 Years	Emergency Management, Communications/PIO
All	Purchase generators for critical facilities.	Up to $150k per generator	General Funds Grant: Hazard Mitigation Assistance	Medium	Short 1-3 Years	Emergency Management
All	Build, renovate, rehabilitate, or convert building(s) for use as emergency shelter(s) for individuals and families.	$1m	General Funds Grant: Hazard Mitigation Assistance	High	Medium 3-5 Years	Emergency Management
College Station	Create disaster debris management plan with respective contracts to be approved by TDEM and FEMA.	$50k	Enterprise Funds Grant: Hazard Mitigation Assistance	High	Medium 3-5 Years	Public Works
College Station	Hold annual tabletop exercises for roadway clearing and debris management activities.	$1,500	Enterprise Funds Grant: Hazard Mitigation Assistance	High	Long 5-10 Years	Public Works
College Station	Encourage the construction of safe rooms.	$1,000	General Funds	High	Long 5-10 Years	Risk Management
College Station	Conduct tornado awareness activities.	$1,000	General Funds	High	Long 5-10 years	Risk Management
Bryan	Develop, review, and update Debris Management plan.	<$50k	General Funds	High	Short 1-3 Years	Public Works
Bryan	Develop strong continuity of operations/government plans.	<$100k	General Funds	High	Medium 3-5 Years	Emergency Management
Wixon Valley	Purchase generators for critical facilities	Up to $200k per generator	General Funds	Medium	Long 5-10 Years	Emergency Management
Wixon Valley	Build, renovate, rehabilitate, or convert a building or buildings for use as emergency shelters for individuals and families.	$7 million	General Funds	Medium	Long 5-10 Years	Emergency Management

Hail Mitigation Projects

Jurisdiction	Mitigation Action	Est. Cost	Funding Source(s)	Priority	Project Length	Responsible Department(s)
All	Develop an annual public hazards workshop or expo for all residents to educate them on hail and associated hazards and to develop methods to mitigate hail damage to personal property. Educate residents about the need for and creation of preparedness kits.	$2,000	General Funds Corporate Donations	High	Short 1-3 Years	Emergency Management, Communications/PIO
All	Purchase generators for critical facilities.	Up to $150k per generator	General Funds Grant: Hazard Mitigation Assistance	Medium	Short 1-3 Years	Emergency Management
All	Build, renovate, rehabilitate, or convert building(s) for use as emergency shelter(s) for individuals and families.	$1m	General Funds Grant: Hazard Mitigation Assistance	High	Medium 3-5 Years	Emergency Management
College Station	Locate safe rooms to minimize damage.	$1,000	General Funds	High	Medium 3-5 Years	Risk Management
College Station	Increase hail awareness.	$1,000	General Funds	High	Long 5-10 Years	Risk Management
Kurten	Create mailouts and/or social media messages that provide information to residents regarding the use of weather radios, the dangers of lightning, and safety precautions for when severe weather and lightning threaten.	$250	General Funds	High	Short 1-3 Years	Emergency Management
Bryan	Continue social media campaigns to notify public of emergency situations, hail damage reporting how-tos, road closures, and severe weather safety.	$5,000	General Funds	High	Long 5-10 Years	Emergency Management, Utilities, Communications and Marketing
Bryan	Protect fleet and emergency vehicles during hail events with covered parking.	<$100k	General Funds Grant: BRIC, Hazard Mitigation Assistance	High	Long 5-10 Years	Risk Management
Bryan	Invest in impact-rated roofing, A/C unit covers, and siding for critical facilities.	>$1m	General Funds Grant: BRIC	Low	Long 5-10 Years	Risk Management
Bryan	Develop strong continuity of operations/government plans.	<$100k	General Funds	High	Medium 3-5 Years	Emergency Management
Wixon Valley	Build, renovate, rehabilitate, or convert a building or buildings for use as emergency shelters for individuals and families.	$7 million	General Funds	Medium	Long 5-10 Years	Emergency Management
Wixon Valley	Create mailouts and/or social media messages that provide information to residents regarding the use of weather radios, teach residents about the dangers of hail and safety precautions to take when severe weather and hail threatens.	$500	General Funds	High	Short 1-3 Years	Emergency Management

Thunderstorms (including Lightning and High Winds) Mitigation Projects

Jurisdiction	Mitigation Action	Est. Cost	Funding Source(s)	Priority	Project Length	Responsible Department(s)
All	Develop an annual public hazards workshop or expo for all residents to educate them on thunderstorms that produce lightning, high winds and associated hazards to develop methods to mitigate this damage to personal property. Educate residents about the need for and creation of preparedness kits.	$2,000	General Funds Corporate Donations	High	Short 1-3 Years	Emergency Management, Communications/PIO
All	Purchase generators for critical facilities.	Up to $150k per generator	General Funds Grant: Hazard Mitigation Assistance	Medium	Short 1-3 Years	Emergency Management
All	Build, renovate, rehabilitate, or convert building(s) for use as emergency shelter(s) for individuals and families.	$1m	General Funds Grant: Hazard Mitigation Assistance	High	Medium 3-5 Years	Emergency Management
College Station	Create social media lightning campaign for inclusion with City of College Station water bills.	$2,500	General Funds	Medium	Short 1-3 Years	Utilities
College Station	Conduct lightning awareness programs.	$1,000	General Funds	Medium	Medium 3-5 Years	Utilities
Kurten	Create mailouts and/or social media messages that provide information to residents regarding the use of weather radios, the dangers of lightning, and safety precautions for when severe weather and lightning threaten.	$250	General Funds	High	Short 1-3 Years	Emergency Management, City Council
Wixon Valley	Install surge and strike reduction rods and systems in the new City Hall.	$10k	General Funds	Medium	Short 1-3 Years	City Council
Wixon Valley	Purchase generators for critical facilities	Up to $200k per generator	General Funds	Medium	Long 5-10 Years	Emergency Management
Wixon Valley	Build, renovate, rehabilitate, or convert a building or buildings for use as emergency shelters for individuals and families.	$7 million	General Funds	Medium	Long 5-10 Years	Emergency Management
Bryan	Continue social media campaign to notify the public of emergency situations.	$5,000	General Funds	Low	Long 5-10 Years	Emergency Management, Utilities, Communications and Marketing
Bryan	Invest in lightning rods for critical infrastructure.	<$50k	General Funds	Low	Long 5-10 Years	Risk Management

Dam and Levee Failure Mitigation Projects

Jurisdiction	Mitigation Action	Est. Cost	Funding Source(s)	Priority	Project Length	Responsible Department(s)
All	Develop an annual public hazards workshop or expo for all residents to educate them on dams and levees and associated hazards and to develop methods to mitigate flooding damage to personal property. Educate residents about the need for and creation of preparedness kits.	$2,000	General Funds Corporate Donations	High	Short 1-3 Years	Emergency Management, Communications/PIO
All	Purchase generators for critical facilities.	Up to $150K per generator	General Funds Grant: Hazard Mitigation Assistance	Medium	Short 1-3 Years	Emergency Management
All	Build, renovate, rehabilitate, or convert building(s) for use as emergency shelter(s) for individuals and families.	$1m	General Funds Grant: Hazard Mitigation Assistance	High	Medium 3-5 Years	Emergency Management
Brazos County; College Station; Bryan	Conduct hydrology studies to identify the extent for each dam on the list that does not have current information. Extents will be stated in the form of water depth in the inundation area for each dam.	$50k	Grant: Hazard Mitigation Assistance	Medium	Medium 3-5 Years	Emergency Management
College Station	Conduct a study estimating economic consequences for dam failure scenarios.	$40k	Grant: BOR	Medium	Medium 3-5 Years	Planning and Development
College Station	Conduct a study estimating loss of life in the dam sectors for failure scenarios.	$40k	Grant: BOR	Medium	Medium 3-5 Years	Planning and Development
Bryan	Develop a dam safety public education and evacuation plan for at-risk areas of the community including routes, transportation, and housing.	<$100k	General Funds	Medium	Medium 3-5 Years	Public Works, Utitlties
Wixon Valley	Purchase generators for critical facilities	Up to $200k per generator	General Funds	Medium	Long 5-10 Years	Emergency Management
Wixon Valley	Build, renovate, rehabilitate, or convert a building or buildings for use as emergency shelters for individuals and families.	$7 million	General Funds	Medium	Long 5-10 Years	Emergency Management

Excessive or Extreme Heat Mitigation Projects

Jurisdiction	Mitigation Action	Est. Cost	Funding Source(s)	Priority	Project Length	Responsible Department(s)
All	Develop an annual public hazards workshop or expo for all residents to educate them on excessive heat and associated hazards and to develop methods to mitigate heat-related damage to personal property. Educate residents about the need for and creation of preparedness kits.	$2,000	General Funds Corporate Donations	High	Short 1-3 Years	Emergency Management, Communications/PIO
All	Purchase generators for critical facilities.	Up to $150k per generator	General Funds Grant: Hazard Mitigation Assistance	Medium	Short 1-3 Years	Emergency Management
All	Build, renovate, rehabilitate, or convert building(s) for use as emergency shelter(s) for individuals and families.	$1m	General Funds Grant: Hazard Mitigation Assistance	High	Medium 3-5 Years	Emergency Management
All	Provide information to the public on where they can go to stay cool during periods of excessive heat.	$1,500	General Funds	Medium	Short 1-3 Years	Emergency Management, Communications
All	Educate vulnerable populations about sources of fans and programs that can assist citizens having trouble paying utility bills.	$1,500	General Funds	Medium	Short 1-3 Years	Emergency Management, Communications
Wixon Valley	Purchase generators for critical facilities	Up to $200k per generator	General Funds	Medium	Long 5-10 Years	Emergency Management
Wixon Valley	Build, renovate, rehabilitate, or convert a building or buildings for use as emergency shelters for individuals and families.	$7 million	General Funds	Medium	Long 5-10 Years	Emergency Management
Wixon Valley	Provide information to the public on where they can go to stay cool during periods of excessive heat.	$2,000	General Funds	High	Short 1-3 Years	Emergency Management
Wixon Valley	Educate vulnerable populations about sources of fans and sources of programs that can assist citizens having trouble paying utility bills.	$2,000	General Funds	High	Short 1-3 Years	Emergency Management

Infectious Disease Mitigation Projects

In the chart that follows, the listed projects will be completed by the Brazos County Health District on behalf of Brazos County and participating entities.

Mitigation Action	Est. Cost	Funding Source(s)	Priority	Project Length	Responsible Department(s)
Identify family assistance centers and/or points of dispensing for supplies during a pathogenic event.	$50,000	General Funds Grant: IDCU-TECE	Medium	Medium 3-5 Years	PHEP Coordinator Brazos County Health District
Monitor zoonotic diseases thought to be associated with changes in weather conditions and climate change. Inform public of any changes so they can better protect themselves.	$100,000	General Funds Grant: IDCU-TECE	Medium	Medium 3-5 Years	Epidemiologist Brazos County Health District
Implement education and awareness program(s) utilizing social media, traditional media, bulletins, flyers, etc. to educate citizens of hazards that can threaten the area and of mitigation measures to reduce cases of disease and fatalities.	$50,000	General Funds	Medium	Medium 3-5 Years	Public Information Officer Brazos County Health District

This page intentionally left blank.

Section 17 – Plan Management

Monitoring and Evaluation

Periodic revisions of the plan are required to ensure that goals, objectives, and mitigation actions are kept current. When the plan is discussed in these sections it includes the risk assessment and mitigation actions as a part of the monitoring, evaluating, updating and review process. Revisions may be required to ensure the plan is following federal and state statutes and regulations.

The planning team will meet once or twice a year to evaluate the plan and identify any needed changes and assess the effectiveness of the plan achieving its stated purpose and goals. The team will evaluate the number of mitigation actions implemented along with the loss-reduction associated with each action. Actions that have not been implemented will be evaluated to determine whether any social, political, or financial barriers are impeding implementation and if any changes are necessary to improve the viability of an action. The team will evaluate changes in land development and/or programs that affect mitigation priorities in their respective entities. The evaluation process will help to determine whether any changes are necessary. In addition, the plan will be similarly evaluated immediately after extreme weather events including but not limited to state and federally declared disasters.

Disaster Declarations

Following a disaster declaration, the Brazos County Hazard Mitigation Plan will be revised as necessary to reflect lessons learned, or to address specific issues and circumstances arising from the event. The Hazard Mitigation Action Planning Team will meet under special circumstances and invite stakeholders to participate in the plan revision and update process following declared disaster events.

Plan Amendments

Amendments can be made at any time necessary to the Brazos County Hazard Mitigation Action Plan. Material changes to mitigation actions or major changes in the overall direction of the plan or the policies contained within it, must be subject to formal adoption by the participating entities.

The participating entities within Brazos County will review proposed amendments and vote to accept, reject, or amend the proposed change. Upon ratification, the amendment will be transmitted to TDEM.

In determining whether to recommend approval or denial of a plan amendment request, participating entities will consider the following factors:

- Errors or omissions made in the identification of issues or needs during the preparation of the plan update.
- New issues or needs that were not adequately addressed in the plan update; and

- Changes in information, data, or assumptions from those on which the plan update was based.

Hazard Mitigation Action Plan Review

In addition, with the review plan listed above, the plan will be *thoroughly* reviewed by the planning team at the end of three years from the approval date, to determine whether there have been significant changes in the planning area that necessitate changes in the types of mitigation actions proposed. Factors that may affect the content of the plan include new development in identified hazard areas, increased exposure to hazards, disaster declarations, increase or decrease in capability to address hazards, and changes to federal or state legislation.

The plan review process provides the participating entities within Brazos County an opportunity to evaluate mitigation actions that have been successful, identify losses avoided due to the implementation of specific mitigation measures, and address mitigation actions that may not have been successfully implemented as assigned. It is recommended that the full planning team and stakeholders meet to review the plan at the end of the 3 years because grant funds may be necessary for the development of a 5-year update. Reviewing planning grant options in advance of the 5-year plan update deadline is recommended considering the timelines for grant and planning cycles can be more than a year.

During the 5-year plan review process, the following questions will be considered as criteria for assessing the effectiveness and appropriateness of the Plan:

- Do the goals address current and expected conditions?
- Has the nature or magnitude of risks changed?
- Are the current resources appropriate for implementing the Plan?
- Are there implementation problems, such as technical, political, legal or coordination issues with other agencies?
- Have the outcomes occurred as expected?
- Did County departments participate in the plan implementation process as assigned?

Following the plan review, any revisions deemed necessary will be summarized and implemented according to the reporting procedures and plan amendment process outlined herein. Upon completion of the review, update, and amendment process the revised plan will be submitted to TDEM for final review and approval in coordination with FEMA.

Continued Public Involvement

44 CFR Requirement
44 CFR Part 201.6(c)(4)(iii): The plan maintenance process shall include a discussion on how the community will continue public participation in the plan maintenance process.

Public input was an integral part of the preparation of this plan and will continue to be essential for plan updates. The public will be directly involved in the annual evaluation, monitoring,

reviews, and cyclical updates, using the Public Survey and Public Meetings. Changes or suggestions to improve or update the Plan will provide opportunities for additional public input.

The public can review the plan on the participating entities' websites, where officials and the public will be invited to provide ongoing feedback via email.

The planning team may also designate voluntary citizens from the planning area or willing stakeholder members from the private sector businesses that were involved in the plan's development to provide feedback on an annual basis. It is important that stakeholders and the immediate community maintain a vested interest in preserving the functionality of the planning area as it pertains to the overall goals of the mitigation plan. The planning team is responsible for notifying stakeholders and community members on an annual basis and maintaining the plan.

Media, including local newspaper and radio stations, will be used to notify the public of any maintenance or periodic review activities during the implementation, monitoring, and evaluation phases. Additionally, local news media will be contacted to cover information regarding plan updates, status of grant applications, and project implementation. Social media outlets, such as Facebook and Twitter (X), will keep the public and stakeholders apprised of potential opportunities to fund and implement mitigation projects identified in the plan.

This page was intentionally left blank.

Appendix A – Planning Team

Brazos County	
Name	**Title**
Michele Meade	Emergency Management Coordinator
Jason Ware	Deputy Emergency Management Coordinator
Arron Constante	Emergency Management Planner
Fred Paine	Operations Manager, Brazos County Road and Bridge Department
Prarthana Banerji	County Engineer, Brazos County Road and Bridge Department
Megan Lott	GIS Coordinator, Brazos County Road and Bridge Department
Robert Lamkin	Environmental Health Services Manager, Brazos County Health District
City of Bryan	
Jeanelle Johnson	Emergency Management Coordinator
Marc McFeron	Fire Marshal
Kyle McCain	Environmental Operations Supervisor
Victor Harris	Wastewater Plant Supervisor
Kelly Sullivan	Civil Engineer
Nicholas Cook	Production/Division Manager, Bryan Texas Utilities
Matthew Cline	GIS Analyst
Eric Zaragoza	Environmental Services Manager
City of College Station	
Tradd Mills	Emergency Management Coordinator
Caroline Ask	Solid Waste Division Manager
Glenn Gavit	Assistant Director of Electricity Services
Stephen Maldonado Jr	Assistant Director of Water Services
David Vaughn	Engineering Program Specialist
Matthew Ellis	Senior Planner
Carol Cotter	City Engineer
City of Kurten	
Chris Court	Mayor, Emergency Management Director
City of Wixon Valley	
Jim Soefje	Mayor, Emergency Management Director
Kimberly Hinton	Floodplain Coordinator
Texas A&M University	
Monica Martinez	Director of Emergency Management
Leslie Lutz	Assistant Director of Emergency Management
Amanda Fox	Emergency Management Specialist
Jeff Truss	Assistant Director of Environmental Health and Safety
Ralph Davila	Director of Facilities
Valerie Hadley	Assistant Director of Facilities and Dining Administration
Rob Meyer	Supervisor of Utilities and Energy Services
Shannon Van Zandt	Professor of Landscape Architecture and Urban Planning
Walter Peacock	Professor of Landscape Architecture and Urban Planning
John T. Cooper	Associate Professor of Landscape Architecture and Urban Planning
Brazos County Department of Health	
Edward Davila	Epidemiologist
Takira Lyles	Epidemiologist
Noelle McGhee	Public Health Accreditation Fellow
Megan Sullivan	Public Health Emergency Preparedness Administrative Assistant

Arthur Davila	Public Health Emergency Preparedness Manager

Hazard Mitigation Planning Team Capabilities and Mitigation Categories

Department	Prevention	Property and Natural Resource Protection	Emergency Services	Education and Awareness
Engineering and Floodplain Management	✓	✓		
Planning and Development	✓	✓		✓
Environmental Health and Safety	✓	✓		✓
Fire and EMS	✓	✓	✓	✓
Utilities			✓	✓
Marketing and Communications			✓	✓
Parks and Recreation		✓		
Brazos County Health Department	✓			✓

Appendix B – Critical Infrastructure

Name	Type	Jurisdiction
Coulter Field	Airport	COB
Easterwood Field	Airport	COCS, TAMUS
BISD Transportation Center	BISD Facility	COB
Bryan ISD Administration Buildings	BISD Facility	COB
Brazos Transit District	Bus	COB
Greyhound Bus Station	Bus	COB
Transportation Services	Bus	TAMU
City of Bryan City Hall	City Hall	COB
City of College Station City Hall	City Hall	COCS
City of Wixon Valley City Hall	City Hall	WV
KYLE	Communication	COB
WTAW	Communication	COCS
KEOS	Communication	COB
KNFX-FM	Communication	COB
KKYS	Communication	COB
KORA	Communication	COB
KAMU	Communication	TAMU
KBTX	Communication	COB
Brazos County Exposition Center	Community Center/Gathering Area	COB, BC
Brazos Center	Community Center/Gathering Area	COB, BC
COCS Visit College Station Center	Community Center/Gathering Area	COCS
COCS Meyer Senior & Community Center	Community Center/Gathering Area	COCS
COB Clara B. Mounce Public Library	Community Center/Gathering Area	COB
Carnegie History Center	Community Center/Gathering Area	COB
COCS Larry J Ringer Public Library	Community Center/Gathering Area	COCS
COCS Southwood Community Center	Community Center/Gathering Area	COCS
COCS Veterans Park American Pavilion	Community Center/Gathering Area	COCS
COCS Gary Halter Nature Center	Community Center/Gathering Area	COCS
COCS Wolf Pen Creek Amphitheater	Community Center/Gathering Area	COCS
COCS Lincoln Center	Community Center/Gathering Area	COCS
Kurten Community Center	Community Center/Gathering Area	Kurten
Brazos County Courthouse	Courthouse	BC
College Station ISD Administration Buildings	CSISD Facility	COCS
Barbara Bush Parent Center	CSISD Facility	COCS
CSISD Transportation Center	CSISD Facility	COCS

George Bush Presidential Library	Cultural Landmark	TAMU
Bryan Texas Utilities	Electric	COB
College Station Utilities	Electric	COCS
Central Utilities Plant	Electric	TAMU
Satellite Utility Plant No. 1	Electric	TAMU
Satellite Utility Plant No. 2	Electric	TAMU
Satellite Utility Plant No. 3	Electric	TAMU
West Campus Cogeneration Company	Electric	TAMU
Community Emergency Operations Center	Emergency	BC, COB, COCS, TAMU
Kyle Field Command	Emergency	TAMU
College Station Fire Department Station #1	Fire Station	COCS
College Station Fire Department Station #2	Fire Station	COCS
College Station Fire Department Station #3	Fire Station	COCS
College Station Fire Department Station #4	Fire Station	COCS
College Station Fire Department Station #5	Fire Station	COCS
College Station Fire Department Station #6	Fire Station	COCS
Bryan Fire Department Station #1	Fire Station	COB
Bryan Fire Department Station #2	Fire Station	COB
Bryan Fire Department Station #3	Fire Station	COB
Bryan Fire Department Station #4	Fire Station	COB
Bryan Fire Department Station #5	Fire Station	COB
Brazos County District 2 VFD Station #1	Fire Station	BC
Brazos County District 2 VFD Station #2	Fire Station	BC
Brazos County Precinct 3 VFD Station #1	Fire Station	BC
Brazos County Precinct 3 VFD Station #2	Fire Station	BC
Brazos County Precinct 3 VFD Station #3	Fire Station	BC
Brazos County Precinct 4 VFD Station #1	Fire Station	BC
Brazos County Precinct 4 VFD Station #2	Fire Station	BC
Brazos county Precinct 4 VFD Station #3	Fire Station	BC
South Brazos County FD Station #1	Fire Station	BC
South Brazos County FD Station #2	Fire Station	BC
South Brazos County FD Station #3	Fire Station	BC
South Brazos County FD Station #4	Fire Station	BC
Brazos County Administration	Government	BC
Brazos County Precinct 3 Justice of the Peace/Constable	Government	BC
Brazos County Precinct 1 Justice of the Peace/Constable	Government	BC
United States Post Offices (7)	Government	BC, COB, COCS, K, TAMU

Business 6/ Texas Avenue	Highway	BC, COB, COCS
Earl Rudder Freeway/ State Highway 6	Highway	BC, COB, COCS
Farm to Market 50	Highway	BC
Farm to Market 60 (Raymond Stotzer/University Dr)	Highway	BC, COB, COCS
Farm to Market 158 (Boonville Road/ William J. Bryan Parkway)	Highway	COB, BC
Farm to Market 159	Highway	BC
Farm to Market 974 (Tabor Road)	Highway	BC, COB
Farm to Market 1179 (Briarcrest/ Villa Maria)	Highway	COB, BC
Farm to Market 1687 (Sandy Point Road)	Highway	COB, BC
Farm to Market 1688 (Leonard Road)	Highway	COB, BC
Farm to Market 2038	Highway	BC, Kurten
Farm to Market 2154 (Wellborn Road)	Highway	BC, COB, COCS
Farm to Market 2223 (Old Cameron Ranch Road)	Highway	BC
Farm to Market 2347 (George Bush Dr)	Highway	COCS
Farm to Market 2776	Highway	BC, WV
Farm to Market 2818 (Harvey Mitchell Parkway)	Highway	BC, COB, COCS
Old San Antonio Road (OSR)	Highway	BC
State Highway 21	Highway	BC, COB, WV, Kurten
State Highway 30 (Harvey Road)	Highway	BC, COB, COCS
State Highway 40	Highway	COCS
State Highway 47	Highway	COCS, COB, BC
State Highway 105	Highway	BC
Accel Transitional Care and Rehabilitation	Medical	COCS
Baylor Scott & White Clinic - Bryan W Villa Maria	Medical	COB
Baylor Scott & White Clinic - Boonville	Medical	COB
BPL Plasma	Medical	COCS
Brazos Valley Urgent Care	Medical	COCS
Caprock Hospital	Medical	COB
CHI St. Joseph Health Emergency & Trauma Center	Medical	COB
CHI St. Joseph Health Express Care	Medical	COB
CHI St. Joseph Health Primary Care - Austin's Colony	Medical	COB
CHI St. Joseph Health Primary Care - Bryan	Medical	COB
CHI St. Joseph Health Primary Care - University Dr	Medical	COB
CHI St. Joseph Health Primary Care - W Villa Maria	Medical	COB
CHI St Joseph Health Primary Care	Medical	COCS
CHI St Joseph/Occ/Clinic	Medical	COCS

CHI St. Joseph Health Rehabilitation Hospital	Medical	COB
Fortress Health and Rehabilitation	Medical	COCS
Health Point Acute Care	Medical	COB
Physicians Premier	Medical	COB
Scott & White Clinic	Medical	COCS
Scott & White Cosmetic Surgery Center/Pharmacy	Medical	COCS
Scott & White today Care Clinic	Medical	COCS
Scott & White Hospital	Medical	COCS
St Joseph Regional Health Center - Bryan Campus	Medical	COB
St Joseph Regional Health Center - CS Campus	Medical	COCS
St Joseph Family Medicine	Medical	COCS
St Joseph Pediatrics	Medical	COCS
Signature Care Emergency Center	Medical	COCS
The Blood Center of Brazos Valley	Medical	COCS
The Physicians Centre Hospital	Medical	COB
VA/ABC Clinic	Medical	COCS
University Emergency Medical Service	Medical	TAMU
Nuclear Science Center	Nuclear Science	COCS/TAMU
Bluebonnet House Assisted Living	Nursing/Assisted Living Home	COCS
Broadmoor Place	Nursing/Assisted Living Home	COB
Carriage Inn - Bryan	Nursing/Assisted Living Home	COB
Crestview Retirement Community	Nursing/Assisted Living Home	COB
Dansby House	Nursing/Assisted Living Home	COB
Generation Center for Senior Living	Nursing/Assisted Living Home	COB
Hudson Creek Alzheimer's Special Care Center	Nursing/Assisted Living Home	COB
Isle at Water crest - Bryan	Nursing/Assisted Living Home	COB
Lampstand Health & Rehab of Bryan	Nursing/Assisted Living Home	COB
Langford Methodist Retirement Community	Nursing/Assisted Living Home	COCS
Sodalis Senior Living	Nursing/Assisted Living Home	COCS
Waldonbrooke Estates	Nursing/Assisted Living Home	COB
Watercrest At Bryan Tx	Nursing/Assisted Living Home	COB
Waterford at College Station	Nursing/Assisted Living Home	COCS
City of Bryan Police Department	Police Station	COB
City of College Station Police	Police Station	COCS
Brazos County Sheriff's Office	Police Station	COB (BC)
Texas Department of Public Safety	Police Station	COB
University Police Department	Police Station	TAMU

Union Pacific Railroad	Railway bridge	BC, COB, COCS
Burlington Northern Santa Fe	Railway bridge	BC, COB, COCS
A & M Consolidated High School	School	COCS
A&M Consolidated Middle School	School	COCS
Aggieland Country School	School	COCS
Allen Academy	School	COB
Anson Jones Elementary	School	COB
Arthur Davila Middle School	School	COB
Ben Milam Elementary	School	COB
Bonham Elementary	School	COB
Brazos Christian School	School	COB
Bryan Collegiate High School	School	COB
Bryan High School	School	COB
Center For Alternative Learning	School	COCS
College Hills Elementary	School	COCS
College Station High School	School	COCS
College Station Middle School	School	COCS
CornerStone Christian Academy	School	COB
Creekview Elementary School	School	COCS
Crockett Elementary	School	COB
Cypress Grove Intermediate	School	COCS
Disciplinary Alternative Educational Program	School	COB
Fannin Elementary	School	COB
Forest Ridge Elementary School	School	COCS
Greens Prairie Elementary School	School	COCS
Harmony Science Academy	School	COB
Harvey Mitchell Elementary	School	COB
Henderson Elementary	School	COB
IL Texas College Station K-8	School	COCS
IL Texas Aggieland High School	School	COCS
Jane Long Middle	School	COB
Johnson Elementary	School	COB
Kemp Elementary	School	COB
Keystone Montessori School	School	COB
Mary Branch Elementary	School	COB
Mary Catherine Harris School of Choice High School	School	COB
Montessori School House	School	COB

Navarro Elementary	School	COB
Neal Elementary	School	COB
Oakwood Intermediate	School	COCS
O.W. Sadberry Intermediate	School	COB
Pebble Creek Elementary	School	COCS
Rock Prairie Elementary	School	COCS
Rudder High School	School	COB
Sam Houston Elementary	School	COB
Sam Rayburn Middle	School	COB
South Knoll Elementary	School	COCS
Southwood Valley Elementary	School	COCS
Special Opportunity School	School	COB
St. Michaels Academy	School	COB
St. Joseph Catholic School	School	COB
Stephen F Austin Middle	School	COB
Still Creek Christian School	School	BC
Sul Ross Elementary	School	COB
COCS Cell Towers (12)	Services	COCS
COCS Central Park Admin	Services	COCS
COB Electrical Facilities	Services	COB
COCS Electric Facilities (11)	Services	COCS
COCS Lift Stations (17)	Services	COCS
COB Municipal Court	Services	COB
COCS Municipal Court, Public Works, & Fire Administration	Services	COCS
COCS Northgate Parking Garage	Services	COCS
COCS Point Pump Stations (2)	Services	COCS
COCS Utilities, Meeting & Training Facility	Services	COCS
COCS Water Towers (3)	Services	COCS
COCS Wells (7)	Services	COCS
Burton Creek Wastewater Treatment Plant	Wastewater	COB
Still Creek Wastewater Treatment Plant	Wastewater	COB
Thompson Creek Wastewater Treatment Plant	Wastewater	COB
Carter Creek Wastewater Treatment	Wastewater	COCS
COB Still Creek Wastewater Treatment	Wastewater	COB
COB Thompsons Creek Wastewater Treatment Plant	Wastewater	COB
Lick Creek Wastewater Treatment	Wastewater	COCS
Texas A&M University	Wastewater	TAMU

Utilities and Energy Services	Wastewater	TAMU
Legend: COB - City of Bryan, COCS - City of College Station, BC - Brazos County, TAMU - Texas A&M University, WV - City of Wixon Valley, and K - City of Kurten		

Appendix C – Public Survey Questions and Results

Survey Distribution

The Community Survey was distributed to the citizens of Brazos County and participating entities through a variety of means including paper copies distributed at public meetings and events, in public locations such as libraries and City Halls, and digitally through an online form available by hyperlink located on publicly accessible websites. This hyperlink to the online survey was also sent via email to Brazos County employees and employees of the City of Bryan, the City of College Station, and Texas A & M employees. The table below indicates the form of distribution used throughout the planning area.

Survey Data Entry

Responses to the survey submitted via digital means (hyperlinks available on websites and through email) were captured and recorded through the SurveyMonkey website (www.surveymonkey.com/r/BCHMPUpdate) and the Brazos CEOC website (https://brazosceoc.org/brazos-county-resident-hazard-mitigation-action-plan-update-survey/). Responses to the survey submitted via printed means were entered into the digital format of the survey and added to the SurveyMonkey website totals. Currently, the survey is a total of 131 responses (digital and print combined) which were recorded and saved for analysis. It is, however, prudent to mention that the survey will remain open for the foreseeable future so that information is continually collected and assessed as an ongoing method of interacting with the communities.

Website for Public Survey Participation:
https://brazosceoc.org/brazos-county-resident-hazard-mitigation-action-plan-update-survey/

This Survey was offered in English and Spanish.

Q1 Have you ever experienced a natural disaster?

- ○ Yes (1)
- ○ No (2)

Q2 If yes, which natural disasters have you experienced while living in Brazos County? (Check all that apply)

- ☐ Flood (1)
- ☐ Winter Storm (2)
- ☐ Tornado (3)
- ☐ Urban/Wildland Fire (4)
- ☐ Dam Failure (5)
- ☐ Severe Thunderstorm (6)
- ☐ Lightning (7)
- ☐ Hail (8)
- ☐ Drought (9)
- ☐ Excessive/Extreme Heat (10)
- ☐ Other (please specify) (11)

Q3 How concerned are you about the following natural hazards in your area?

	Very (1)	A little (2)	Not at all (3)
Flood (1)	o	o	o
Winter Storm (2)	o	o	o
Tornado (3)	o	o	o
Urban/Wildfire (4)	o	o	o
Dam Failure (6)	o	o	o
Severe Thunderstorm (7)	o	o	o
Lightning (8)	o	o	o
Hail (9)	o	o	o
Drought (10)	o	o	o
Excessive/Extreme Heat (11)	o	o	o
Other (12)	o	o	o

Q4 Does your family plan for any of the following hazards? (Check all that apply)
▢ Flood (1)
▢ Winter Storm (2)
▢ Tornado (3)
▢ Urban/Wildfire (4)
▢ Dam Failure (5)
▢ Severe Thunderstorm (6)
▢ Lightning (7)
▢ Hail (8)
▢ Drought (9)
▢ Excessive/Extreme Heat (10)
▢ Other (11)

Q5 How do you receive warnings and alerts about emergencies? (Check all that apply)
▢ Television (1)
▢ Radio (2)
▢ Brazos County Emergency Notification System (CodeRed) (3)
▢ Texas A&M's Code Maroon Notification System (4)
▢ Blinn Alert Notification System (6)
▢ NOAA Weather Radio (7)
▢ Cell Phone Services / Apps (8)
▢ Social Media (e.g., Facebook, Twitter, etc.) (10)
▢ Cable TV System Alerts (11)
▢ Other (please specify) (12)

Q6 What are the best ways for YOU to get information about hazards and hazard safety? (Check all that apply)
▢ Local Newspaper (1)
▢ Television or Local Cable Channel (2)
▢ Radio (3)
▢ Information on Utility Bills (4)
▢ Direct Mailings (5)
▢ Email (6)
▢ County/City Website (7)
▢ County/City Meetings (8)
▢ School Meetings and/or Messages (9)
▢ Information at Local Library (10)
▢ Roadside Message Boards (11)
▢ Emergency Notification System (Phone or Text Message) (12)
▢ Social Media (e.g., Facebook, Twitter, etc.) (13)
▢ Other (please specify) (14)

Q7 What kind of housing do you have?
O Single-family home (1)
O Duplex (2)
O Apartment (3)
O Condominium or Townhome (4)
O Manufactured Home (Modular) (5)
O Mobile Home or Trailer (6)
O Other (Please specify) (7)

Q8 Is your home in a floodplain?
O Yes (1)
O No (2)
O Unsure (3)

Q9 Flood insurance is available in Brazos County! Do you have flood insurance?

O Yes (1)
O No (2)
O Unsure (3)

Q10 If you do NOT have flood insurance, why? (Check all that apply)
☐ I am not located in a floodplain (1)
☐ I don't experience floods (2)
☐ My home is protected from floods already (3)
☐ It's not required (4)
☐ It's too expensive (5)
☐ I've never thought about it (6)
☐ Other (please specify) (7)

Q11 Think about Brazos County as a whole. How important are the following efforts in your area?

	Very (1)	A little (2)	Not at all (3)
Protecting private property (1)	o	o	o
Protecting critical facilities (e.g., hospitals, fire stations, etc.) (2)	o	o	o
Protecting utilities (3)	o	o	o
Protecting roads and bridges (4)	o	o	o
Preventing development in hazardous areas (5)	o	o	o
Protecting the environment (6)	o	o	o
Protecting cultural and historical landmarks (7)	o	o	o
Improving emergency response (8)	o	o	o
Improving public education on hazards (9)	o	o	o
Identifying hazardous areas with signs (10)	o	o	o

Q12 Are you aware that your local schools, businesses, or churches have emergency plans?
O Yes (1)
O No (2)
O Unsure (3)

Q13 If you want to be notified about Hazard Mitigation Plan public meetings, please enter your contact information.
O Name: (1)
O Phone: (4)
O Email: (5)

Demographic Information (Voluntary)

Q14 How long have you lived in Brazos County?
O 0 - 1 year (1)
O 2 - 5 years (2)
O 6 - 10 years (3)
O 11 - 20 years (4)
O 21 - 30 years (5)
O 30+ years (6)

Q15 What is your zip code?

_____

Q16 Do you rent or own the place you live in?
O Own (1)
O Rent (2)

Q17 How do you identify?
O Male (1)
O Female (2)
O non-binary / third gender (3)
O Prefer not to say (4)

Q18 What is your highest education level?
O No High School Diploma (1)
O High School Diploma / GED (2)
O Some College (3)
O Trade-Specific Certificate / Associate degree (4)
O Bachelor's degree (5)
O Master's degree or Higher (6)

Q19 How many people under age 18 live with you?

_____

Q20 How many people over age 65 live with you?

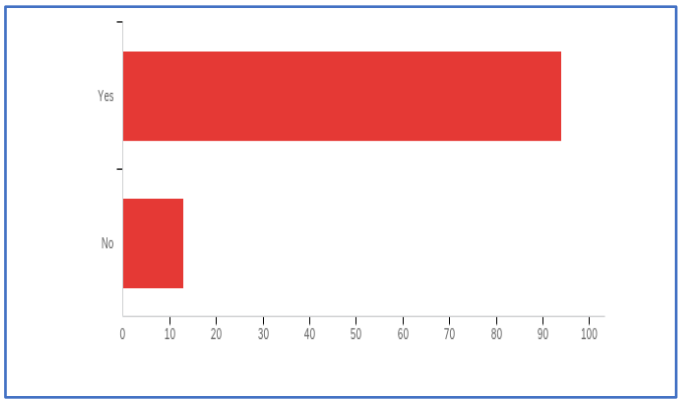
_____

Q21 Please select the option that best describes you:
O White (1)
O Black or African American (2)
O Asian (3)
O Hispanic (4)
O American Indian or Alaskan Native (5)
O Native Hawaiian or Pacific Islander (6)
O Other (please specify) (7)

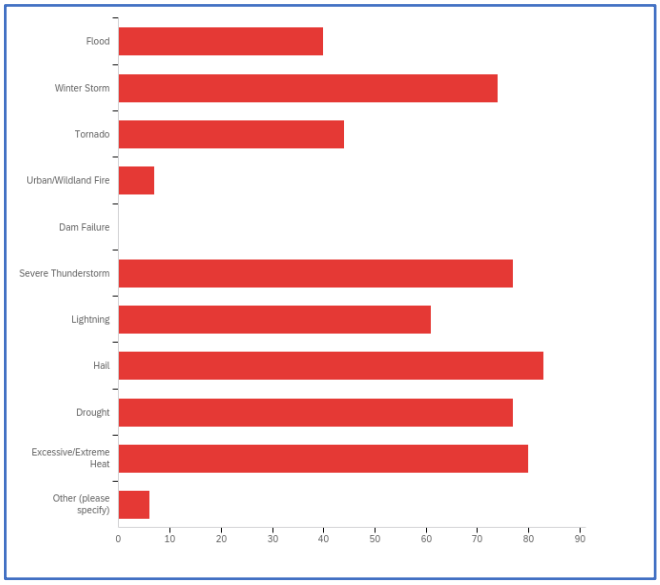
Results Captured from the Surveys (September 2023 – January 2024)

Results are sent and calculated by Texas A & M University for accuracy. *2024-2029 Brazos County HMAP – FINAL - Analyzed on* February 15th, 2024, 9:48 am CST

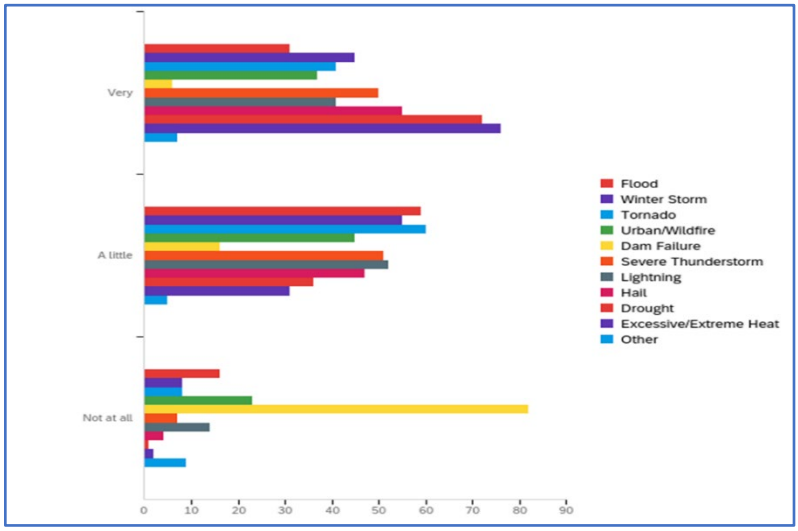
Q1 – Have you experienced a natural disaster?



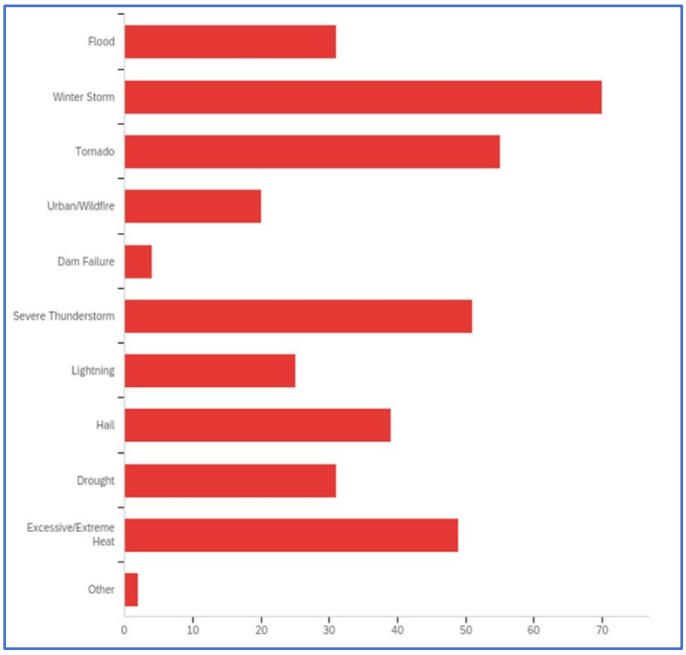
Q2 – If yes, which natural disasters have you experienced while living in Brazos County?



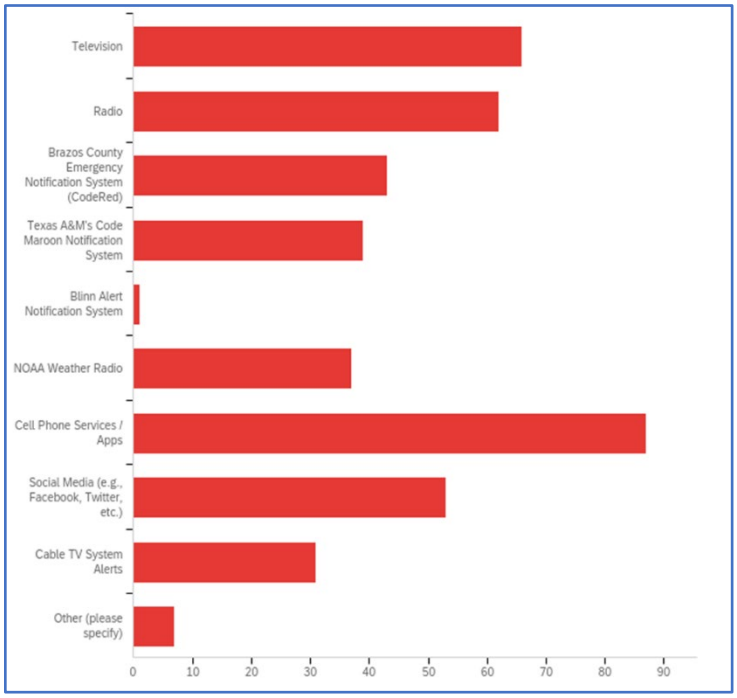
Q3 – How concerned are you about the following natural hazards in your area?



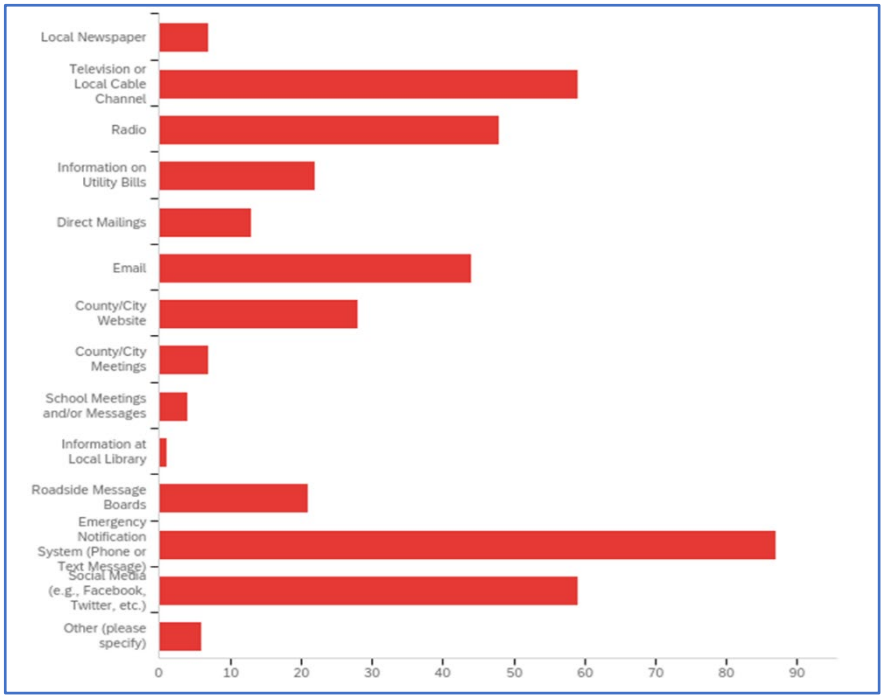
Q4 – Does your family plan for any of the following hazards?



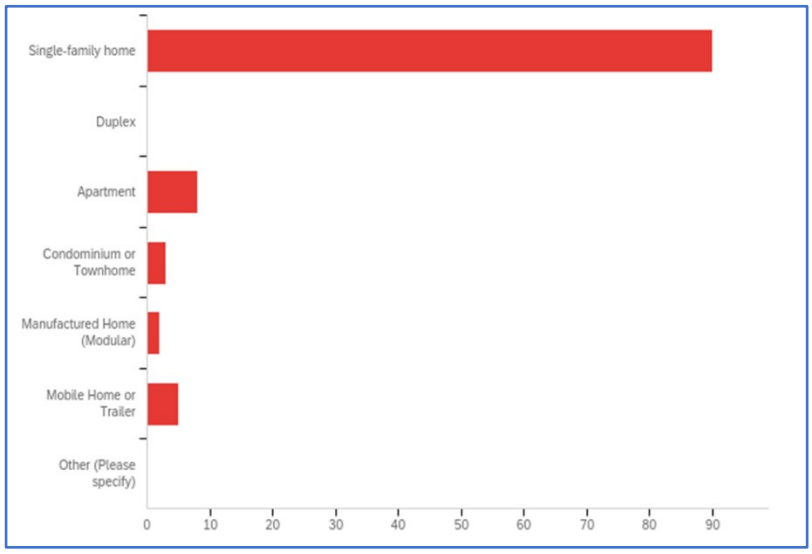
Q5 – How do you receive warnings and alerts about emergencies?



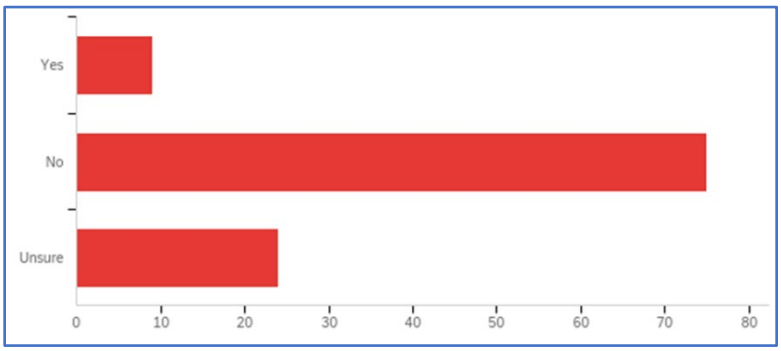
Q6 – What are the best ways for you to get information about hazards and hazard safety.



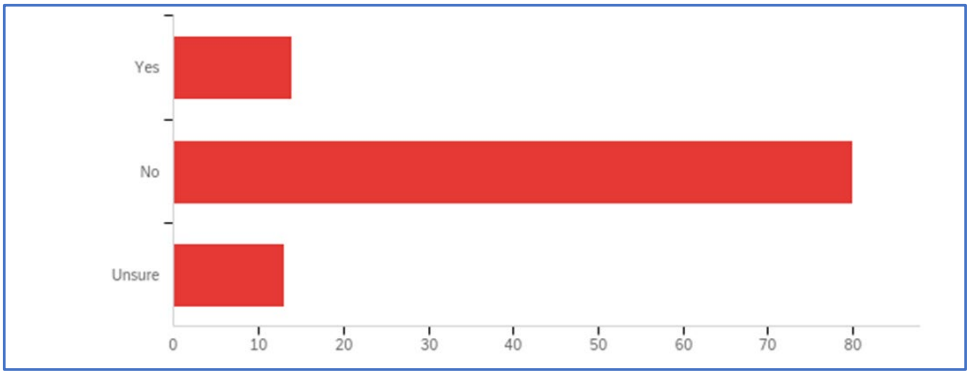
Q7 – What kind of housing do you have?



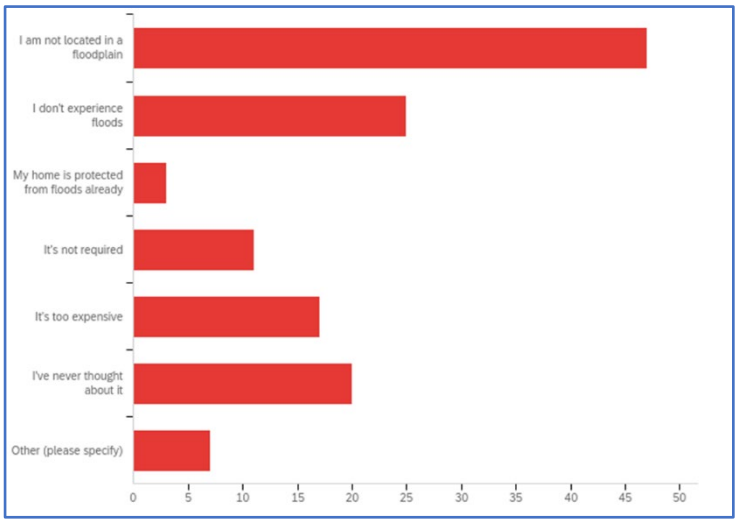
Q8 – Is your home in a floodplain?



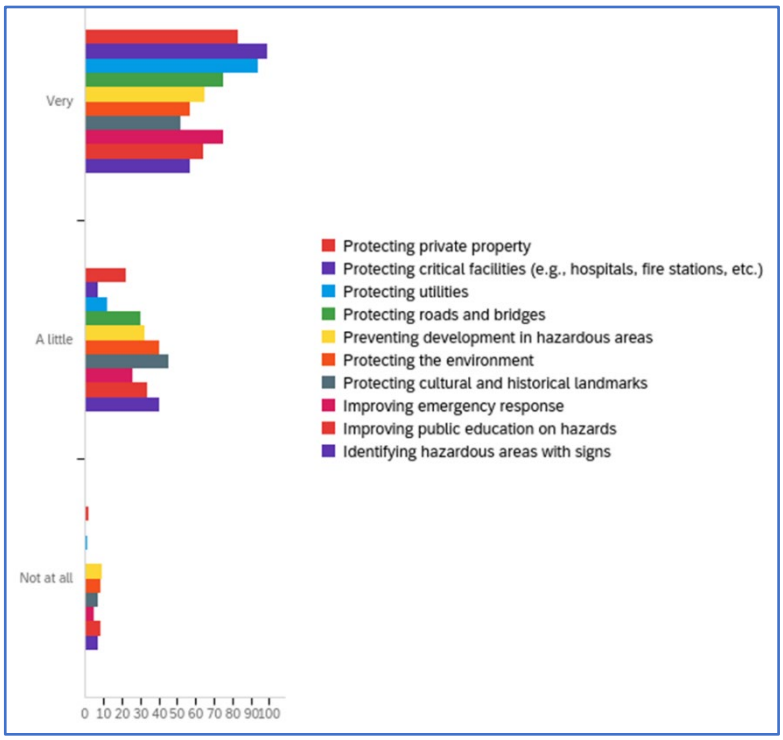
Q9 - Flood insurance is available in Brazos County! Do you have flood insurance?



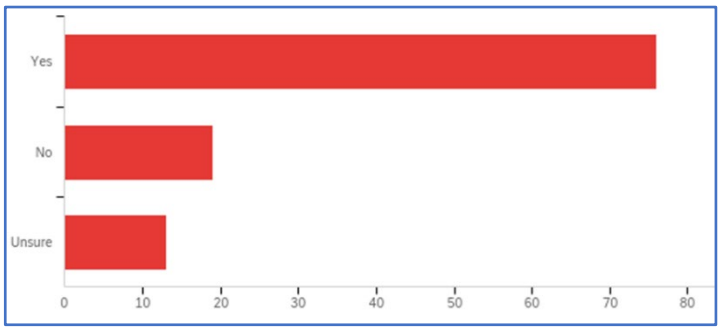
Q10 – If you do not have flood insurance, why?



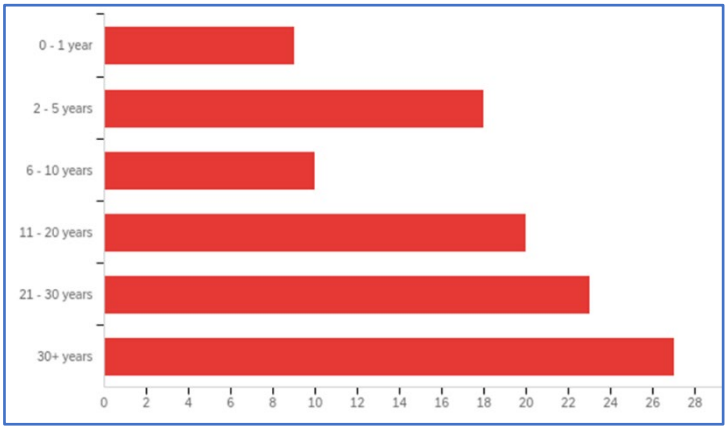
Q11 – Think about Brazos County as a whole. How important are the following efforts in your area?



Q12 - Are you aware that your local schools, businesses, or churches have emergency plans?

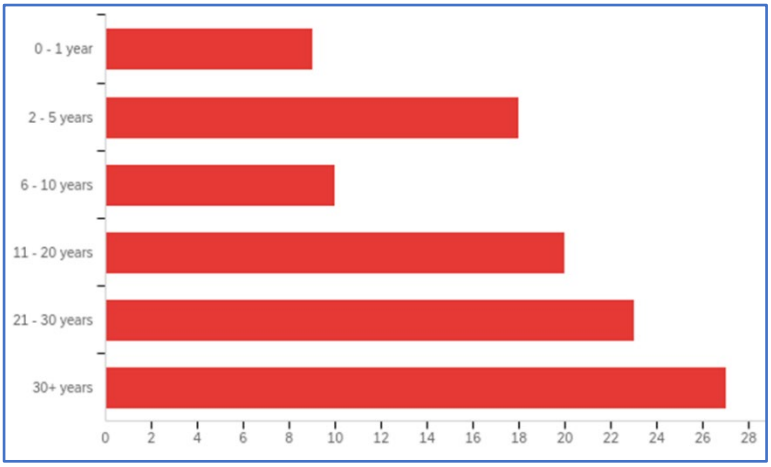


Q13 – How long have you lived in Brazos County?



Demographic Information (Voluntary)

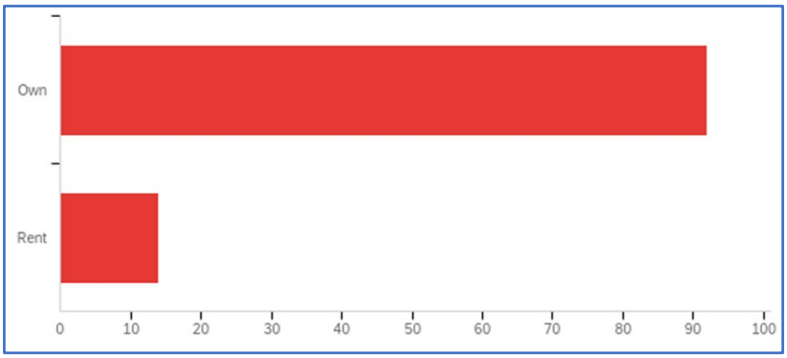
Q14 How long have you lived in Brazos County?



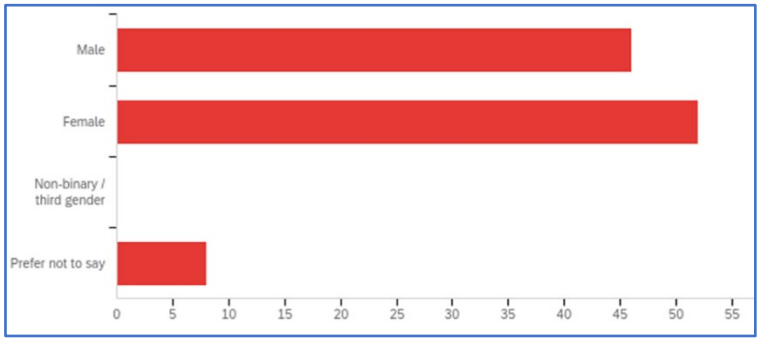
Q15 – What is your zip code?

Zip Code (identified)	Reporting Number
77681	1
77801	3
77802	34
77803	10
77807	8
77808	22
77840	3
77845	21
77859	1
77864	1

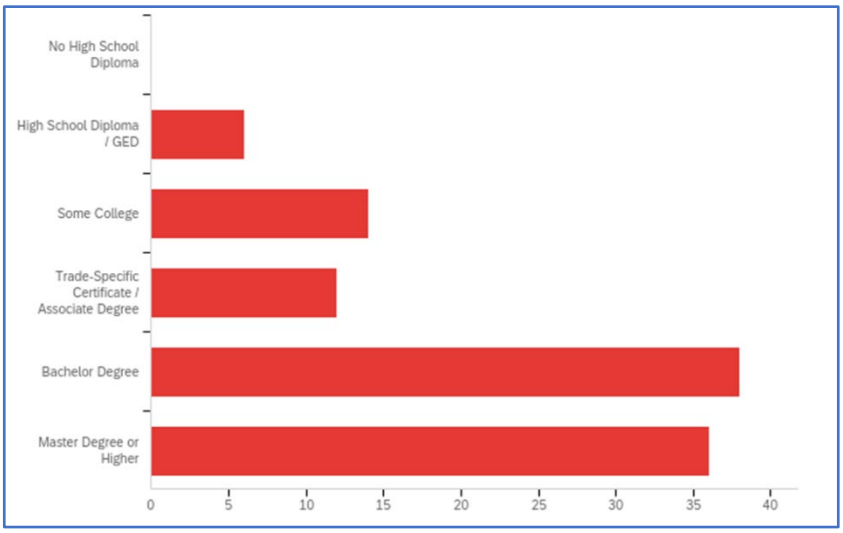
Q16 – Do you rent or own the place you live in?



Q17 – How Do you identify?



Q18 – What is your highest education level?



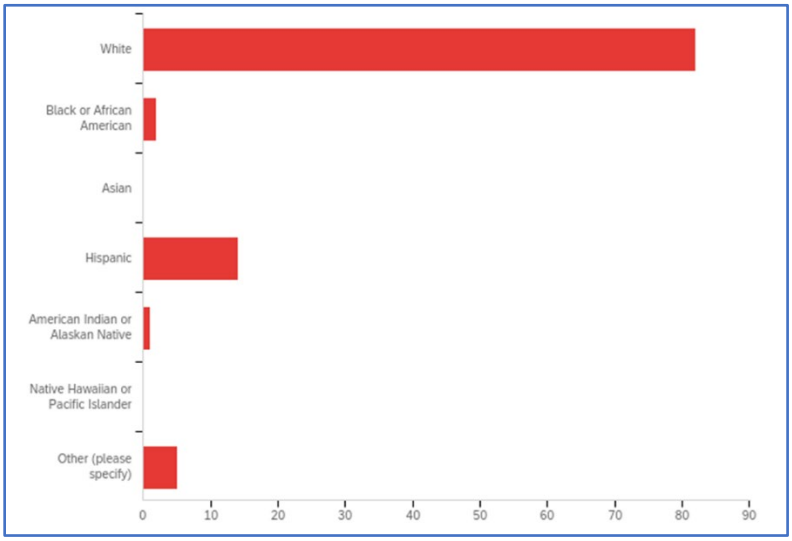
Q19 - How many people under age 18 live with you?

Number	Reporting Number
0	62
1	21
2	7
3	2
4	1
5	0
6	0
7	0
8	0
9	1
10	0

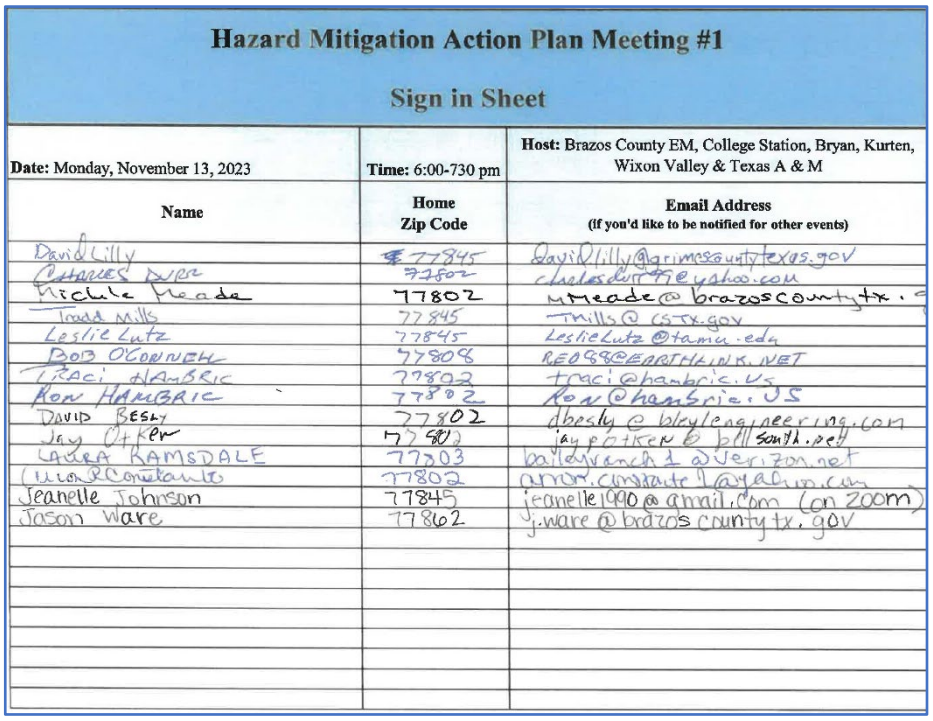
Q20 – How many people over age 65 live with you?

Number	Reporting Number
0	54
1	24
2	9
3	0
4	0
5	0
6	0
7	0
8	0
9	0
10	0

Q21 – Please select the option that best describes you:



Appendix D – Community Meeting Documents



Hazard Mitigation Action Plan Meeting #1

Sign in Sheet

Date: Monday, November 13, 2023	**Time:** 6:00-730 pm	**Host:** Brazos County EM, College Station, Bryan, Kurten, Wixon Valley & Texas A & M
Name	**Home Zip Code**	**Email Address** (If you'd like to be notified for other events)
David Lilly	77845	DavidLilly@brimescountytexas.gov
Charles Dyer	77802	charlesdyer@yahoo.com
Nicole Meade	77802	nmeade@brazoscountytx.g
Todd Mills	77845	TMills@CSTX.gov
Leslie Lutz	77845	LeslieLutz@tamu.edu
Bob O'Connell	77808	REOSSC@EARTHLINK.NET
Traci Hambric	77802	traci@hambric.us
Ron Hambric	77802	Ron@hambric.us
David Besly	77802	dbesly@bkvlengineering.com
Jay Otter	77802	jayotter@bellsouth.net
Laura Ramsdale	77803	bairdranch1@verizon.net
Wilson&Company	77802	arron.christie1@aecom.com
Jeanelle Johnson	77845	jeanelle1990@gmail.com (on Zoom)
Jason Ware	77862	j.ware@brazoscountytx.gov

CEOC

HAZARD MITIGATION ACTION PLAN UPDATE COMMUNITY MEETING AGENDA

Location: Brazos Center

Date: Monday, November 13, 2023

Time: 600 - 730 pm

Facilitator: Brazos County, Cities of Bryan, College Station, Kurten, Wixon Valley, and Texas A & M Emergency Management (a) Entities

Agenda Items

6:00 – 6:30 pm — Sign-In, Refreshments, & Welcome

6:30 – 7:00 — What is the Hazard Mitigation Action Plan and how does it affect you and your community?

7:00 – 7:30 — Questions & Survey

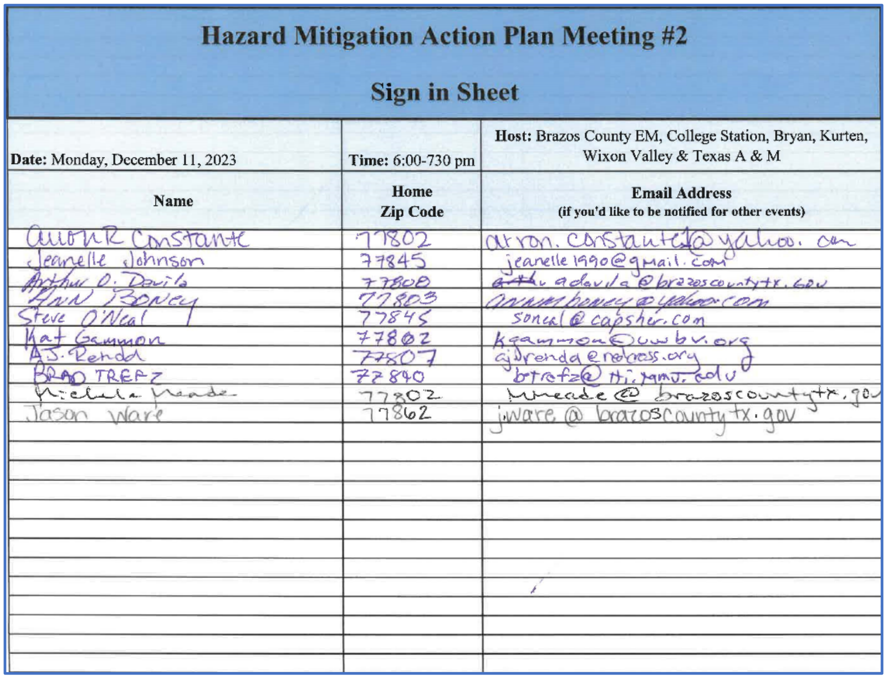
Additional Information

Please feel free to grab refreshments at any time and the bathrooms are located in the main hall entry! Thank you for taking your time to help make our communities and Texas A & M safer!

Public Meeting 1 was held on Monday, November 13, 2023. This meeting was held at the Brazos Center located in Bryan, Texas. This meeting was also hosted through Zoom for those that may not have been able to attend in person.

The meeting invitation was sent out to the Brazos County Employee Network, the Texas A & M Network, The City of Bryan, and College Station Employees. Posted on the CEOC Facebook Page and flyers posted within Brazos County and the participating entities.

Flyers with link for the Hazard Mitigation Action Plan Survey – Posted in Public Areas within Brazos County and the participating entities.



Hazard Mitigation Action Plan Meeting #2

Sign in Sheet

Date: Monday, December 11, 2023	**Time:** 6:00-730 pm	**Host:** Brazos County EM, College Station, Bryan, Kurten, Wixon Valley & Texas A & M
Name	**Home Zip Code**	**Email Address** (if you'd like to be notified for other events)
Aaron R Constante	77802	arron.constante@yahoo.com
Jeanelle Johnson	77845	jeanelle1990@gmail.com
Arthur O. Davila	77808	adavila@brazoscountytx.gov
Ann Boney	77803	annmboney@yahoo.com
Steve O'Neal	77845	soneal@capsher.com
Kat Gammon	77802	kgammon@uwbv.org
AJ. Renda	77807	ajrenda@redcross.org
BRAD TREFZ	77840	btrefz@tti.tamu.edu
Michele Meade	77802	mmeade@brazoscountytx.gov
Jason Ware	77862	jware@brazoscountytx.gov

Public Meeting 2 was held on Monday, December 11, 2023. This meeting was held at the Brazos Center located in Bryan, Texas. This meeting was also hosted through Zoom for those that may not have been able to attend in person.

The meeting invitation was sent out to the Brazos County Employee Network, the Texas A & M Network, The City of Bryan, and College Station Employees. Posted on the CEOC Facebook Page and flyers posted within Brazos County and the participating entities. This meeting was also posted in the local newspaper, "The Eagle" in the Marketplace section on Tuesday December 5, 2023.

Appendix E – Partners in Outreach Meeting Documents

Brazos County and its participating entities work with various partners in outreach within our communities. These partners are volunteer organizations that promote active, timely, and nimble collaborative opportunities with individuals and organizations. Brazos County and its participating entities work closely with these organizations and appreciate their service to the communities and value their suggestions for ideas that we can include in our operations for better outreach and mitigation practices.

Good morning:

First and foremost, I want to start by saying thank you for all that you do for all the residents of Brazos County and your continuing efforts to lift our communities up!

I need to share information about a project the Emergency Management community has been working on. There is a committee that has been working since early last year to update our Brazos County Hazard Action Mitigation Plan. The Hazard Mitigation Action Plan (HMAP) describes the natural hazards/weather (flooding, drought, wildland fire, severe winter weather, tornadoes, hail, thunderstorms and wind, excessive/extreme heat) that impact our community. We have also included a quasi-technological hazard (dam failures) and a chapter on infectious diseases. The Plan identifies actions/projects that can be taken or done to help reduce or eliminate long-term risks to human and animal lives as well as minimize or eliminate damage to properties (both residential and business).

The HMAP is required to be updated and approved by TDEM and FEMA every five years. During the process, it is made available for the public/stakeholders to see, review, and submit comments to Committee members. This document outlines the mitigation information/efforts for Brazos County, the Cities of Bryan, College Station, Kurten Wixon Valley, and Texas A & M University.

We are trying to put the finishing touches on the updated HMAP. But the Committee needs you and your organization's help. FEMA has added a section that requires us to reach out to the organizations in our community that work with the underserved, more vulnerable residents. We are asking you to review the mitigation actions/projects that have been identified for the different hazards and participating entities and let us know if there are other actions/projects that you think would help your organization better serve the underserved/vulnerable residents of Brazos County. I have attached the current project listing for all participating entities. Examples of these mitigation projects that are already included in the actions/project's listings could be: purchasing generators for use on buildings that would be used for sheltering or for cooling/warming centers, fans or blankets that can be distributed to our residents through our VOAD organizations, etc.

In a nutshell, we need your feedback, tell us what you're doing, what you have planned, or what we can do to better assist in your efforts. The Emergency Management Coordinators would be to discuss any ideas you might have. If possible, can you review and provide input by next Monday, February 12th. Please reach out if you have any questions.

Thank you for your time in this matter and we appreciate your feedback!

Michele Bailey-Meade
Emergency Management Coordinator
Brazos County Office of Emergency Management
110 N. Main Street, Suite 100
Bryan, TX 77803
(979) 821-1011 office

Partner Responses

Group Identification	Person/Position Reached	Recommendations/Suggestions	Reasons	In Place?
United Way of Brazos County	Peggi Goss/President & CEO	Infectious Disease Mitigation	We are seeing so many illnesses taking people out right now (flue, strep, covid, etc.). Is it possible to create a few mitigation steps? Possibly something that would encourage people to keep children out of school and assist certain organizations in having the proper equipment to work from home or alternate locations during times of outbreaks.	No
			There should be training in the faith-based community and senior care facilities that could help with mitigation (for illnesses). It seems like the older and vulnerable populations are reverting to the old days/ways, when everyone attends even if they are sick and then infects the compromised/vulnerable population.	
			Schools and critical infrastructure organizations are going back to the emphasis on physical attendance that is a detriment to controlling the spread of any infectious disease.	
St. Vincent DePaul and St. Joseph Health	Pat Schoenemann	Audio Visual Program	Short video PSA type bits that are educational and can be downloaded from a webpage or posted on Facebook or Instagram, would be a great way to reach the public, as opposed to an event-based workshop or expo, which is expensive and has one-time outreach. I can see setting up at expo type events and just playing many such PSA videos and giving out other free items. The first Friday of every month would be a great forum. Free to set up and done year-round, great crowds.	No
			Audio PSAs can be done on radio, and video possibly on cable or streaming services. These may have a long shelf life if they are basic educational bits about Emergency Preparedness Kits, Flood Hazard Mitigation; Tornado Safety, Drought Damage Mitigation, Burn Bans, Foundation Watering, Water Conservation, etc.	No
			You can build a library of digital PSA videos at no cost, and they can be posted on several county and municipal web pages, and possibly on the utility web pages as well. Perhaps, if sponsorship money is needed, the utility companies will be willing to kick in some funding toward this effort and be listed as a film's sponsor.	No
American Red Cross	Sahai Fleurant/Disaster Program Manager	Smoke Detector Program	We would love to continue our smoke detector program with Bryan Fire Department (BFD) and would love to also partner with the College Station Fire Department (CSFD).	Yes
			Utilization of CERT Team for local disaster relief. Also, allowing the CERT Team trained in sheltering and other "volunteer" roles.	No
			Annual Community Awareness Meetings, Red Cross would like to participate and present information on disaster preparedness.	No

Health For All	Elizabeth Dickey, Executive Director	Emergency Preparedness (proposed)	Could we ask students to create tools or conduct workshops tailored for underserved communities, providing information on creating emergency plans, assembling emergency kits, and understanding evacuation procedures?	
		Accessible Transportation Services (proposed)	Collaborate with local transportation providers to ensure accessible and affordable transportation options for vulnerable residents during evacuations or emergency situations.	
		Community Safe Spaces (proposed)	Identify and establish safe spaces within underserved neighborhoods where residents can gather during extreme weather events, offering protection and access to essential resources - most likely churches or community centers.	
		Community Based Early Warning Systems (proposed)	Implement early warning systems within underserved neighborhoods, utilizing community leaders and local communication channels to disseminate timely information about impending disasters. (Again, we would likely begin with churches and community centers.)	
		Information Dissemination (proposed)	We can do a better job of communicating pertinent information to churches, nonprofit listservs, etc. to better communicate with our areas underserved and more vulnerable residents.	
		Information Dissemination (planned)	We post flyers in exam rooms, the lobby, restrooms, etc. to educate and inform patients on issues and services that would benefit them and their families.	
		Medical Health Services (planned)	We provide primary and preventative care for residents as well as assisting in obtaining free or affordable prescriptions. These services are for established patients of the clinic.	
		Medical Health Services (planned)	We provide culturally sensitive counseling and support services for residents dealing with the psychological impact of disasters.	
		Food Security Initiatives	We address food security through our community garden, partnering with the local food bank, and ensuring access to nutritious meals for vulnerable populations.	
		Financial Assistance Programs (future)	Financial assistance programs to help vulnerable residents purchase emergency supplies, make necessary home improvements for disaster resilience, or cover evacuation-related expenses.	
		Home Repair Programs (future)	Assistance programs to help vulnerable residents make necessary home repairs after a disaster.	
Catholic Charities/Salvation Army	Tilly Flores	Response	There are no current actions/projects that are not already in place or proposed. (subject to change)	

Appendix F – Capability Assessment

Texas A & M University

Planning and Regulatory				
Planning/Regulatory Tool	**Capability Type**	**In Place (Y/N) or N/A**	**FT/PT**	**Notes**
Hazard Mitigation Plan	Plans, Education/Outreach, Technical, and Administrative	Y		Shared jurisdictional plan with Brazos County and Cities of Bryan and College Station; available on website; stakeholders included in planning process; staff with skills and resources for mitigation planning and actions.
Emergency Operations Plan	Plans, Administrative, Technical and Education/Outreach	Y		Shared jurisdictional plan with Brazos County and Cities of Bryan and College Station; approved by executive administration; available on website; staff with skills and resources to implement.
Continuity of Operations Plan (COOP)	Plans, Administrative, Technical and Education/Outreach	Y		Overarching campus plan: many departments/units have specific plans; training offered in person and online; staff with skills and resources to implement.
Disaster Recovery Plan	Plans, Technical, and Administrative	Y		Maintained by IT; staff with skills and resources to implement.
Economic Development Plan	Plans, Education and Outreach	Y		Associate VP-level managed; multiple community programs for education.
Stormwater Management Plan	Plans, Technical, and Administrative	Y		Plan maintained by EHS; staff with skills and resources to implement.
Evacuation Plan	Plans, Technical, and Administrative	Y		Building plans have evacuation procedures; staff with skills and resources to implement.
Capital Improvement Plan	Plans and Administrative	Y		System-level, approved by Board of Regents.
Codes and Ordinances				
Code/Ordinance Tool	**Capability Type**	**In Place (Y/N) or N/A**	**FT/PT**	**Notes**
Building Codes	Plans	Y		System provides facility design guidelines.
Fire Department Inspections	Plans; Technical; Administrative	Y		Compliant with NFPA 101 (life safety code); staff with skills and resources to implement.

City of Bryan

Planning and Regulatory				
Planning/Regulatory Tool	**Capability Type**	**In Place (Y/N) or N/A**	**FT/PT**	**Notes**
Hazard Mitigation Plan	Plans, Education/Outreach, Technical, and Administration	Y		Shared jurisdictional plan with Brazos County and Cities of Bryan and College Station; available on website; stakeholders included in planning process; staff with skills and resources for mitigation planning and actions.
Emergency Operations Plan	Plans, Administration, and Technical	Y		Shared jurisdictional plan with Brazos County and Cities of Bryan and College Station; approved by executive administration; available on website; staff with skills and resources to implement.
Comprehensive Land Use Plan	Plans, Administration, and Technical	Y		This Comprehensive Plan assesses the growth that Bryan has experienced and estimates the likely growth that the city will have to manage in the future. New infrastructure and development are required to sustain the built environment and maintain the character and quality of life that make Bryan unique. A current and accurate plan is essential to this process. This Comprehensive Plan provides a vision to guide Bryan's growth and development for the near term and for years to come. https://www.bryantx.gov/planning-and-development-services/long-range-planning/.
National Flood Insurance Program (NFIP)	Plans, Administration, and Technical	Y		Flood Insurance Rate Maps are used to identify flood prone areas and plans are made accordingly with land acquisition, drainage, and collection of rain, as well as considerations made to TXDOT projects within the City of Bryan and their potential to affect flooding in a positive or negative way.
Community Wildfire Protection Plan	Plans	Y		The intent of the COB 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. https://docs.bryantx.gov/fire/Bryan%20Community%20Wildfire%20Protection%20Plan.pdf.
Continuity of Operations Plan (COOP)	Plans, Administration, and Technical	Y		City of Bryan is working to enhance the current COOP plans once grant funds have been identified.
Disaster Recovery Plan	Plans, Administration, and Technical	Y		This is an action item listed in the current Flood Mitigation Plan.
Economic Development Plan	Plans and Finance	Y		Contained in Chapter 2 of the Comprehensive Land Use Plan.
Flood Mitigation Plan	Plans, Administration, and Technical	Y		Contained in Appendix B, Section B.1.3 of the Floodplain Management Plan, "Natural Resource Protection".
Land Acquisition (open space/public recreation)	Plans, Administration, and Technical	Y		Contained in Chapter 8 of the Comprehensive Land Use Plan, "Parks, Recreation, and Open Space".
Stormwater Management Plan	Plans, Administration, and Technical	Y		https://docs.bryantx.gov/water/stormwater/accessible/COB_SWMP_2020.pdf and https://docs.bryantx.gov/engineering/Report.pdf. and https://library.municode.com/tx/bryan/codes/code_of_ordinances?nodeId=PTIICOOR_CH46STMA.
Evacuation Plan	Plans, Administration, and Technical	Y		Multi-Agency evacuation plan contained in Emergency Management Annex E: Evacuation.
Capital Improvement Plan	Plans and Administrative	Y		Rolling 5-year CIP that is updated every 2 years.
Historic Preservation Plan	Plans	Y		Planning staff updated the plan in June 2023, and it is maintained by development services.
Natural Resources Protection Plan	Plans	Y		Contained in Appendix B, Section B.1.3 of the Floodplain Management Plan, "Natural Resource Protection".
Codes and Ordinances				
Code/Ordinance Tool	**Capability Type**	**In Place (Y/N) or N/A**	**FT/PT**	**Notes**

Floodplain Management Ordinance/NFIP Compliance	Plans	Y		Contained in the FMP: https://docs.bryantx.gov/engineering/FMP.pdf.
Building Codes	Plans	Y		The COB has adopted the 2021 International Building Code and International Roofing Resiliency Code to assist with insurance and mitigation strategies.
Fire Department Inspections	Plans, Administration, and Technical	Y		Managed by the City Fire Marshal's Office.
International Property Maintenance Code	Plans, Administration, and Technical	Y		Managed by the City Fire Marshal's Office.
Hazard Specific Ordinances	Plans, Administration, and Technical	Y		Code of ordinances at https://library.municode.com/tx/bryan/codes/code_of_ordinances?nodeId=14054.
Site Plan Development Review Ordinances	Plans; Technical; Administrative	Y		Code of ordinances at https://library.municode.com/tx/bryan/codes/code_of_ordinances?nodeId=14054.
Subdivision Development Review Ordinances	Plans, Administration, and Technical	Y		Code of ordinances at https://library.municode.com/tx/bryan/codes/code_of_ordinances?nodeId=14054.
Zoning Ordinances	Plans, Administration, and Technical	Y		Code of ordinances at https://library.municode.com/tx/bryan/codes/code_of_ordinances?nodeId=14054.
Code of Ordinances	Plans, Administration, and Technical	Y		Code of ordinances at https://library.municode.com/tx/bryan/codes/code_of_ordinances?nodeId=14054.
Post Disaster Redevelopment Ordinance	Plans, Administration, and Technical	Y		Contained in the Floodplain Management Plan, Appendix B.1.4 "Emergency Services Measures." This is something that will be enhanced from recent lessons learned - tornado, winter storms, etc.

Administrative and Technical				
Administrative/Technical Tool	**Capability Type**	**In Place (Y/N) or N/A**	**FT/PT**	**Notes**
Engineering Department	Administration and Engineering Services	Y	Y	W. Paul Kaspar, P.E., City Engineer. Engineering Department Manager. https://www.bryantx.gov/engineering-services/.
Code Enforcement Department	Administration and Code Enforcement	Y	Y	The City of Bryan Code Enforcement Department is responsible for handling code violations. The city is divided into 10 zones, or areas, each of which has one officer assigned to handle all violations within that zone. https://www.bryantx.gov/codeenforcement/.
Board of Education	Bryan Independent School District	Y	Y	The Bryan ISD Board of Trustees are elected leaders who establish policies and regulations to operate the school district. They also identify district needs and goals, conduct elections, approve employee certified personnel, adopt the district budget, approve the district tax rate, approve purchase of property, award bids, approve building plans, accept projects, serve as an appellate body, and serve on standing committees. https://www.bryanisd.org/o/bisd/page/board-of-trustees.
Emergency Management	BC CEOC	Y	Y	Emergency Management Coordinator - Jeanelle Johnson - johnsonj@bryantx.gov (subject to change).
Maintenance Department	Facility Services	Y	Y	Marcus Walker. Parks Operations and Facility Services Manager. 979-209-5522.
Mitigation Implementation Team	BC CEOC	Y	Y	Emergency Management Coordinator - Jeanelle Johnson - johnsonj@bryantx.gov (subject to change).
Mutual Aid Agreements	BC CEOC	Y	Y	Emergency Management Coordinator - Jeanelle Johnson - johnsonj@bryantx.gov (subject to change).
Planning Commission/Zoning Board	Planning and Development Services	Y	Y	Planning and Development. 979-209-5030. planning@bryantx.gov/Building Permits and Inspections. 979-209-5030. building@bryantx.gov (subject to change).
Public Utility Board (s)	Administration	Y	Y	The BTU Board was created in 2001 by Ordinance of the Bryan City Council to oversee the operations of the electric utility and is appointed by the City Council. Https://www.btutilities.com/about-btu/leadership/.
Public Works Department	Public Works	Y	Y	City of Bryan Public Works Department (979) 209-5900.

Purchasing Department	Purchasing Services	Y	Y	Purchasing Services is responsible for procuring goods and services for all city departments and performing these purchases in accordance with state and local requirements. Phebe Mosley. Manager. 979-209-5500. purchasingweb@bryantx.gov.
Civil Engineer/Construction Management	Administration and Engineering Services	Y	Y	W. Paul Kaspar, P.E., City Engineer. Engineering Department Manager. https://www.bryantx.gov/engineering-services/.
Grant Administrator	Finance	Y	Y	Fiscal Services. 979-209-5080.
Grant Writer	COB Employees (Departments Vary)	Y	Y	COB employees are responsible for finding, writing, filing, and dispersing grant(s) as pertains to their department or service.
Financial				
Financial Tool	**Capability Type**	**In Place (Y/N) or N/A**	**FT/PT**	**Notes**
Capital Improvements Program	Plans, Administration, and Technical	Y		Rolling 5-year CIP that is updated every 2 years.
Community Development Block Grant	Plans, Administration, and Technical	N		Did not pursue for current grant cycle but being considered for new fiscal year.
FEMA - Public Assistance 406 Mitigation	Plans, Administration, and Technical	Y		Multiple projects open and closed.
Funding Programs (State)	Plans, Administration, and Technical	Y		Public safety funding provided through OOG and TFS.
Education and Outreach				
Education/Outreach Tool	**Capability Type**	**In Place (Y/N) or N/A**	**FT/PT**	**Notes**
Storm Ready Certification	Plans, Administration, and Technical	N		The City of Bryan is pursuing this through National Weather Service.
Seasonal Emergency Management and Mitigation Outreach	BC CEOC	Y		Emergency Management Coordinator - Jeanelle Johnson - johnsonj@bryantx.gov (subject to change).
Fire Wise USA Certification	Plans, Administration, and Technical	Y		City Marshall's Office.
Local Citizen Groups or Non-Profit Organizations	BC CEOC	Y		Managed through partnerships, Agreements with VOADS.
Environmental Protection	Public Works	Y		City of Bryan Public Works Department (979) 209-5900.
Emergency Preparedness	BC CEOC	Y		Emergency Management Coordinator - Jeanelle Johnson - johnsonj@bryantx.gov (subject to change).
Access and Functional Needs	Plans, Administration, and Technical	Y		STEAR Data Custodian.
Natural Disaster or Safety Related School Programs	Bryan Independent School District	Y		The Bryan ISD Board of Trustees are elected leaders who establish policies and regulations to operate the school district. They also identify district needs and goals, conduct elections, approve employee certified personnel, adopt the district budget, approve the district tax rate, approve purchase of property, award bids, approve building plans, accept projects, serve as an appellate body, and serve on standing committees. https://www.bryanisd.org/o/bisd/page/board-of-trustees.
Ongoing Public Education or Information Programs	BC CEOC	Y		Emergency Management Coordinator - Jeanelle Johnson - johnsonj@bryantx.gov (subject to change).
Environmental Education	Public Works	Y		City of Bryan Public Works Department (979) 209-5900.
Fire Safety	Plans, Administration, and Technical	Y		City Marshall's Office.
Household Preparedness	BC CEOC	Y		Managed through partnerships, mostly American Red Cross.

Responsible Water Use	Public Works	Y		City of Bryan Public Works Department (979) 209-5900.
Public/Private Partnership initiatives addressing disaster-related issues	BC CEOC	Y		Emergency Management Coordinator - Jeanelle Johnson - johnsonj@bryantx.gov (subject to change).

City of College Station

Planning and Regulatory				
Planning/Regulatory Tool	**Capability Type**	**In Place (Y/N) or N/A**	**FT/PT**	**Notes**
Hazard Mitigation Plan	Plans, Education/Outreach, Technical, and Administration	Y		Shared jurisdictional plan with Brazos County and Cities of Bryan and College Station; available on website; stakeholders included in planning process; staff with skills and resources for mitigation planning and actions.
Emergency Operations Plan	Plans, Administration, and Technical	Y		Shared jurisdictional plan with Brazos County and Cities of Bryan and College Station; approved by executive administration; available on website; staff with skills and resources to implement.
Comprehensive Land Use Plan	Plans, Administration, and Technical	Y		The strategic guide that expresses the values and aspirations of our community is called the Comprehensive Plan. It is the broadest public policy document that our community creates. It establishes a long-range vision for College Station's growth and development, housing, mobility, parks, the environment, economic development, city-provided infrastructure and services, and other related topics. The College Station Comprehensive Plan acts as a guidebook for decision-makers and is implemented over time through ordinances, infrastructure investments, and other public and private development decisions. The Comprehensive Plan includes, among other components, Future Land Use and Thoroughfare Plans.
National Flood Insurance Program (NFIP)	Plans, Administration, and Technical	Y		Flood Insurance Rate Maps are used to identify flood prone areas and plans are made accordingly with land acquisition, drainage, and collection of rain, as well as considerations made to TXDOT projects within the City of College Station and their potential to affect flooding in a positive or negative way.
Community Wildfire Protection Plan	Plans, Administration, and Technical	Y		A CWPP can help protect against the threats of wildfire and reduce losses. By developing a CWPP, the COCS in outlining a strategic plan to mitigate, prepare, respond, and recover.
Continuity of Operations Plan (COOP)	Plans, Administration, and Technical	Y		When a natural or human-caused disaster strikes, city services are extremely vulnerable to disruptions at the very time when they are needed most. Having viable Continuity of Operations (COOP) plans that allow the City of College Station to operate under the most adverse conditions is critical, not only to continuing essential services, but also to maintaining public confidence. Intelligent and thorough planning— specifically, tailored COOP plans can help to ensure the city's ability to rebound quickly and effectively after a disruption event.
Economic Development Plan	Plans and Finance	Y		The College Station Economic Development Master Plan was adopted by the city council in 2020 and guides the community's economic development path for the next 5-10 years. The intent of the master planning process is to ensure growth and development advance the city's economic development objectives.
Flood Mitigation Plan	Plans, Administration, and Technical	Y		This article is adopted under the authority of the Constitution and laws of the State and pursuant to the provisions of the Charter of the City. (Code 2011 (Repub.), § 13-1(A)) State Law reference— Flood Control and Insurance Act, Texas Water Code § 16.311 et seq.; governing body required to adopt ordinances or orders necessary to participate in National Flood Insurance Program, Texas Water Code § 16.3145; responsibility to establish flood hazard regulations, Texas Water Code § 16.315.
Transportation Plan	Transportation Division	Y		The Transportation Planning Division is responsible for leading the long range and short-range planning efforts related to multi-modal transportation and providing support as different aspects of the transportation system are implemented through land acquisition and the development review process. The Thoroughfare Plan provides a long-term vision of the major street network necessary to meet future travel needs. The Thoroughfare Plan locates and classifies major streets by access to adjacent land use, mobility for through traffic, and context.
Stormwater Management Plan	Plans, Administration, and Technical	Y		The City of College Station developed a city-wide Stormwater Management Program in accordance with the requirements published in the MS4 General Permit TXR040000 for obtaining authorization for stormwater discharges and certain non-stormwater discharges. The SWMP has been developed to facilitate the City's efforts in reducing stormwater pollutants from the City's MS4 to the maximum extent practicable.
Capital Improvement Plan	Plans and Administrative	Y		The City of College Station has a five-year Capital Improvement Plan that addresses infrastructure needs in College Station resulting from growth and aging existing infrastructure. General government capital projects include streets, parks, and public facilities.

Codes and Ordinances				
Code/Ordinance Tool	**Capability Type**	**In Place (Y/N) or N/A**	**FT/PT**	**Notes**
Floodplain Management Ordinance/NFIP Compliance	Plans	Y		This article is adopted under the authority of the Constitution and laws of the State and pursuant to the provisions of the Charter of the City. (Code 2011 (Repub.), § 13-1(A)) State Law reference— Flood Control and Insurance Act, Texas Water Code § 16.311 et seq.; governing body required to adopt ordinances or orders necessary to participate in National Flood Insurance Program, Texas Water Code § 16.3145; responsibility to establish flood hazard regulations, Texas Water Code § 16.315.
Building Codes	Plans	Y		The COB has adopted the 2021 International Building Code and International Roofing Resiliency Code to assist with insurance and mitigation strategies. For additional information or questions, please contact Building Official, Brian Binford at bbinford@cstx.gov or 979.764.3570. (subject to change).
Fire Department Inspections	Plans, Administration, and Technical	Y		The Fire Marshal's Office performs pre-construction site reviews and inspections, fire alarm and sprinkler systems plan review, inspection and testing, fire safety inspections for commercial occupancies (as well as daycare centers, foster homes, and health care facilities), and fire cause investigations. Criteria for all reviews and inspections are based upon the 2021 International Fire Code, the Unified Development Ordinance, and adopted amendments.
International Property Maintenance Code	Plans, Administration, and Technical	Y		The City of College Station has adopted the family of International Building Codes to regulate construction. You can view a copy of these codes in our office. We have adopted the following which came into effect on June 1, 2022. https://www.cstx.gov/departments___city_hall/pds/regulations/building_codes.
Site Plan Development Review Ordinances	Plans	Y		The city has also adopted local changes or amendments to some of the codes listed below. You may access our local amendments to each code by clicking on "Adopted Amendments". https://www.cstx.gov/departments___city_hall/pds/regulations/udo.
Subdivision Development Review Ordinances	Plans	Y		The Unified Development Ordinance (UDO)contains all development regulations in one document and includes regulations pertaining to zoning and use, platting, site plan development, and building permits. The UDO also includes an overview of the development review bodies, review procedures, zoning districts, use regulations, development standards, and non-conformities. https://www.cstx.gov/departments___city_hall/pds/regulations/udo.
Zoning Ordinances	Plans	Y		The Unified Development Ordinance (UDO)contains all development regulations in one document and includes regulations pertaining to zoning and use, platting, site plan development, and building permits. The UDO also includes an overview of the development review bodies, review procedures, zoning districts, use regulations, development standards, and non-conformities. https://www.cstx.gov/departments___city_hall/pds/regulations/udo.

Administrative and Technical				
Administrative/Technical Tool	**Capability Type**	**In Place (Y/N) or N/A**	**FT/PT**	**Notes**
Engineering Department	Engineering Department	Y	Y	Carol Cotter, P.E., CFM, City Engineer. ccotter@cstx.gov (subject to change).
Code Enforcement Department	Code Enforcement Division	Y	Y	The Code Enforcement Division is the "one stop shop" for premise code enforcement issues. 979-764-6363 or codeenforcement@cstx.gov (subject to change).
Board of Education	College Station Independent School District	Y	Y	The seven-member College Station ISD Board of Trustees all serve for three-year terms in large positions. The CSISD Board of Trustees meets the third Tuesday of each month unless otherwise indicated on the meeting schedule. https://www.csisd.org/board.
Emergency Management	BC CEOC	Y	Y	Tradd Mills. Emergency Management Coordinator. tmills@cstx.gov (subject to change).

Maintenance Department	Public Works Department	Y	Y	The Public Works Department consists of the following divisions: Administration, Drainage Maintenance, Facilities Maintenance, Fleet Maintenance, Landscape and Irrigation Maintenance, Solid Waste and Recycling Collections, Streets Maintenance, and Traffic Engineering, Signals, Signs and Markings. The department has held the prestigious American Public Works Association (APWA) accreditation since 2012. pubworks@cstx.gov (subject to change).
Mitigation Implementation Team	BC CEOC and City Manager	Y	Y	Emergency Management Coordinator - Tradd Mills - tmills@cstx.gov (subject to change).
Mutual Aid Agreements	BC CEOC and City Manager	Y	Y	Emergency Management Coordinator - Tradd Mills - tmills@cstx.gov (subject to change).
Planning Commission/Zoning Board	Planning and Development	Y	Y	Planning and Development Services. 979-764-3570. cspds@cstx.gov.
Public Utility Board (s)	College Station Utilities	Y	Y	College Station Utilities is a leading utility providing high-quality, customer-owned services to citizens. We provide electric, water and wastewater services, and manage a 24-hour dispatch for residential and commercial customers in College Station. 979.764.3535 (subject to change).
Public Works Department	Public Works Department	Y	Y	The Public Works Department consists of the following divisions: Administration, Drainage Maintenance, Facilities Maintenance, Fleet Maintenance, Landscape and Irrigation Maintenance, Solid Waste and Recycling Collections, Streets Maintenance, and Traffic Engineering, Signals, Signs and Markings. The department has held the prestigious American Public Works Association (APWA) accreditation since 2012. (subject to change).
Purchasing Department	Purchasing Division	Y	Y	The City of College Station Purchasing Division is committed to procuring goods and services in a manner that provides for free and unrestricted competition while ensuring the taxpayers the best possible return on and use of their tax dollars. All procurement activities shall be in compliance with all City policies and applicable local, state, and federal laws. Lisa D. Davis, CPM, APP. Purchasing Manager. ldavis@cstx.gov (subject to change).
Civil Engineer/Construction Management	Administration	Y	Y	David Vaughn, CFM, Engineering Program Specialist. Dvaughn.cstx.gov (subject to change).
Grant Administrator	Administration	Y	Y	Fiscal Services.
Grant Writer	COCS Employees (Each Department Vary)	Y	Y	COCS employees are responsible for finding, writing, filing, and dispersing grant(s) as pertains to their department or service.
Financial				
Financial Tool	**Capability Type**	**In Place (Y/N) or N/A**	**FT/PT**	**Notes**
Capital Improvements Program	Plans, Administration, and Technical	Y		The City of College Station has a five-year Capital Improvement Plan that addresses infrastructure needs in College Station resulting from growth and aging existing infrastructure. General government capital projects include streets, parks, and public facilities.
Community Development Block Grant	Plans, Administration, and Technical	N		Did not pursue for current grant cycle but being considered for new fiscal year.
FEMA - Hazard Mitigation Assistance	Plans, Administration, and Technical	Y		Multiple projects open and closed.
FEMA - Public Assistance 406 Mitigation	Plans, Administration, and Technical	Y		Public safety funding provided through OOG and TFS.
Education and Outreach				
Education/Outreach Tool	**Capability Type**	**In Place (Y/N) or N/A**	**FT/PT**	**Notes**
Storm Ready Certification	Emergency Management and City Manager	Y		On Feb. 28, 2008, the City of College Station received a Storm Ready® Certification.

Seasonal Emergency Management and Mitigation Outreach	BC CEOC	Y		Emergency Management Coordinator - Tradd Mills - tmills@cstx.gov (subject to change).
Fire Wise USA Certification	Plans, Administration, and Technical	Y		City Fire Marshall's Office.
Local Citizen Groups or Non-Profit Organizations	VOADS	Y		National VOAD, American Red Cross, FB - ARC Bryan, Brazos ARES, Brazos Valley CERT, Brazos Valley Food Bank, FB - The Salvation Army, Texas Methodist Men Disaster Relief, and The United Way of the Brazos Valley.
Environmental Protection	Public Works	Y		The Public Works Department consists of the following divisions: Administration, Drainage Maintenance, Facilities Maintenance, Fleet Maintenance, Landscape and Irrigation Maintenance, Solid Waste and Recycling Collections, Streets Maintenance, and Traffic Engineering, Signals, Signs and Markings. The department has held the prestigious American Public Works Association (APWA) accreditation since 2012. (subject to change).
Emergency Preparedness	BC CEOC	Y		Emergency Management Coordinator - Tradd Mills - tmills@cstx.gov (subject to change).
Access and Functional Needs	Plans, Administration, and Technical	Y		STEAR Data Custodian.
Natural Disaster or Safety Related School Programs	College Station Independent School District	Y		The seven-member College Station ISD Board of Trustees all serve for three-year terms in large positions. The CSISD Board of Trustees meets the third Tuesday of each month unless otherwise indicated on the meeting schedule. https://www.csisd.org/board.
Ongoing Public Education or Information Programs	BC CEOC	Y		Emergency Management Coordinator - Tradd Mills - tmills@cstx.gov (subject to change).
Environmental Education	Public Works	Y		The Public Works Department consists of the following divisions: Administration, Drainage Maintenance, Facilities Maintenance, Fleet Maintenance, Landscape and Irrigation Maintenance, Solid Waste and Recycling Collections, Streets Maintenance, and Traffic Engineering, Signals, Signs and Markings. The department has held the prestigious American Public Works Association (APWA) accreditation since 2012. (subject to change).
Fire Safety	Plans, Administration, and Technical	Y		City Fire Marshall's Office.
Household Preparedness	BC CEOC	Y		Managed through partnerships, mostly American Red Cross.
Responsible Water Use	Public Works Department	Y		The Public Works Department consists of the following divisions: Administration, Drainage Maintenance, Facilities Maintenance, Fleet Maintenance, Landscape and Irrigation Maintenance, Solid Waste and Recycling Collections, Streets Maintenance, and Traffic Engineering, Signals, Signs and Markings. The department has held the prestigious American Public Works Association (APWA) accreditation since 2012. (subject to change).
Public/Private Partnership initiatives addressing disaster-related issues	BC CEOC	Y		Emergency Management Coordinator - Tradd Mills - tmills@cstx.gov (subject to change).

City of Wixon Valley

Planning and Regulatory				
Planning/Regulatory Tool	**Capability Type**	**In Place (Y/N) or N/A**	**FT/PT**	**Notes**
Hazard Mitigation Plan	Plans and Administration	Y		Shared jurisdictional plan with Brazos County and Cities of Bryan, Wixon Valley, Kurten and College Station; available on website; stakeholders included in planning process; staff with skills and resources for mitigation planning and actions.
Emergency Operations Plan	Plans and Administration	Y		Shared jurisdictional plan with Brazos County and Cities of Bryan, Wixon Valley, Kurten, and College Station; approved by executive administration; available on website; staff with skills and resources to implement.
National Flood Insurance Program (NFIP)	Plans and Administration	Y		Flood Insurance Rate Maps are used to identify flood prone areas and plans are made accordingly with land acquisition, drainage, and collection of rain, as well as considerations made to TXDOT projects within the City of College Station and their potential to affect flooding in a positive or negative way.
Community Wildfire Protection Plan	Plans and Administration	Y		A CWPP can help protect against the threats of wildfire and reduce losses. By developing a CWPP, the COCS in outlining a strategic plan to mitigate, prepare, respond, and recover. Being developed for Brazos County to include the City of Wixon Valley and the City of Kurten.
Disaster Recovery Plan	Plans, Administration, and Emergency Management	Y		Emergency Management Annex J - Recovery https://bcdem.org/emergency/plans.
Economic Development Plan	Plans and Administration	Y		The purpose of the CEDs is to serve as the guide in the continuing successful economic development projects, the facilitation of new projects, and establishing economic recovery based on analysis of the region's economic situation because of the COVID -19 pandemic. https://www.bvcog.org/Portals/0/Economic%20Dev/CEDS/Final_2021CEDS.pdf.
Transportation Plan	Plans and Administration	Y		Emergency Management Annex S - Transportation https://bcdem.org/emergency/plans.
Stormwater Management Plan	Plans and Administration	Y		To the extent allowable by State and local law, Brazos County SWMP was developed and will be implemented according to requirements of TPDES General Permit TXR 040000, for discharges of stormwater to surface water in the State. This SWMP was developed to prevent pollution in storm drainage systems to the maximum extent practicable.
Evacuation Plan	Plans, Administration, and Emergency Management	Y		Emergency Management Annex E - Evacuation https://bcdem.org/emergency/plans.
Codes and Ordinances				
Code/Ordinance Tool	**Capability Type**	**In Place (Y/N) or N/A**	**FT/PT**	**Notes**
Floodplain Management Ordinance/NFIP Compliance	Plans and Administration	Y		This involves a combination of flood mitigation, emergency management, flood forecasting and warning measures, land-use planning, and infrastructure design considering the local flood situation and the associated hazards.
Administrative and Technical				
Administrative/Technical Tool	**Capability Type**	**In Place (Y/N) or N/A**	**FT/PT**	**Notes**
Board of Education	Bryan Independent School District	Y	FT	Wixon Valley is served by Bryan Independent School District (BISD).
Emergency Management	BC CEOC and City Mayor	Y	FT	Emergency Management Director/Mayor - Jim Soefje wixonvalley@gmail.com (subject to change).

Mutual Aid Agreements	BC CEOC and City Mayor	Y	FT	Emergency Management Director/Mayor - Jim Soefje wixonvalley@gmail.com (subject to change). Intra- Brazos County Agreement.
Public Utility Board (s)	Administration	Y	PT	Wickson Creek SUD.
Purchasing Department	Administration	Y	PT	All purchases for the City of Wixon Valley are approved by the Mayor and City Council.
Financial				
Financial Tool	**Capability Type**	**In Place (Y/N) or N/A**	**FT/PT**	**Notes**
Funding Programs (Federal) - NON- FEMA	Administration	Y		ARPA Funds Received.
Education and Outreach				
Education/Outreach Tool	**Capability Type**	**In Place (Y/N) or N/A**	**FT/PT**	**Notes**
Seasonal Emergency Management and Mitigation Outreach	Administration	Y		Use of Social Media Accounts for the City of Wixon Valley and National Night Out. https://www.facebook.com/WixonValleyTX/.
Local Citizen Groups or Non-Profit Organizations	Administration	Y		Use of Social Media Accounts for the City of Wixon Valley and National Night Out. https://www.facebook.com/WixonValleyTX/.
Emergency Preparedness	BC CEOC and City Mayor	Y		Use of Social Media Accounts for the City of Wixon Valley and National Night Out. https://www.facebook.com/WixonValleyTX/.
Natural Disaster or Safety Related School Programs	Administration	Y		Use of Social Media Accounts for the City of Wixon Valley and National Night Out. https://www.facebook.com/WixonValleyTX/.
Ongoing Public Education or Information Programs	Administration	Y		Use of Social Media Accounts for the City of Wixon Valley and National Night Out. https://www.facebook.com/WixonValleyTX/.
Fire Safety	Administration	Y		Use of Social Media Accounts for the City of Wixon Valley and National Night Out. https://www.facebook.com/WixonValleyTX/.
Household Preparedness	Administration	Y		Use of Social Media Accounts for the City of Wixon Valley and National Night Out. https://www.facebook.com/WixonValleyTX/.
Responsible Water Use	Administration	Y		Wickson Creek SUD.

City of Kurten

Planning and Regulatory				
Planning/Regulatory Tool	**Capability Type**	**In Place (Y/N) or N/A**	**FT/PT**	**Notes**
Hazard Mitigation Plan	Plans and Administration	Y		Shared jurisdictional plan with Brazos County and Cities of Bryan, Wixon Valley, Kurten and College Station; available on website; stakeholders included in planning process; staff with skills and resources for mitigation planning and actions.
Emergency Operations Plan	Plans and Administration	Y		Shared jurisdictional plan with Brazos County and Cities of Bryan, Wixon Valley, Kurten, and College Station; approved by executive administration; available on website; staff with skills and resources to implement.
Comprehensive Land Use Plan	Plans and Administration	N		Discussions are underway to develop a plan.
National Flood Insurance Program (NFIP)	Plans and Administration	Y		Flood Insurance Rate Maps are used to identify flood prone areas and plans are made accordingly with land acquisition, drainage, and collection of rain, as well as considerations made to TXDOT projects within the City of College Station and their potential to affect flooding in a positive or negative way.
Community Wildfire Protection Plan	Plans and Administration	Y		A CWPP can help protect against the threats of wildfire and reduce losses. By developing a CWPP, the COCS in outlining a strategic plan to mitigate, prepare, respond, and recover. Being developed for Brazos County to include the City of Wixon Valley and the City of Kurten.
Disaster Recovery Plan	Plans, Administration, and Emergency Management	Y		Emergency Management Annex J - Recovery https://bcdem.org/emergency/plans.
Economic Development Plan	Plans and Administration	Y		The purpose of the CEDs is to serve as the guide in the continuing successful economic development projects, the facilitation of new projects, and establishing economic recovery based on analysis of the region's economic situation as a result of the COVID - 19 pandemic. https://www.bvcog.org/Portals/0/Economic%20Dev/CEDS/Final_2021CEDS.pdf.
Flood Mitigation Plan	Plans and Administration	Y		This involves a combination of flood mitigation, emergency management, flood forecasting and warning measures, land-use planning, and infrastructure design considering the local flood situation and the associated hazards.
Transportation Plan	Plans and Administration	Y		Emergency Management Annex S - Transportation https://bcdem.org/emergency/plans.
Stormwater Management Plan	Plans and Administration	Y		To the extent allowable by State and local law, Brazos County SWMP was developed and will be implemented according to requirements of TPDES General Permit TXR 040000, for discharges of stormwater to surface water in the State. This SWMP was developed to prevent pollution in storm drainage systems to the maximum extent practicable.
Evacuation Plan	Plans and Administration	Y		Emergency Management Annex E - Evacuation https://bcdem.org/emergency/plans.
Codes and Ordinances				
Code/Ordinance Tool	**Capability Type**	**In Place (Y/N) or N/A**	**FT/PT**	**Notes**
Floodplain Management Ordinance/NFIP Compliance	Plans and Administration	Y		This involves a combination of flood mitigation, emergency management, flood forecasting and warning measures, land-use planning, and infrastructure design considering the local flood situation and the associated hazards.
Site Plan Development Review Ordinances	Plans and Administration	Y		Ordinance #17 - City of Kurten (Oct 2012) This Ordinance classifies and regulates the use of land and structures within the city limits of Kurten, as hereinafter set forth. https://www.kurtentexas.com/wp-content/uploads/2021/08/cokzoningordinance.pdf.
Subdivision Development Review Ordinances	Plans and Administration	Y		Ordinance #4 - Subdivision and Development Regulations - https://www.kurtentexas.com/wp-content/uploads/2021/08/Kurten-Ordinance-4.pdf.

Zoning Ordinances	Plans and Administration	Y		Ordinance #17 - City of Kurten (Oct 2012) This Ordinance classifies and regulates the use of land and structures within the city limits of Kurten, as hereinafter set forth. https://www.kurtentexas.com/wp-content/uploads/2021/08/cokzoningordinance.pdf.
Administrative and Technical				
Administrative/Technical Tool	**Capability Type**	**In Place (Y/N) or N/A**	**FT/PT**	**Notes**
Code Enforcement Department	Administration	Y	FT	Planning and Zoning Personnel.
Board of Education	Bryan Independent School District	Y	FT	Kurten is served by Bryan Independent School District (BISD).
Emergency Management	BC CEOC and City Mayor	Y	FT	Emergency Management Director/Mayor Chris Court - chris.court@kurten.texas.gov (subject to change).
Mutual Aid Agreements	BC CEOC and City Mayor	Y	FT	Emergency Management Director/Mayor Chris Court - chris.court@kurten.texas.gov (subject to change). Intra-Brazos County Agreement.
Purchasing Department	Administration	Y	PT	All purchases for the City of Kurten are approved by the City Council.
Grant Administrator	Grant Works and Administration	Y	PT	3rd Party Contractor - Grant Works.
Grant Writer	Grant Works and Administration	Y	PT	3rd Party Contractor - Grant Works.
Financial				
Financial Tool	**Capability Type**	**In Place (Y/N) or N/A**	**FT/PT**	**Notes**
Funding Programs (Federal) - NON-FEMA	Administration	Y		ARPA Funds Received.
Impact fees for new development	Administration	Y		Several fees depend on developments requested.
Education and Outreach				
Education/Outreach Tool	**Capability Type**	**In Place (Y/N) or N/A**	**FT/PT**	**Notes**
Seasonal Emergency Management and Mitigation Outreach	Administration	Y		Use of Social Media Accounts for the City of Kurten. https://www.kurtentexas.com/.
Emergency Preparedness	BC CEOC and City Mayor	Y		Use of Social Media Accounts for the City of Kurten. https://www.kurtentexas.com/.
Ongoing Public Education or Information Programs	Administration	Y		Use of Social Media Accounts for the City of Kurten. https://www.kurtentexas.com/.
Environmental Education	Administration	Y		Use of Social Media Accounts for the City of Kurten. https://www.kurtentexas.com/.
Fire Safety	Administration	Y		Use of Social Media Accounts for the City of Kurten. https://www.kurtentexas.com/.
Household Preparedness	Administration	Y		Use of Social Media Accounts for the City of Kurten. https://www.kurtentexas.com/.
Responsible Water Use	Administration	Y		Wickson Creek SUD.

Brazos County

Planning and Regulatory				
Planning/Regulatory Tool	**Capability Type**	**In Place (Y/N) or N/A**	**FT/PT**	**Notes**
Hazard Mitigation Plan	Plans, Administration, and Emergency Management	Y		Shared jurisdictional plan with Brazos County and Cities of Bryan, Wixon Valley, Kurten and College Station; available on website; stakeholders included in planning process; staff with skills and resources for mitigation planning and actions.
Emergency Operations Plan	Plans, Administration, and Emergency Management	Y		Shared jurisdictional plan with Brazos County and Cities of Bryan, Wixon Valley, Kurten, and College Station; approved by executive administration; available on website; staff with skills and resources to implement.
National Flood Insurance Program (NFIP)	Brazos County Road & Bridge	Y		Flood Insurance Rate Maps are used to identify flood prone areas and plans are made accordingly with land acquisition, drainage and collection of rain, as well as considerations made to TXDOT projects within Brazos County and participating entities and their potential to affect flooding in a positive or negative way.
Disaster Recovery Plan	Plans, Administration, and Emergency Management	Y		Emergency Management Annex J - Recovery https://bcdem.org/emergency/plans.
Economic Development Plan	Brazos Valley Council of Government (BVCOG)	Y		The purpose of the CEDs is to serve as the guide in the continuing successful economic development projects, the facilitation of new projects, and establishing economic recovery based on analysis of the region's economic situation as a result of the COVID - 19 pandemic. https://www.bvcog.org/Portals/0/Economic%20Dev/CEDS/Final_2021CEDS.pdf.
Flood Mitigation Plan	Brazos County Road & Bridge	Y		This involves a combination of flood mitigation, emergency management, flood forecasting and warning measures, land-use planning, and infrastructure design considering the local flood situation and the associated hazards.
Transportation Plan	Plans and Administration	Y		Emergency Management Annex S - Transportation https://bcdem.org/emergency/plans.
Stormwater Management Plan	Brazos County Road & Bridge	Y		To the extent allowable by State and local law, Brazos County SWMP was developed and will be implemented according to requirements of TPDES General Permit TXR 040000, for discharges of stormwater to surface water in the State. This SWMP was developed to prevent pollution in storm drainage systems to the maximum extent practicable.
Evacuation Plan	Plans, Administration, and Emergency Management	Y		Emergency Management Annex E - Evacuation https://bcdem.org/emergency/plans.
Capital Improvement Plan	Plans, County Judges Office, and County Commissioners.	Y		The CIP is a five-year infrastructure plan which matches the County's highest priority capital needs with a financing schedule. The CIP includes building, remodeling, and upgrading of public facilities and infrastructure systems. https://brazoscountytx.gov/609/Capital-Improvement-Program.
Codes and Ordinances				
Code/Ordinance Tool	**Capability Type**	**In Place (Y/N) or N/A**	**FT/PT**	**Notes**
Floodplain Management Ordinance/NFIP Compliance	Brazos County Road & Bridge	Y		This involves a combination of flood mitigation, emergency management, flood forecasting and warning measures, land-use planning, and infrastructure design considering the local flood situation and the associated hazards.
Building Codes	Brazos County Road & Bridge	Y		On 1 September 2009, Brazos County adopted the 2003 International Residential Code and the 2002 National Electrical Code. Proof of construction compliance with these codes in the unincorporated areas of BC is required. More information is through the Brazos County Road & Bridge for permitting requirements related to driveways/culverts

				and for permitting requirements related to development in the floodplain. https://brazoscountytx.gov/455/Land-Development.
Subdivision Development Review Ordinances	Brazos County Road & Bridge	Y		These regulations have been prepared in general to aid in the orderly development of Brazos County, Texas. And provide guidelines which will lead to a desirable environment. Effective Date: 5 July 2016. https://www.brazoscountytx.gov/DocumentCenter/View/896/Sudivision-and-Development-Regs?bidId.
Zoning Ordinances	Brazos County Road & Bridge	Y		On September 1, 2009, BC adopted the 2003 International Residential Code and the 2002 National Electrical Code. Proof of Construction Compliance with these codes in the unincorporated areas of BC is required. https://brazoscountytx.gov/DocumentCenter/View/1330/Memorandum-Development-Requirements?bidId.
Administrative and Technical				
Administrative/Technical Tool	**Capability Type**	**In Place (Y/N) or N/A**	**FT/PT**	**Notes**
Engineering Department	Brazos County Road & Bridge	Y	FT	County Engineer - Prarthana Banerji - pbanerji@brazoscountytx.gov (subject to change).
Emergency Management	Plans, Administration, and Emergency Management	Y	FT	Emergency Management Coordinator - Michele Meade - emc@bcdem.org (subject to change).
Maintenance Department	County Court	Y	FT	Building Maintenance.
Mitigation Implementation Team	Plans, Administration, and Emergency Management	Y	FT	Emergency Management Coordinator - Michele Meade - emc@bcdem.org (subject to change)
Mutual Aid Agreements	Plans, Administration, and Emergency Management	Y	FT	Emergency Management Coordinator - Michele Meade - emc@bcdem.org (subject to change).
Purchasing Department	County Court	Y	FT	Purchasing Agent.
Civil Engineer/Construction Management	Brazos County Road & Bridge	Y	FT	County Engineer.
Grant Administrator	Administration Services	Y	FT	This unit, consisting of various administrative staff, is primarily responsible for five major functions: administration and management of grants, policy and procedure, annual budgets, residential and nonresidential contracts, and maintenance of department facilities.
Grant Writer	BC Employees (Each Department Vary) and Grant Works	Y	PT	BC employees are responsible for finding, writing, filing, and dispersing grant(s) as pertains to their department or service and 3rd Party Contractor - Grant Works.
Financial				
Financial Tool	**Capability Type**	**In Place (Y/N) or N/A**	**FT/PT**	**Notes**
Funding Programs	Administration Services	Y		ARPA Funds Received.
Funding Programs (State)	Administration Services	Y		Law Enforcement, Public Defenders
Capital Improvements Program	Plans, County Judges Office, and County Commissioners.	Y		Enacted in 2023. The CIP is a five-year infrastructure plan which matches the County's highest priority capital needs with a financing schedule. The CIP includes building, remodeling, and upgrading of public facilities and infrastructure systems. https://brazoscountytx.gov/609/Capital-Improvement-Program.
Education and Outreach				
Education/Outreach Tool	**Capability Type**	**In Place (Y/N) or N/A**	**FT/PT**	**Notes**

Seasonal Emergency Management and Mitigation Outreach	Plans, Administration, and Emergency Management	Y		BC CEOC hosts platforms on Facebook, and a CEOC website that distributes seasonal mitigation information as well as mitigation outreach. https://brazosceoc.org/info and National Night Out.
Local Citizen Groups or Non-Profit Organizations	VOADS	Y		National VOAD, American Red Cross, FB - ARC Bryan, Brazos ARES, Brazos Valley CERT, Brazos Valley Food Bank, FB - The Salvation Army, Texas Methodist Men Disaster Relief, and The United Way of the Brazos Valley.
Emergency Preparedness	Plans, Administration, and Emergency Management	Y		BC CEOC hosts platforms on Facebook, and a CEOC website that distributes seasonal mitigation information as well as mitigation outreach. https://brazosceoc.org/info and National Night Out.
Access and Functional Needs	Plans, Administration, and Emergency Management	Y		BC CEOC hosts platforms on Facebook, and a CEOC website that distributes seasonal mitigation information as well as mitigation outreach. https://brazosceoc.org/info and National Night Out.
Ongoing Public Education or Information Programs	Plans, Administration, and Emergency Management	Y		BC CEOC hosts platforms on Facebook, and a CEOC website that distributes seasonal mitigation information as well as mitigation outreach. https://brazosceoc.org/info and National Night Out.
Fire Safety	Plans, Administration, and Emergency Management	Y		BC CEOC hosts platforms on Facebook, and a CEOC website that distributes seasonal mitigation information as well as mitigation outreach. https://brazosceoc.org/info and National Night Out.
Household Preparedness	Plans, Administration, and Emergency Management	Y		BC CEOC hosts platforms on Facebook, and a CEOC website that distributes seasonal mitigation information as well as mitigation outreach. https://brazosceoc.org/info and National Night Out.

Appendix G – Previous Mitigation Actions (2019-2024)

Projects 2019 - 2024				
Hazard	**Jurisdiction**	**Mitigation Action**	**Completed?**	**If not, why?**
Floods	All participating entities (Brazos County; Cities of Bryan, College Station, Kurten, Wixon Valley; and TAMU)	Develop an annual public hazards workshop or expo for all residents to educate them on flooding hazards, National Flood Insurance Program and develop methods to mitigate damage to personal properties from flooding.	Not completed	Source of funding not identified and inadequate staffing.
	All participating entities (Brazos County; Cities of Bryan, College Station, Kurten, Wixon Valley; and TAMU)	Purchase generators for critical facilities.	Not completed	Source of funding not identified and inadequate staffing.
	All participating entities (Brazos County; Cities of Bryan, College Station, Kurten, Wixon Valley; and TAMU)	Build, renovate, rehabilitate, or convert a building or buildings for use as emergency shelters for individuals and families.	Not completed	Source of funding not identified and inadequate staffing.
	Brazos County	Do a hydrology study of the watersheds that exist in Brazos County that contribute to flooding during heavy rain incidents.	Not completed	Source of funding not identified and inadequate staffing.
	City of Bryan	Create 2D "rain on mesh" model to better identify flooding hazards outside of riverine areas (local flooding hazards).	Completed	Completed.
	City of Bryan	Create a map showing low water crossings in the City of Bryan. The results of the flood mapping will be used to prioritize low water crossing replacements/improvements.	Ongoing	Ongoing.
	City of Bryan	Perform detailed studies of areas prone to flooding to determine the most cost-effective means to reduce potential loss. The flood studies will be used to prevent new buildings from being built in the flood hazard area.	Ongoing	Ongoing.
	City of Bryan	Purchase or elevate existing properties subject to repetitive loss or serious repetitive losses.	Not completed	Source of funding not identified and inadequate staffing.
	City of Bryan	Replace drainage culverts identified in Stormwater Master Plan to improve their efficiency.	Ongoing	Ongoing.
	College Station	Continue to enforce building codes and STP's.	Ongoing	Continuous.
	College Station	Improve flood risk assessment.	Ongoing	Continuous.
	City of Kurten	Join the National Flood Insurance Program so residents can be eligible for flood insurance.	Ongoing	Ongoing.
	City of Wixon Valley	Include space for a shelter in the new City Hall.	Ongoing	Ongoing.
	`	Design and construct detention ponds to control runoff of rainwater from Texas A&M University property.	Ongoing	Continuous.
Drought	All participating entities (Brazos County; Cities of Bryan, College Station, Kurten, Wixon Valley; and TAMU)	Develop an annual public hazards workshop or expo for all residents to educate them on drought and develop methods to mitigate damage to personal properties from drought.	Not completed	Source of funding not identified and inadequate staffing.
	All participating entities (Brazos County; Cities of Bryan, College Station, Kurten, Wixon Valley; and TAMU)	Purchase generators for critical facilities.	Not completed	Source of funding not identified and inadequate staffing.
	All participating entities (Brazos County; Cities of Bryan, College Station, Kurten, Wixon Valley; and TAMU)	Create a series of PSA's/outreach for topics such as burn bans, foundation watering how to's, water conservation in times of drought.	Not completed	Source of funding not identified and inadequate staffing.
	City of Bryan	Aquifer storage and recovery (ASR).	Not completed	Source of funding not identified and inadequate staffing.
	College Station	Monitor water supply.	Ongoing	Continuous.
	College Station	Educate residents on water saving techniques.	Ongoing	Continuous.

	Texas A&M University	Incorporate drought tolerant practices into landscaping of current and new open spaces to reduce dependence on irrigation.	Completed	Completed.
Wildland Fires	All participating entities (Brazos County; Cities of Bryan, College Station, Kurten, Wixon Valley; and TAMU)	Develop an annual public hazards workshop or expo for all residents to educate them on wildfires, the hazards associated with wildfires, and develop methods to mitigate damage to personal properties from wildfires. Additionally, educate residents about the need for and creation of preparedness kits.	Not completed	Source of funding not identified and inadequate staffing.
	All participating entities (Brazos County; Cities of Bryan, College Station, Kurten, Wixon Valley; and TAMU)	Purchase generators for critical facilities.	Not completed	Source of funding not identified and inadequate staffing.
	All participating entities (Brazos County; Cities of Bryan, College Station, Kurten, Wixon Valley; and TAMU)	Build, renovate, rehabilitate, or convert a building or buildings for use as emergency shelters for individuals and families.	Not completed	Source of funding not identified and inadequate staffing.
	Brazos County; Cities of Kurten and Wixon Valley	Develop wildfire plan (CWPP) for the unincorporated areas of Brazos County, to also include the cities of Kurten and Wixon Valley.	Some work done, but not completed	Source of funding not identified and inadequate staffing.
	City of Bryan	Obtain updated low level aerial photography and topographic mapping within the city limits and ETJ. Imagery can be used to delineate areas susceptible to urban/wildland fire hazards.	Completed	Completed.
	City of Bryan	Update/maintain wildfire plan (CWPP).	Ongoing	Ongoing.
	City of Bryan	Work with Red Cross to initiate a smoke alarm program.	Ongoing	Ongoing.
	College Station	Map and assess vulnerability to wildfire.	Ongoing	Continuous.
	College Station	Increase wildfire risk awareness.	Ongoing	Continuous.
	City of Wixon Valley	Purchase and install flagpole and burn ban warning flags.	Ongoing	Ongoing.
	City of Wixon Valley	Install/expand City of Wixon Valley hydrant coverage.	Ongoing	
	Texas A&M University	Continue to enhance and improve the fire inspection program.	Ongoing	Continuous.
Severe Winter Storms	All participating entities (Brazos County; Cities of Bryan, College Station, Kurten, Wixon Valley; and TAMU)	Develop an annual public hazards workshop or expo for all residents to educate them on winter storms, the hazards associated with winter storms, and develop methods to mitigate damage to personal properties from winter storms. Additionally, educate residents about the need for and creation of preparedness kits.	Not completed	Source of funding not identified and inadequate staffing.
	All participating entities (Brazos County; Cities of Bryan, College Station, Kurten, Wixon Valley; and TAMU)	Purchase generators for critical facilities.	Not completed	Source of funding not identified and inadequate staffing.
	All participating entities (Brazos County; Cities of Bryan, College Station, Kurten, Wixon Valley; and TAMU)	Build, renovate, rehabilitate, or convert a building or buildings for use as emergency shelters for individuals and families.	Not completed.	Source of funding not identified and inadequate staffing.
	City of Bryan	Create an SOP for winter storm events including roadway safety, power outages, etc.	Not completed	Source of funding not identified and inadequate staffing.
	City of Bryan	Maintain hazardous weather condition information on the city's website, including closures, safety tips, etc.	Ongoing	Ongoing.
	College Station	Conduct winter weather risk awareness activities.	Ongoing	Continuous.
	College Station	Assist vulnerable populations.	Ongoing	Continuous.
Tornadoes	All participating entities (Brazos County; Cities of Bryan, College Station, Kurten, Wixon Valley; and TAMU)	Develop an annual public hazards workshop or expo for all residents to educate them on tornadoes, the hazards associated with tornadoes, and develop methods to mitigate damage to personal properties from tornadoes. Additionally, educate residents about the need for and creation of preparedness kits.	Not completed	Source of funding not identified and inadequate staffing.

	All participating entities (Brazos County; Cities of Bryan, College Station, Kurten, Wixon Valley; and TAMU)	Purchase generators for critical facilities.	Not completed	Source of funding not identified and inadequate staffing.
	All participating entities (Brazos County; Cities of Bryan, College Station, Kurten, Wixon Valley; and TAMU)	Build, renovate, rehabilitate, or convert a building or buildings for use as emergency shelters for individuals and families.	Not completed	Source of funding not identified and inadequate staffing.
	All participating entities (Brazos County; Cities of Bryan, College Station, Kurten, Wixon Valley; and TAMU)	Purchase generators for critical facilities.	Not completed	Source of funding not identified and inadequate staffing.
	All participating entities (Brazos County; Cities of Bryan, College Station, Kurten, Wixon Valley; and TAMU)	Build, renovate, rehabilitate, or convert a building or buildings for use as emergency shelters for individuals and families.	Not completed	Source of funding not identified and inadequate staffing.
	City of Bryan	Maintain hazardous weather condition information on the city's website and PSA's, including closures, safety tips, etc.	Ongoing	Ongoing.
	City of Bryan	Create PSA's, procedures to provide to residents regarding cleanup/permit requirements after incidents, and information on choosing contractors.	Ongoing	Ongoing.
	College Station	Encourage construction of safety rooms.	Ongoing	Continuous.
	College Station	Conduct tornado awareness activities.	Ongoing	Continuous.
	Texas A&M University	Enhance building emergency plans to include "areas of refuge".	Ongoing	Continuous.
Hail	All participating entities (Brazos County; Cities of Bryan, College Station, Kurten, Wixon Valley; and TAMU)	Develop an annual public hazards workshop or expo for all residents to educate them on storms that produce hail, the hazards associated with storms that produce hail, and develop methods to mitigate damage to personal properties from storms that produce hail. Additionally, educate residents about the need for and creation of preparedness kits.	Not completed	Source of funding not identified and inadequate staffing.
	All participating entities (Brazos County; Cities of Bryan, College Station, Kurten, Wixon Valley; and TAMU)	Purchase generators for critical facilities.	Not completed	Source of funding not identified and inadequate staffing.
	All participating entities (Brazos County; Cities of Bryan, College Station, Kurten, Wixon Valley; and TAMU)	Build, renovate, rehabilitate, or convert a building or buildings for use as emergency shelters for individuals and families.	Not completed	Source of funding not identified and inadequate staffing.
	City of Bryan	Maintain hazardous weather condition information on the city's website and PSA's, including closures, safety tips, etc.	Ongoing	Ongoing.
	City of Bryan	Create PSA's, procedures to provide to residents regarding cleanup/permit requirements after events and choosing contractors.	Ongoing	Ongoing.
	College Station	Locate safe rooms to minimize damage.	Ongoing	Continuous.
	College Station	Increase hail awareness.	Ongoing	Continuous.
	City of Kurten	Create mailouts and/or social media messages that provide information to residents regarding the use of weather radios, teach residents about the dangers of lightning and safety precautions to take when severe weather and lightning threatens.	Ongoing	Ongoing.
Thunderstorms (to include lightning and windstorm)	All participating entities (Brazos County; Cities of Bryan, College Station, Kurten, Wixon Valley; and TAMU)	Develop an annual public hazards workshop or expo for all residents to educate them on thunderstorms that produce lightning and excessive winds, the hazards associated with storms that produce lightning and excessive winds and develop methods to mitigate damage to personal properties from storms that produce lightning and excessive winds. Additionally, educate residents about the need for and creation of preparedness kits.	Not completed	Source of funding not identified and inadequate staffing.
	All participating entities (Brazos County; Cities of Bryan, College Station, Kurten, Wixon Valley; and TAMU)	Purchase generators for critical facilities.	Not completed	Source of funding not identified and inadequate staffing.

	All participating entities (Brazos County; Cities of Bryan, College Station, Kurten, Wixon Valley; and TAMU)	Build, renovate, rehabilitate, or convert a building or buildings for use as emergency shelters for individuals and families.	Not completed	Source of funding not identified and inadequate staffing.
	City of Bryan	Maintain hazardous weather condition information on the city's website and PSA's, including closures, safety tips, etc.	Ongoing	Ongoing.
	City of Bryan	Install detectors in areas where there may be significant numbers of residents congregating outside (pools, parks, etc.).	Ongoing	Ongoing.
	City of Bryan	Create/maintain tree trimming program (BTU).	Ongoing	Ongoing.
	College Station	Conduct lightning awareness programs.	Ongoing	Continuous.
	College Station	Create and mail lightning safety brochures with COCS water bills.	Ongoing	Continuous.
	City of Kurten	Create mailouts and/or social media messages that provide information to residents regarding the use of weather radios, teach residents about the dangers of thunderstorms and safety precautions to take when severe weather threatens.	Ongoing	Ongoing.
	City of Wixon Valley	Install surge and strike reduction rods/system in the new City Hall.	Ongoing	Ongoing.
	Texas A&M University	Enhance building emergency plans to include "areas of refuge".	Ongoing	Continuous.
Dam Failure	All participating entities (Brazos County; Cities of Bryan, College Station, Kurten, Wixon Valley; and TAMU)	Develop an annual public hazards workshop or expo for all residents to educate them on dam and levee failures, the hazards associated with dam and levee failure, and develop methods to mitigate damage to personal properties from dam and levee failure. Additionally, educate residents about the need for and creation of preparedness kits.	Not completed	Source of funding not identified and inadequate staffing.
	All participating entities (Brazos County; Cities of Bryan, College Station, Kurten, Wixon Valley; and TAMU)	Purchase generators for critical facilities.	Not completed	Source of funding not identified and inadequate staffing.
	All participating entities (Brazos County; Cities of Bryan, College Station, Kurten, Wixon Valley; and TAMU)	Build, renovate, rehabilitate, or convert a building or buildings for use as emergency shelters for individuals and families.	Not completed	Source of funding not identified and inadequate staffing.
	Brazos County; Cities of Bryan and College Station	Conduct hydrology studies to identify the extent for each dam on the list for which there is no current information. The extent will be stated in the form of water depth in the inundation area for each dam. This project is to address data deficiencies identified in Section 13.	Not completed	Source of funding not identified and inadequate staffing.
	City of Bryan	Maintain/update Emergency Action Plans for Country Club Lake and Lake Bryan.	Completed	Completed.
	City of Bryan	Update development regulations within the hazard areas identified with the EAP's.	Ongoing	Ongoing.
	College Station	Conduct a study estimating economic consequences for dam failure scenarios.		Ongoing.
	College Station	Conduct a study estimating loss of life for dam sector for dam failure scenarios.		Ongoing.
	Texas A&M University	Enhance routine dam maintenance to include vegetation evaluation and removal (as appropriate) annually.	Ongoing	Continuous.
Excessive or Extreme Heat	All participating entities (Brazos County; Cities of Bryan, College Station, Kurten, Wixon Valley; and TAMU)	Develop an annual public hazards workshop or expo for all residents to educate them on excessive heat, the hazards associated with excessive heat, and develop methods to mitigate damage to personal properties from excessive heat. Additionally, educate residents about the need for and creation of preparedness kits.	Not completed	Source of funding not identified and inadequate staffing.
	All participating entities (Brazos County; Cities of Bryan, College Station, Kurten, Wixon Valley; and TAMU)	Purchase generators for critical facilities.	Not completed	Source of funding not identified and inadequate staffing.

	All participating entities (Brazos County; Cities of Bryan, College Station, Kurten, Wixon Valley; and TAMU)	Build, renovate, rehabilitate, or convert a building or buildings for use as emergency shelters for individuals and families.	Not completed	Source of funding not identified and inadequate staffing.
	All participating entities (Brazos County; Cities of Bryan, College Station, Kurten, Wixon Valley; and TAMU)	Provide information to the public on where they can go to stay cool during periods of excessive heat.	Not completed	Source of funding not identified and inadequate staffing.
	All participating entities (Brazos County; Cities of Bryan, College Station, Kurten, Wixon Valley; and TAMU)	Educate vulnerable populations about sources of fans and sources of programs that can assist citizens having trouble paying utility bills.	Not completed	Source of funding not identified and inadequate staffing.

Appendix H – Sample Adoption of Hazard Mitigation Action Plan

Plan Adoption

*****Sample Adoption Resolution (This will be replaced with the "Official" Adoption, once approved.)**

(LOCAL GOVERNMENT, INCLUDING SPECIAL DISTRICTS), (STATE)
RESOLUTION NO.

A RESOLUTION OF (LOCAL GOVERNMENT) ADOPTING THE (TITLE AND DATE OF MITIGATION PLAN).

WHEREAS the (local governing body) recognizes the threat that natural hazards pose to people and property within (local government); and

WHEREAS the (local government) has prepared a multi-hazard mitigation plan, hereby known as (title and date of mitigation plan) in accordance with federal laws, including the Robert T. Stafford Disaster Relief and Emergency Assistance Act, as amended; the National Flood Insurance Act of 1968, as amended; and the National Dam Safety Program Act, as amended; and

WHEREAS (title and date of mitigation plan) identifies mitigation goals and actions to reduce or eliminate long-term risk to people and property in (local government) from the impacts of future hazards and disasters; and

WHEREAS adoption by the (local governing body) demonstrates its commitment to hazard mitigation and achieving the goals outlined in the (title and date of mitigation plan).

NOW THEREFORE, BE IT RESOLVED BY THE (LOCAL GOVERNMENT), (STATE), THAT:

Section 1. In accordance with (local rule for adopting resolutions), the (local governing body) adopts the (title and date of mitigation plan). While content related to (local government) may require revisions to meet the plan approval requirements, changes occurring after adoption will not require (local government) to re-adopt any further iterations of the plan. Subsequent plan updates following the approval period for this plan will require separate adoption resolutions.

ADOPTED by a vote of ____ in favor and ____ against, and ____ abstaining, this _____ day of _____, _____.

By: _____ (print name)

ATTEST: By: _____ (print name)

APPROVED AS TO FORM: By: _____ (print name)

This page was left intentionally blank.