4 RISK ASSESSMENT

Table of Contents

4.1 Hazard Identification: Natural Hazards 2
4.1.1 Methodology and Results 3
4.1.2 Disaster Declaration History 4
4.2 Hazard Profiles 6
4.2.1 Dam/Levee Failure 7
4.2.2 Drought 13
4.2.3 Earthquake 19
4.2.4 Flood: General 29
4.2.5 Flood: 100/500 –year Flood 32
4.2.6 Flood: Flash Flood 34
4.2.7 Flood: Riverine Flood 34
4.2.8 Severe Weather: General 35
4.2.9 Severe Weather: Extreme Heat 37
4.2.10 Severe Weather: Hailstorm 40
4.2.11 Severe Weather: Heavy Rain/Thunderstorm/Lightning/High Wind 43
4.2.12 Severe Weather: Tornado 50
4.2.13 Soil Hazard: General 56
4.2.14 Soil Hazard: Stream Bank Erosion/Stability 56
4.2.15 Soil Hazard: Subsidence 59
4.2.16 Tropical Storm/Hurricane 61
4.2.17 Winter Storm/Extreme Cold 66
4.2.18 Natural Hazards Summary 71
4.3 Vulnerability Assessment 73
4.3.1 The City of Bossier City's Vulnerability and Assets at Risk 73
4.3.2 Growth and Development Trends 92
4.3.3 Vulnerability of the City of Bossier City to Specific Hazards 97
4.4 The City of Bossier City's Mitigation Capabilities 111
4.4.1 Bossier City's Regulatory Mitigation Capabilities 112
4.4.2 Bossier City's Administrative/Technical Mitigation Capabilities 122
4.4.3 Bossier City's Fiscal Mitigation Capabilities 129
4.4.4 Other Mitigation Activities 129

Requirement §201.6(c)(2): [The plan shall include] A risk assessment that provides the factual basis for activities proposed in the strategy to reduce losses from identified hazards. Local risk assessments must provide sufficient information to enable the jurisdiction to identify and prioritize appropriate mitigation actions to reduce losses from identified hazards.

As defined by FEMA, risk is a combination of hazard, vulnerability, and exposure. "It is the impact that a hazard would have on people, services, facilities, and structures in a community and refers to the likelihood of a hazard event resulting in an adverse condition that causes injury or damage."

The risk assessment process identifies and profiles relevant hazards and assesses the exposure of lives, property, and infrastructure to these hazards. The process allows for a better understanding of a jurisdiction's potential risk to hazards and provides a framework for developing and prioritizing mitigation actions to reduce risk from future hazard events.

This risk assessment followed the methodology described in the Federal Emergency Management Agency (FEMA) publication *Understanding Your Risks—Identifying Hazards and Estimating Losses* (FEMA 386-2, 2002), which breaks the assessment into a four-step process:

1) Identify hazards
2) Profile hazard events
3) Inventory assets
4) Estimate losses

Data collected through this process has been incorporated into the following sections of this chapter:

- **Section 4.1 Hazard Identification: Natural Hazards** identifies the natural hazards that threaten the planning area and describes why some hazards have been omitted from further consideration.
- **Section 4.2 Hazard Profiles** discusses the threat to the planning area and describes previous occurrences of hazard events and the likelihood of future occurrences.
- **Section 4.3 Vulnerability Assessment** assesses the City's total exposure to natural hazards, considering assets at risk, critical facilities, and future development trends.
- **Section 4.4 Capability Assessment** inventories existing mitigation activities and policies, regulations, and plans that pertain to mitigation and can affect net vulnerability.

This risk assessment covers the entire geographical extent of Bossier City.

4.1 Hazard Identification: Natural Hazards

Requirement §201.6(c)(2)(i): [The risk assessment shall include a] description of the type…of all natural hazards that can affect the jurisdiction.

The Bossier City Hazard Mitigation Planning Committee (HMPC) conducted a hazard identification study to update the hazards that threaten the planning area.

4.1.1 Methodology and Results

Using existing natural hazards data and input gained through planning meetings, the HMPC agreed upon a list of natural hazards that could affect Bossier City. Hazards data from the Louisiana Governors Office of Homeland Security and Emergency Preparedness (GOHSEP), FEMA, the National Oceanic and Atmospheric Administration (NOAA), and many other sources were examined to assess the significance of these hazards to the planning area. Significance was measured in general terms and focused on key criteria such as frequency and resulting damage, which includes deaths and injuries and property and economic damage. The natural hazards evaluated as part of this plan include those that occurred in the past or have the potential to cause significant human and/or monetary losses in the future. Only the more significant (or priority) hazards have a more detailed hazard profile and are analyzed further in Section 4.3 Vulnerability Assessment.

In alphabetical order, the natural hazards identified and investigated for Bossier City Local Hazard Mitigation Plan include:

- Dam/Levee Failure
- Drought
- Earthquake
- Flood
  - 100/500-year Flood
  - Flash Flood
  - Riverine Flood
- Severe Weather
  - Extreme Heat
  - Hailstorm
  - Heavy Rain/Thunderstorm/Lightning/Wind
  - Tornado
- Soil Hazards
  - Stream Bank Erosion/Stability
  - Subsidence
- Tropical Storms/Hurricanes
- Winter Storm

The HMPC considered hazards from the 2006 Bossier City Local Hazard Mitigation Plan, and edited and refined the list to make it even more specific to the planning area. The HMPC separated the flood hazard into three separate hazards (100/500 – year, flash and riverine floods), and added dam/levee failure, earthquake, and the soil hazards to the list.

4.1.2 Disaster Declaration History

The HMPC looked at past events that have triggered federal and/or state emergency or disaster declarations in the planning area. Federal and/or state disaster declarations may be granted when the severity and magnitude of an event surpasses the ability of the local government to respond and recover. When the local government's capacity has been surpassed, a state disaster declaration may be issued, allowing for the provision of supplemental state assistance. Should the disaster be so severe that both the local and state governments' capacities are exceeded, a federal emergency or disaster declaration may be issued allowing for the provision of federal assistance.

The federal government may issue a disaster declaration through FEMA, the U.S. Department of Agriculture (USDA), and/or the Small Business Administration (SBA). FEMA also issues emergency declarations, which are more limited in scope and without the long-term federal recovery programs of major disaster declarations. The quantity and types of damage are the determining factors. This section highlights the state and federal disaster and emergency declarations specific to the planning area.

Bossier City is among the many cities in Louisiana that are susceptible to disaster. Details on federal and state disaster declarations were obtained by the HMPC, FEMA, and GOHSEP and compiled in chronological order in Table 4.1. Most disaster declarations are issued on a county or parish -wide basis, and in some (limited) instances a city or area within a county is specifically designated. A review of state and federal declared disasters indicates that Bossier City itself has never received a disaster declaration. However, Bossier Parish received 11 declarations between 1950 and January 2010. Of the 11 declarations, 4 were associated with severe storms, 3 were associated with hurricanes, 2 were associated with flooding, and 2 were associated with winter storms.

This disaster history (combined federal and state) suggests that Bossier Parish (and Bossier City) experiences a major event worthy of a disaster declaration every 5.4 years. The Parish has a 19 percent chance of receiving a disaster declaration in any given year. Every declaration resulted directly or indirectly from severe weather.

Table 4.1. Bossier City's State and Federal Disaster Declarations, 1950-2009

Hazard Type	Disaster #	Year	Location
Flood	3031	01/31/77	Bossier Parish
Severe Storm/Tornado	567	12/06/78	Bossier Parish
Severe Storm/Flood	902	04/15/91	Bossier Parish
Flood	904	04/2991	Bossier Parish
Winter Storm	1012	02/28/94	Bossier Parish
Severe Storm/ Tornado/ Flood	1269	04/03/99	Bossier Parish
Winter Storm	1269	12/11/00	Bossier Parish

Hazard Type	Disaster #	Year	Location
Hurricane Rita	1603	08/29/05	Statewide
Hurricane Katrina	1607	09/24/05	Statewide
Hurricane Gustav	1786	09/02/08	Statewide
Severe Storms/Tornado/Flood	1863	12/10/09	Bossier Parish

Source: FEMA, http://www.fema.gov/news/disasters_state.fema?id=22

4.2 Hazard Profiles

Requirement §201.6(c)(2)(i): [The risk assessment shall include a] description of the…location and extent of all natural hazards that can affect the jurisdiction. The plan shall include information on previous occurrences of hazard events and on the probability of future hazard events.

The hazards identified in Section 4.1 Hazard Identification: Natural Hazards are profiled individually in this section. Information provided by planning team members is integrated into this section with information from other data sources, such as GOHSEP, FEMA and NOAA. These profiles set the stage for Section 4.3 Vulnerability Assessment, where the vulnerability is quantified or discussed, for each of the priority hazards.

Each hazard is profiled in the following format:

- **Hazard/Problem Description**—This section gives a description of the hazard and associated issues followed by details on the hazard specific to the Bossier City planning area. Where known, this includes information on the hazard extent, seasonal patterns, speed of onset/duration, and magnitude and/or secondary effects.
- **Past Occurrences**—This section contains information on historical incidents, including impacts if available. The extent or location of the hazard within or near the Bossier City planning area is also included here. Historical incident worksheets provided by the HMPC and other data sources were used to capture information on past occurrences.
- **Frequency/Likelihood of Future Occurrence**—The frequency of past events is used in this section, where possible, to gauge the likelihood of future occurrences. It was calculated by dividing the number of events observed by the number of years on record and multiplying by 100. This gives the percent chance of an event happening in any given year. For example, three hazard events occurring over a 30-year period equates to a 10 percent chance of that hazard occurring in any given year ((3/30)*100=10). The likelihood of future occurrences is categorized into one of the following classifications:

  - **Highly Likely**—Near 100 percent chance of occurrence in next year or happens every year.
  - **Likely**—Between 10 and 100 percent chance of occurrence in next year or has a recurrence interval of 10 years or less.
  - **Occasional**—Between 1 and 10 percent chance of occurrence in the next year or has a recurrence interval of 11 to 100 years.
  - **Unlikely**—Less than 1 percent chance of occurrence in next 100 years or has a recurrence interval of greater than every 100 years.

Table 4.2 Natural Hazards Summary provides a summary assessment of the profiles by providing the frequency of occurrence and a priority (high/low) to each hazard.

Table 4.2. Natural Hazards Summary

Hazard	Likelihood of Future Occurrence	Priority Hazard
Dam/Levee Failure	Occasional	Yes
Drought	Occasional	No
Earthquake	Unlikely	No
Flood		
100/500 -year Flood	Occasional	Yes
Flash Flood	Likely	Yes
Riverine Flood	Likely	Yes
Severe Weather		
Extreme Heat	Highly Likely	No
Hailstorm	Highly Likely	No
Heavy Rain/Thunderstorm/Lightning/ Wind	Highly Likely	Yes
Tornado	Likely	Yes
Soil Hazard		
Stream Bank Erosion/Stability	Likely	No
Subsidence	Unlikely	No
Tropical Storm/Hurricane	Likely	Yes
Winter Storm/Extreme Cold	Likely	Yes

Those hazards determined to be of high priority are further evaluated in Section 4.3 Vulnerability Assessment. Those hazards that occur infrequently or have little or no impact on the planning area were determined to be low priority and are not included in Section 4.3 Vulnerability Assessment. Significance and priority level was determined based on the hazards' frequency and threat to the people and property of the planning area. This assessment was used by the HMPC to prioritize those hazards of greatest significance to Bossier City, thus enabling the City to focus resources where most needed.

The following sections provide profiles of the natural hazards that the HMPC identified in Section 4.1 Identifying Hazards.

4.2.1 Dam/Levee Failure

Priority Hazard: **Yes**

Hazard/Problem Description

Dams

A dam is a barrier constructed across a watercourse that stores, controls, or diverts water. Dams are usually constructed of earth, rock, concrete, or mine tailings. The water impounded behind a dam is referred to as the reservoir and is measured in acre-feet. One acre-foot is the volume of water that covers one acre of land to a depth of one foot. Dams can benefit farm land, provide recreation areas, generate electrical power, and help control erosion and flooding issues.

A dam failure is the collapse or breach of a dam that causes downstream flooding. Dam failures may be caused by natural events, human-caused events, or a combination. Due to the lack of advance warning, failures resulting from natural events, such as hurricanes, earthquakes, or landslides, may be particularly severe. Prolonged rainfall and subsequent flooding is the most common cause of dam failure.

Dam failures usually occur when the spillway capacity is inadequate and water overtops the dam or when internal erosion in dam foundation occurs (also known as piping). If internal erosion or overtopping cause a full structural breach, a high-velocity, debris-laden wall of water is released and rushes downstream, damaging or destroying anything in its path. Overtopping is the primary cause of earthen dam failure in the United States.

Dam failures can also result from any one or a combination of the following:

- Prolonged periods of rainfall and flooding;
- Inadequate spillway capacity, resulting in excess overtopping flows;
- Internal erosion caused by embankment or foundation leakage or piping;
- Improper maintenance, including failure to remove trees, repair internal seepage problems, replace lost material from the cross-section of the dam and abutments, or maintain gates, valves, and other operational components;
- Improper design, including the use of improper construction materials and construction practices;
- Negligent operation, including the failure to remove or open gates or valves during high flow periods;
- Failure of upstream dams on the same waterway;
- High winds, which can cause significant wave action and result in substantial erosion;

Water released by a failed dam generates tremendous energy and can cause a flood that is catastrophic to life and property. A catastrophic dam failure could challenge local response capabilities and require evacuations to save lives. Impacts to life safety will depend on the warning time and the resources available to notify and evacuate the public. Major casualties and loss of life could result, as well as water quality and health issues. Potentially catastrophic effects to roads, bridges, and homes are also of major concern. Associated water quality and health concerns could also be issues. Factors that influence the potential severity of a full or

partial dam failure are the amount of water impounded; the density, type, and value of development and infrastructure located downstream; and the speed of failure.

The Louisiana Department of Transportation and Development (DOTD) assigns hazard ratings to large dams within the State. The following two factors are considered when assigning hazard ratings: existing land use and land use controls (zoning) downstream of the dam. Dams are classified in three categories that identify the potential hazard to life and property:

- **High hazard** indicates that a failure would most probably result in the loss of life
- **Significant hazard** indicates that a failure could result in appreciable property damage
- **Low hazard** indicates that failure would result in only minimal property damage and loss of life is unlikely

According to HAZUS-MH MR4 and data from the National Inventory of Dams (NID) and National Performance of Dams Program (NPDP), there are two dams in Bossier Parish that pose a risk to Bossier City (see Table 4.3).

Table 4.3. Dams with Potential to Cause Damaging Floods in Bossier City

Dam	EAP	Owner	Stream	Hazard Rating	Dam Height	Type	Capacity (Acre-feet)*
Bayou Bodcau Dam	Y	Cemvk	Bodcau Lake	High	76 feet	Earth Core	1,197,700
Cypress Dam	Y	Cemvk	Cypress Bayou	Significant	52 feet	Earth Core	755,000

Source: HAZUS-MH MR4, National Performance of Dams Program
*One acre-foot=326,000 gallons

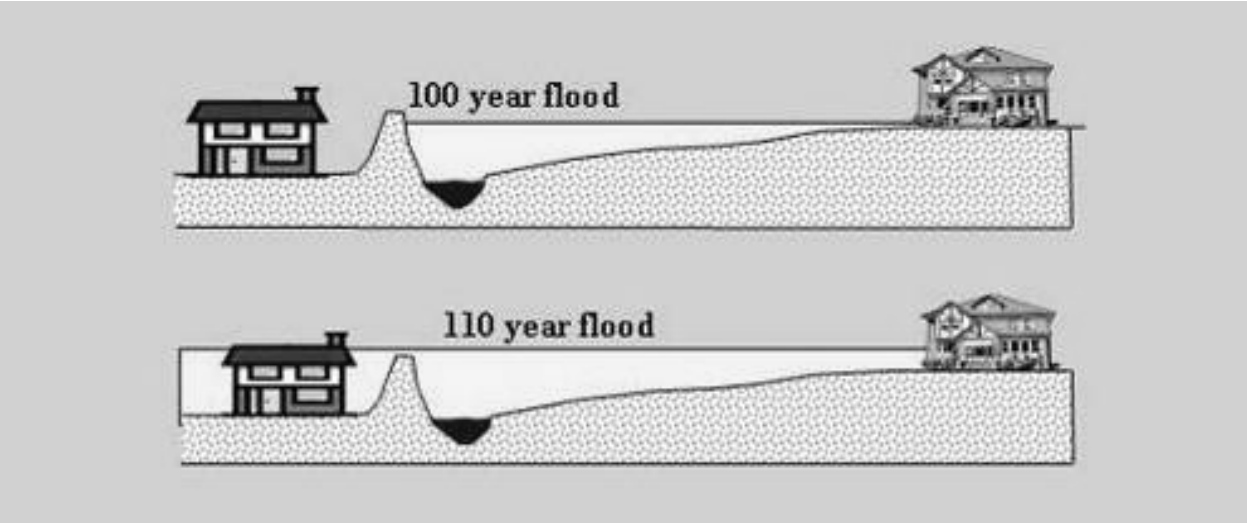
An earth-rockfill dam fails gradually due to erosion of the breach: a flood wave will build gradually to a peak and then decline until the reservoir is empty.

Levees

A levee is a type of dam that runs along the banks of a river or canal. Levees reinforce the banks and help prevent flooding. By confining the flow, levees can also increase the speed of the water. Levees can be natural or man-made. A natural levee is formed when sediment settles on the river bank, raising the level of the land around the river. To construct a man-made levee, workers pile dirt or concrete along the river banks, creating an embankment. This embankment is flat at the top, and slopes at an angle down to the water. For added strength, sandbags are sometimes placed over dirt embankments.

Levees provide strong flood protection, but they are not failsafe. Levees are designed to protect against a specific flood level and could be overtopped during severe weather events. Levees reduce, not eliminate, the risk to individuals and structure behind them.

Figure 4.1. Flooding from Levee Overtopping



Source: Levees In History: The Levee Challenge. Dr. Gerald E. Galloway, Jr., P.E., Ph.D., Water Policy Collaborative, University of Maryland, Visiting Scholar, USACE, IWR.
http://www.floods.org/ace-files/leveesafety/lss_levee_history_galloway.ppt

A levee system failure or overtopping can create severe flooding (see Figure 4.1) and high water velocities. It's important to remember that no levee provides protection from events for which it was not designed, and proper operation and maintenance are necessary to reduce the probability of failure.

Levees in Bossier City protected the City to the Red River's record flood crest of 45.9 feet in 1849. The National Weather Service's Advanced Hydrologic Prediction Service (AHPS) predicts that if a 50 foot flood crest was reached, the following would likely occur:

> Catastrophic flooding of Bossier City and Shreveport area. Water will overtop the levee on the Bossier City side. Also expect catastrophic backwater flooding of Cross and Caddo Lakes with their pool stages rising to near 180.0 ft msl. Catastrophic backwater flooding will affect Caddo Lake and the Big Cypress Bayou to near Jefferson Texas.

The levees in Bossier City, according to the AHPS, protect the City to a higher crest level than do the City of Shreveport's levees.

Figure 4.2. Levee Failure In Louisiana

Source: Levees In History: The Levee Challenge. Dr. Gerald E. Galloway, Jr., P.E., Ph.D., Water Policy Collaborative, University of Maryland, Visiting Scholar, USACE, IWR.
http://www.floods.org/ace-files/leveesafety/lss_levee_history_galloway.ppt

The roughly 50 mile levee system in the Bossier City Area was built by the U.S. Army Corps of Engineers (USACE). These levees are maintained and owned by the Bossier Levee District (BLD). These levees were constructed primarily for flood control purposes; the channels provide drainage for farms, homes and business locations in the district.

In Bossier City, the Bossier Levee District (BLD) is charged with care and certification of levees. The BLD was established in 1898. District boundaries include a total of 157,000 acres, 153,000 of which are in Bossier Parish and 4,000 of which are in Red River Parish. The District is comprised of the alluvial lands south of Benton, Louisiana in Bossier Parish to Loggy Bayou in Red River Parish. Flood protection is provided by 48.6 miles of levee along the left descending bank of the Red River and 18.8 miles of levee along the right descending bank of Red Chute Bayou.

On September 28, 2009, the Bossier Levee District received the following notification from the Vicksburg Corps of Engineers regarding the certification of the Red River Levee:

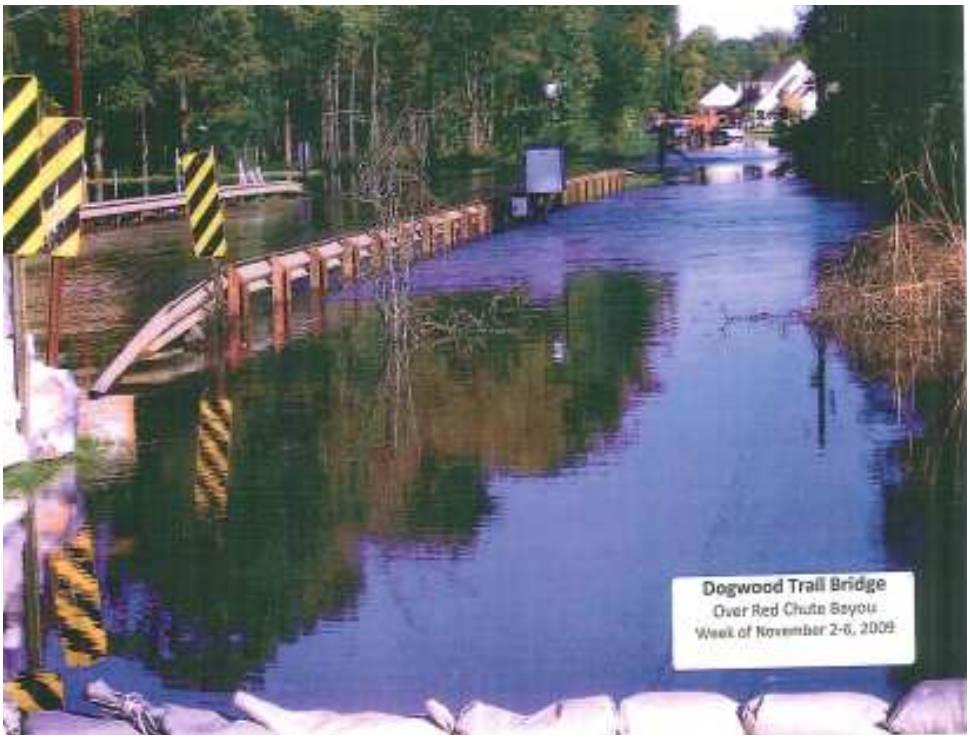
> "The Vicksburg District of the U.S. Army Corps of Engineers (USACE) has certified the Red River East Bank Levee in Bossier Parish, Louisiana. This means that Bossier Parish has met all of the requirements established by USACE for determining that the levee system can be reasonably expected to protect against a flood event with a 1% chance of being exceeded in any given year, also referred to as the base flood."

The Red Chute Bayou Levee provides 25-year protection to Bossier City and as such, cannot be certified by FEMA.

Past Occurrences

There have also been no reported occurrences of dam or levee failure in Bossier City. There have, however, been incidences of overtopping. A November 2009 storm caused water levels to rise. Figure 4.3 shows the seepage and overtopping that occurred on the Red Chute Bayou and Flat River. More than 25,000 residents of Bossier City were urged to evacuate the area. Louisiana Downs evacuated 250 horses to safety. The National Guard was called to aid sandbagging efforts on the levees. The levees were stressed, but held and only minor damage was done in Bossier City. The Red Chute Bayou Levee has overtopped three other times in the past 10 years.

Figure 4.3. Dogwood Trail Bridge during November 2009 Storm



Likelihood of Future Occurrences

Occasional—The City remains at risk to dam failures from the two high hazard dams that protect the City and surrounding areas. Given the density of population and property, and the age and condition of these dams, the potential exists for catastrophic dam failure in Bossier City. Overtopping of the Red Chute Bayou Levee has occurred 4 or more times in 10 years, thus overtopping is **likely** in the future. The risk of levee failure remains at occasional.

4.2.2 Drought

Priority Hazard: **No**

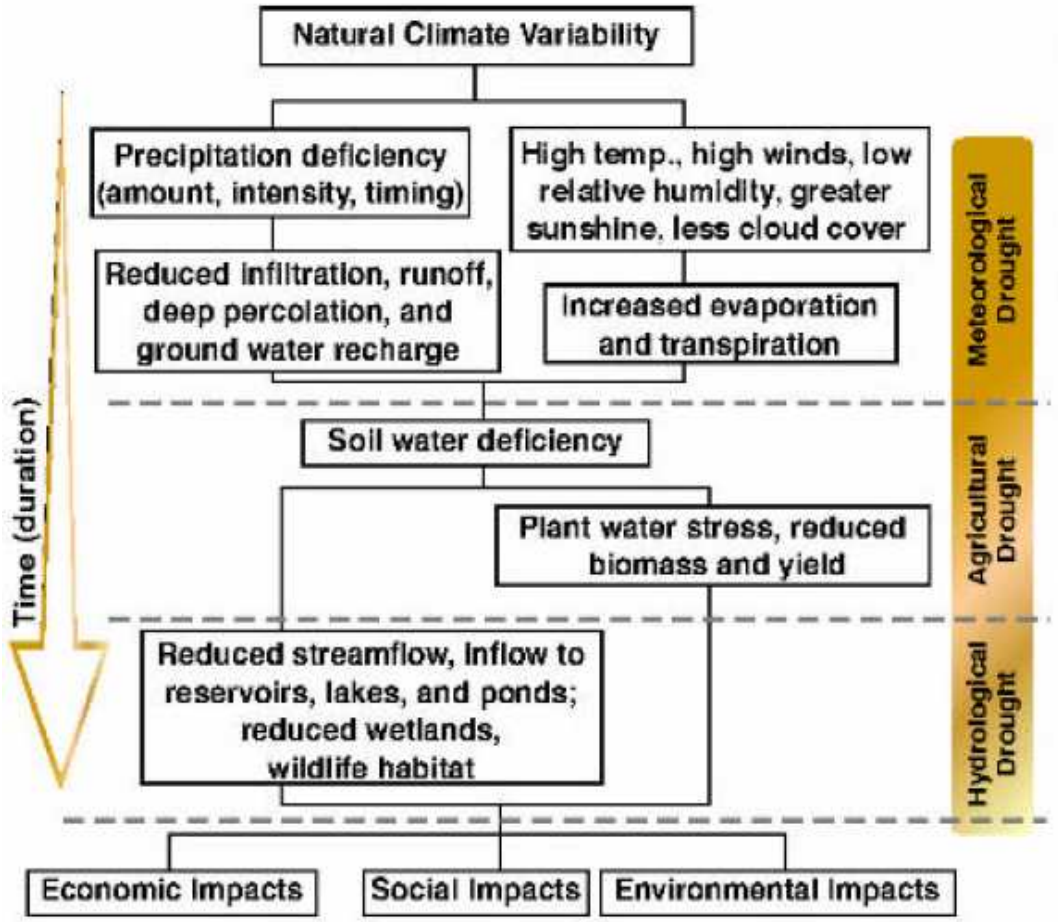
Hazard/Problem Description

Drought is a gradual phenomenon; they differ from typical emergency events. Most natural disasters, such as floods or forest fires, occur rapidly and afford little time for preparation or response. Droughts occur slowly, oftentimes over a multi-year period, and are often not obvious or easy to quantify.

Drought is a complex issue involving many factors (see Figure 4.4) —it occurs when an adequate amount of moisture is not available to satisfy an area's usual water-consuming activities. Drought can often be defined regionally based on its effects:

- **Meteorological** drought is defined by a period of below average water supply.
- **Agricultural** drought occurs when there is an inadequate water supply to meet the needs of the state's crops or livestock.
- **Hydrological** drought is defined as deficiencies in surface and subsurface water supplies. It is generally measured and reported as streamflow, snowpack, or lake, reservoir, and groundwater levels.
- **Socioeconomic** drought occurs when health, well-being, and quality of life are impacted, or when there is an adverse economic impact on the region.

Figure 4.4. Causes and Impacts of Drought



Drought impacts are wide-reaching and may be economic, environmental, and societal. The most significant impacts associated with drought in the planning area are those related to water intensive activities such as agriculture, wildfire protection, municipal usage, commerce, tourism, recreation, and wildlife preservation. Voluntary conservation measures are typically implemented during extended droughts. A reduction of electric power generation and water quality deterioration are also potential problems. Drought conditions can cause soil to compact and not absorb water, making an area more susceptible to flooding.

Past Occurrences

Historically, Louisiana has experienced multiple severe droughts. According to the National Oceanic and Atmospheric Administration's National Climatic Data Center (NCDC), droughts exceeding three years are rare in Northern Louisiana. The driest single year of Louisiana's measured hydrologic record was 1998. The HMPC identified the following droughts as having significant impacts on the planning area:

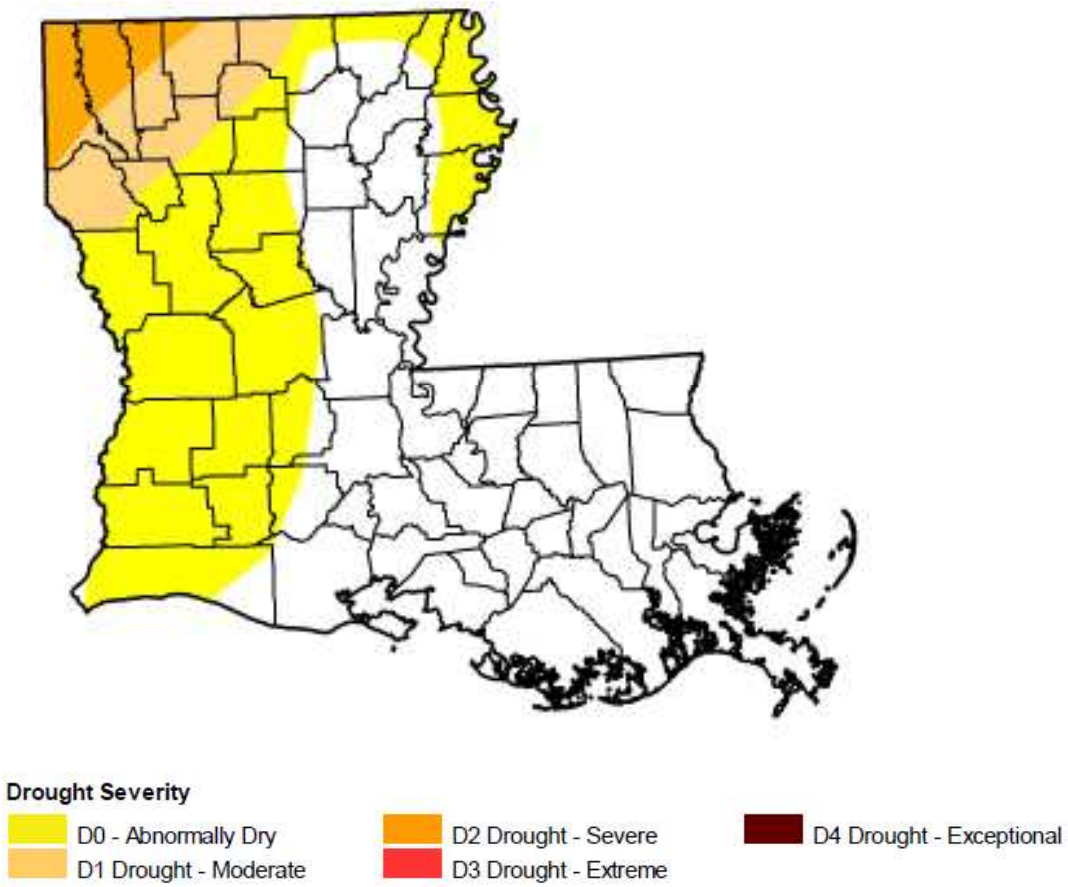
1977 – Northern Louisiana was touched by the Great Western Drought of 1977. Drought conditions in Louisiana were not as dry as other states west of the Mississippi, but a Presidential Emergency Declaration (#3031) was issued on February 22nd of 1977.

1996 - May was not only abnormally hot and dry, but was also the sixth driest and the fifth hottest on record. There were numerous problems in northwest Louisiana attributed to the heat including profit loses in the lumber, agriculture and food production industries. Area lakes and reservoirs suffered also with many reaching near record low water levels.

1998 - Only 1.35 inches of rain fell during June 1998. This brought the three month period total for April, May, and June to 2.29 inches. Of the 1.35 inches of rain, 1.25 inches occurred in a 24 hour period on the 4th and 5th. Although June 1998 was the 30th driest on record, the total three month average precipitation for April, May and June took its toll. Only the fall season of 1924 (1.39 inches) and the summer season of 1934 (2.09 inches) were drier. Area rivers and lakes fell to well below normal levels; water users were urged to conserve. Agriculture and forestry were especially hard hit. Nearly half of the 100 million pine seedlings planted in 1997 were killed. 15 million dollars of damage were attributed to this drought.

2005 – Extreme Northwest Louisiana experienced an abnormally dry summer which resulted in severe drought conditions in a few parishes (see Figure 4.5). The drought and extreme heat resulted in burn bans across portions of the region, and took its toll on the agricultural and hydrological communities. The lack of rainfall through the period resulted in damaged crops, which put a significant strain on the farming community. Water conservation measures were also in place in some areas as pool stages on various lakes were well below normal. Rainfall for the three month period of June, July and August was 30 to 40 percent of normal which led to deficits of 4 to 8 inches across the region. In Shreveport, there were 8 consecutive 100+ degree days in August. The warmest was 104 degrees on 8/22. August 2005 was the 10th warmest on record. The summer of 2005 was also the 9th warmest of record in Shreveport, Louisiana.

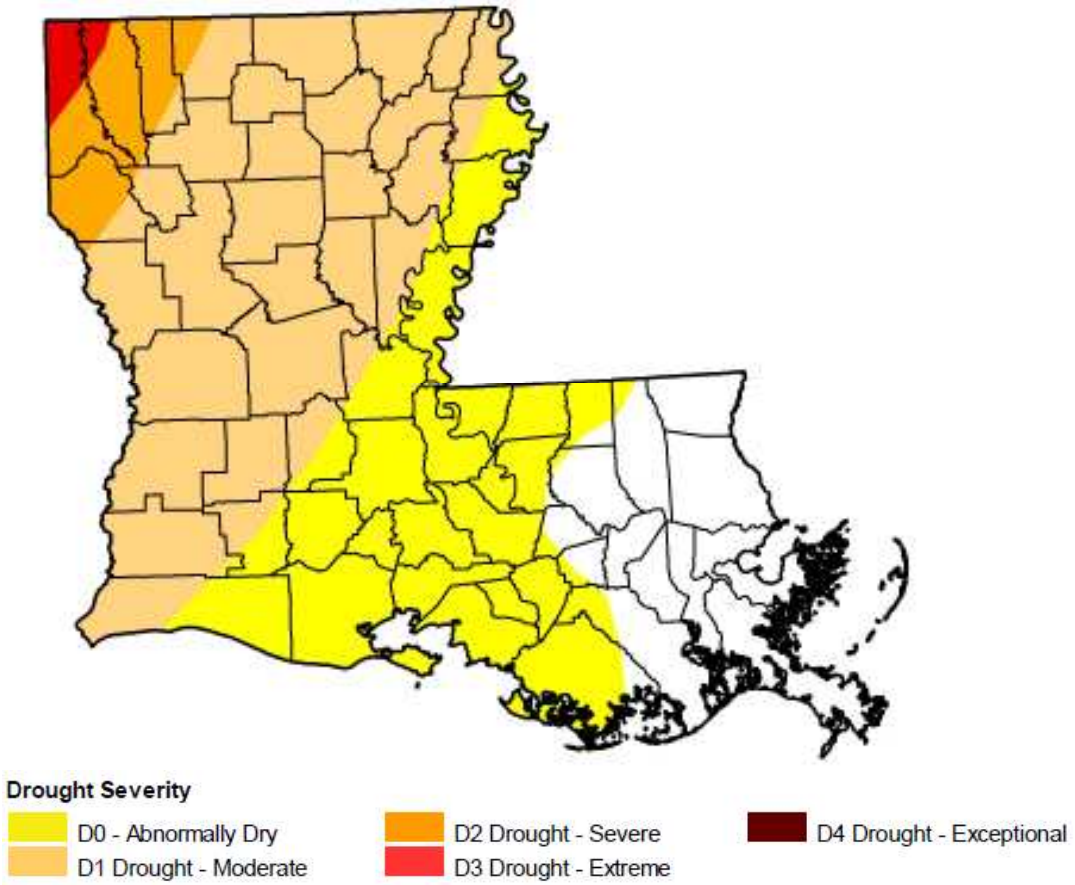
Figure 4.5. US Drought Monitor for August 2, 2005



Source: US Drought Monitor

December 2005 remained abnormally dry (see Figure 4.6) just as the previous several month did across Northwest Louisiana. Rainfall deficits were 15 to 20 inches below normal for the year. A series of dry cold fronts moved through the region during the month which allowed strong winds to compound the already high fire danger. Several small fires broke out across Northwest Louisiana during the month, but damage was minimal. Burn bans continued for many parishes throughout the month as well. This drought forced the City of Shreveport to search for an alternate water supply.

Figure 4.6. US Drought Monitor for December, 2005



Source: US Drought Monitor

2009 – A moderate drought struck the State of Louisiana in the summer of 2009 (see Figure 4.7). Bossier City was located in the abnormally dry section and was not strongly affected by the drought. This drought was severe enough, however, to warrant a USDA Secretarial Disaster Declaration. Disaster declaration S2935 designated Bossier Parish a primary county for drought relief. This declaration was declared because of a combination of the severity of spring and summer drought, followed by excessive rainfall.

Figure 4.7. US Drought Monitor for July 2009

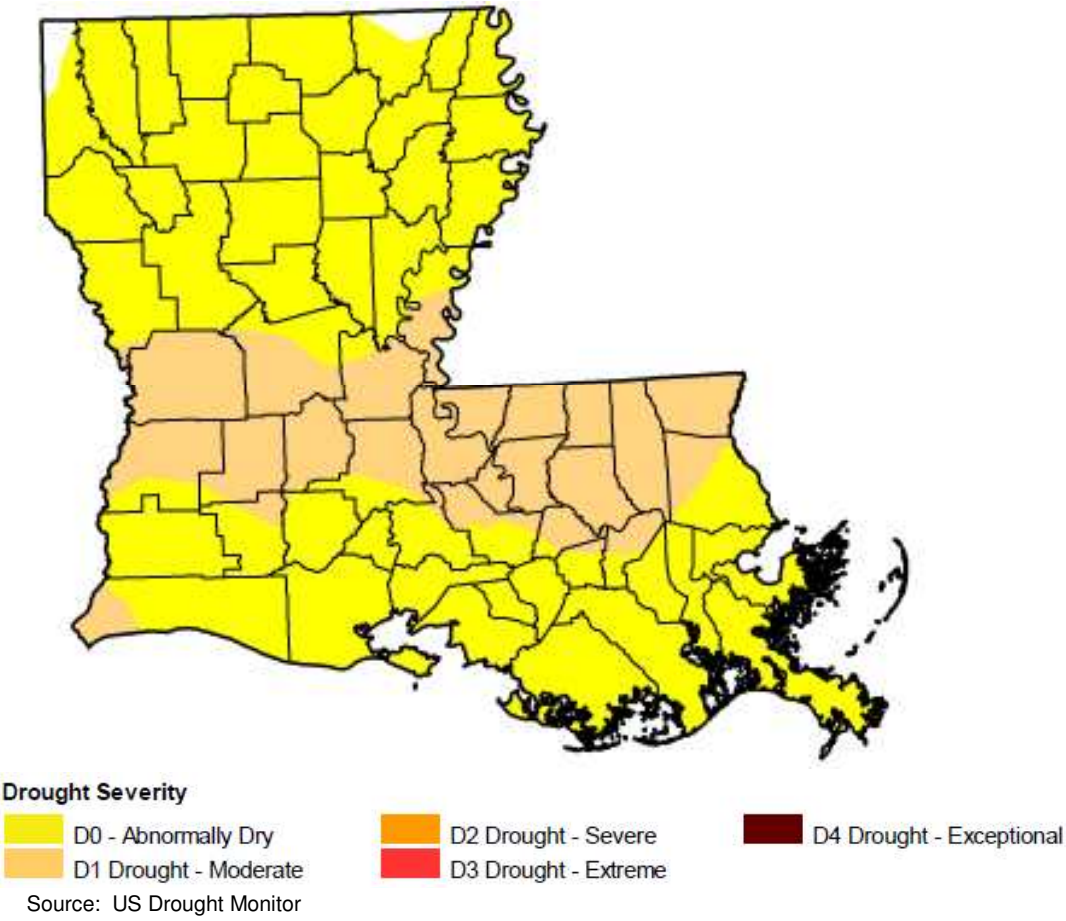


Figure 4.8 provides a "snapshot in time" of the drought conditions in Louisiana in May 2010 from the National Drought Mitigation Center. Bossier City's drought conditions were considered abnormally dry. Abnormally dry is not a drought and thus is not considered in the drought number in probability. This map considers several factors, including the Palmer Drought Index, Soil Moisture Models, U.S. Geological Survey Weekly Streamflows, Standardized Precipitation Index, and Satellite Vegetation Health Index.

Figure 4.8. U.S. Drought Monitor May 4, 2010

U.S. Drought Monitor

Louisiana

May 4, 2010
Valid 7 a.m. EST

Drought Conditions (Percent Area)

	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	0.0	100.0	33.3	0.0	0.0	0.0
Last Week (04/27/2010 map)	10.1	89.9	11.9	0.0	0.0	0.0
3 Months Ago (02/09/2010 map)	100.0	0.0	0.0	0.0	0.0	0.0
Start of Calendar Year (01/05/2010 map)	100.0	0.0	0.0	0.0	0.0	0.0
Start of Water Year (10/06/2009 map)	92.1	7.9	0.0	0.0	0.0	0.0
One Year Ago (05/05/2009 map)	100.0	0.0	0.0	0.0	0.0	0.0

Intensity:

- D0 Abnormally Dry
- D1 Drought - Moderate
- D2 Drought - Severe
- D3 Drought - Extreme
- D4 Drought - Exceptional

The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. See accompanying text summary for forecast statements

http://drought.unl.edu/dm

Released Thursday, May 6, 2010
Author: M. Brewer, NOAA/NCDC

Source: US Drought Monitor

Note: The approximate location of Bossier City is within the red oval

Likelihood of Future Occurrences

Occasional— Historical drought data for Bossier City indicate there have been 5 significant droughts in the last 60 years (1950-2010). This equates to a drought every 12 years on average or an 8.3 percent chance of a drought in any given year. Droughts have a recurrence interval between 11 and 100 years and will only occasionally affect the planning area.

4.2.3 Earthquake

Priority Hazard: **No**

Hazard/Problem Description

An earthquake is typically caused by a sudden slip on a geologic fault. Stresses in the earth's crust build, and the rocks slip suddenly, releasing energy in waves that travel through the earth's crust and cause shaking. The amount of energy released during an earthquake is usually expressed as a magnitude and is measured directly from the earthquake on seismographs. Earthquake intensity can also be measured; it is an expression of the amount of shaking at any given location on the ground surface (see Table 4.4). Seismic shaking is typically the greatest cause of losses to structures during earthquakes.

Table 4.4. Modified Mercalli Intensity (MMI) Scale

MMI	Felt Intensity
I	Not felt except by a very few people under special conditions. Detected mostly by instruments.
II	Felt by a few people, especially those on upper floors of buildings. Suspended objects may swing.
III	Felt noticeably indoors. Standing automobiles may rock slightly.
IV	Felt by many people indoors; by a few outdoors. At night, some people are awakened. Dishes, windows, and doors rattle.
V	Felt by nearly everyone. Many people are awakened. Some dishes and windows are broken. Unstable objects are overturned.
VI	Felt by everyone. Many people become frightened and run outdoors. Some heavy furniture is moved. Some plaster falls.
VII	Most people are alarmed and run outside. Damage is negligible in buildings of good construction, considerable in buildings of poor construction.
VIII	Damage is slight in specially designed structures, considerable in ordinary buildings, and great in poorly built structures. Heavy furniture is overturned.
IX	Damage is considerable in specially designed buildings. Buildings shift from their foundations and partly collapse. Underground pipes are broken.
X	Some well-built wooden structures are destroyed. Most masonry structures are destroyed. The ground is badly cracked. Considerable landslides occur on steep slopes.
XI	Few, if any, masonry structures remain standing. Rails are bent. Broad fissures appear in the ground.
XII	Virtually total destruction. Waves are seen on the ground surface. Objects are thrown in the air.

Source: Multi-Hazard Identification and Risk Assessment, FEMA 1997

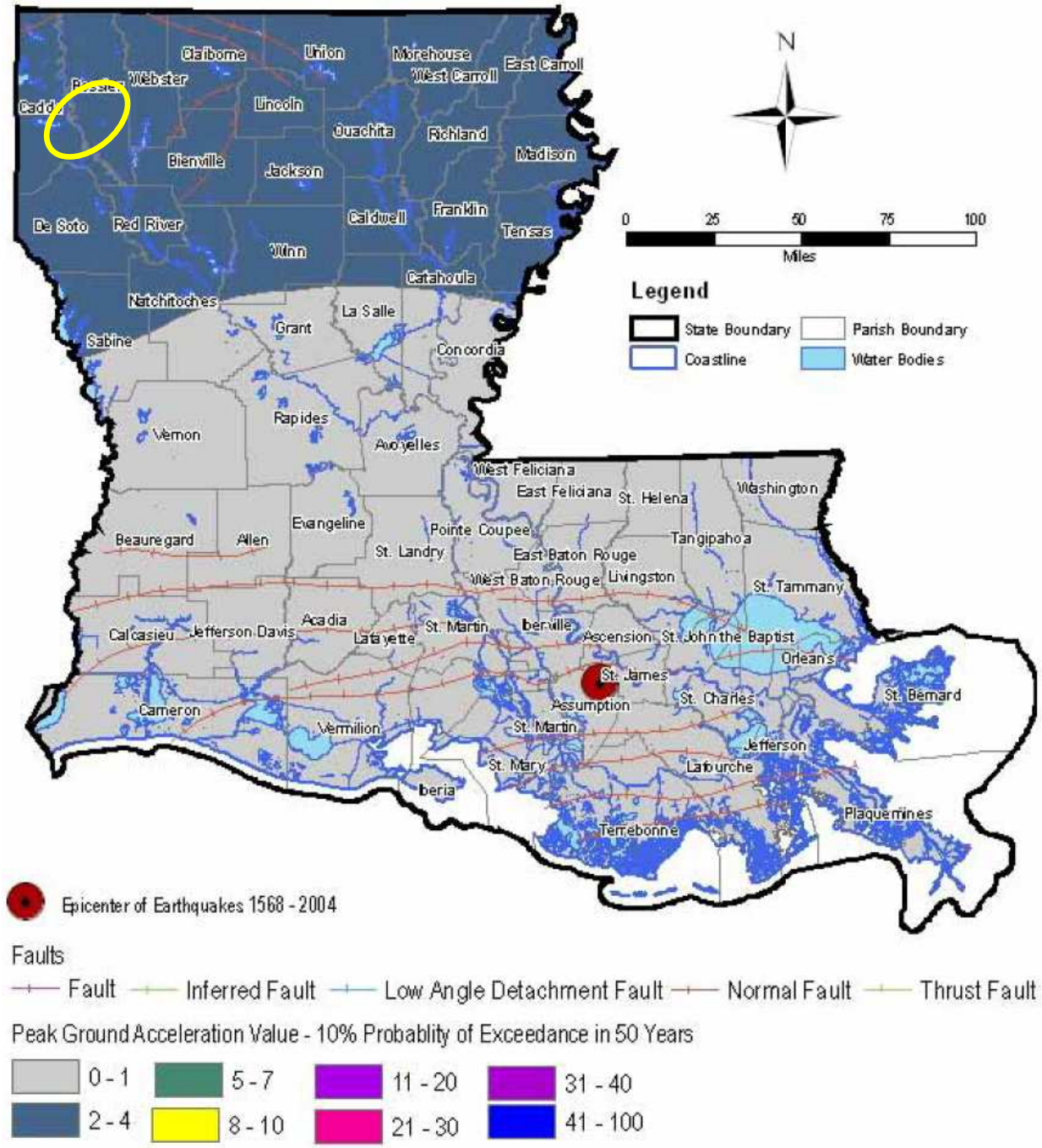
Earthquakes can cause structural damage, injury, and loss of life, as well as damage to infrastructure networks, such as water, power, gas, communication, and transportation. Earthquakes may also cause collateral emergencies including dam and levee failures, hazmat incidents, fires, avalanches, and landslides. The degree of damage depends on the following interrelated factors: magnitude, focal depth, distance from causative fault, source mechanism, duration of shaking, high rock accelerations, type of surface deposits or bedrock, degree of consolidation of surface deposits, presence of high groundwater, topography, and the design, type, and quality of building construction.

Although Louisiana is an area of low seismic risk, a number of earthquakes have occurred in the State over the last 200 years. These earthquakes have had two distinct sources: a system of

subsidence faults (also known as “growth faults”) in southern Louisiana, and the New Madrid seismic zone to the north of Louisiana. Most of these earthquakes were of low magnitude and have occurred infrequently.

The system of subsidence faults in southern Louisiana, shown on Figure 4.9, developed due to accelerated land subsidence and rapid sediment deposition from the Mississippi River. The system stretches across the southern portion of the State from Beauregard Parish in the east to St. Tammany Parish in the west, and includes every parish to the south of this line. This system is thought to be responsible for many of the recorded earthquakes from 1843 to the present (see Figure 4.12). All of the earthquakes that occurred over this period of time were of low magnitude, resulting mostly in limited property damage (i.e. broken windows, damaged chimneys, and cracked plaster).

Figure 4.9. Peak Ground Acceleration of an Earthquake with a 10% Probability of Exceedance in 50 years



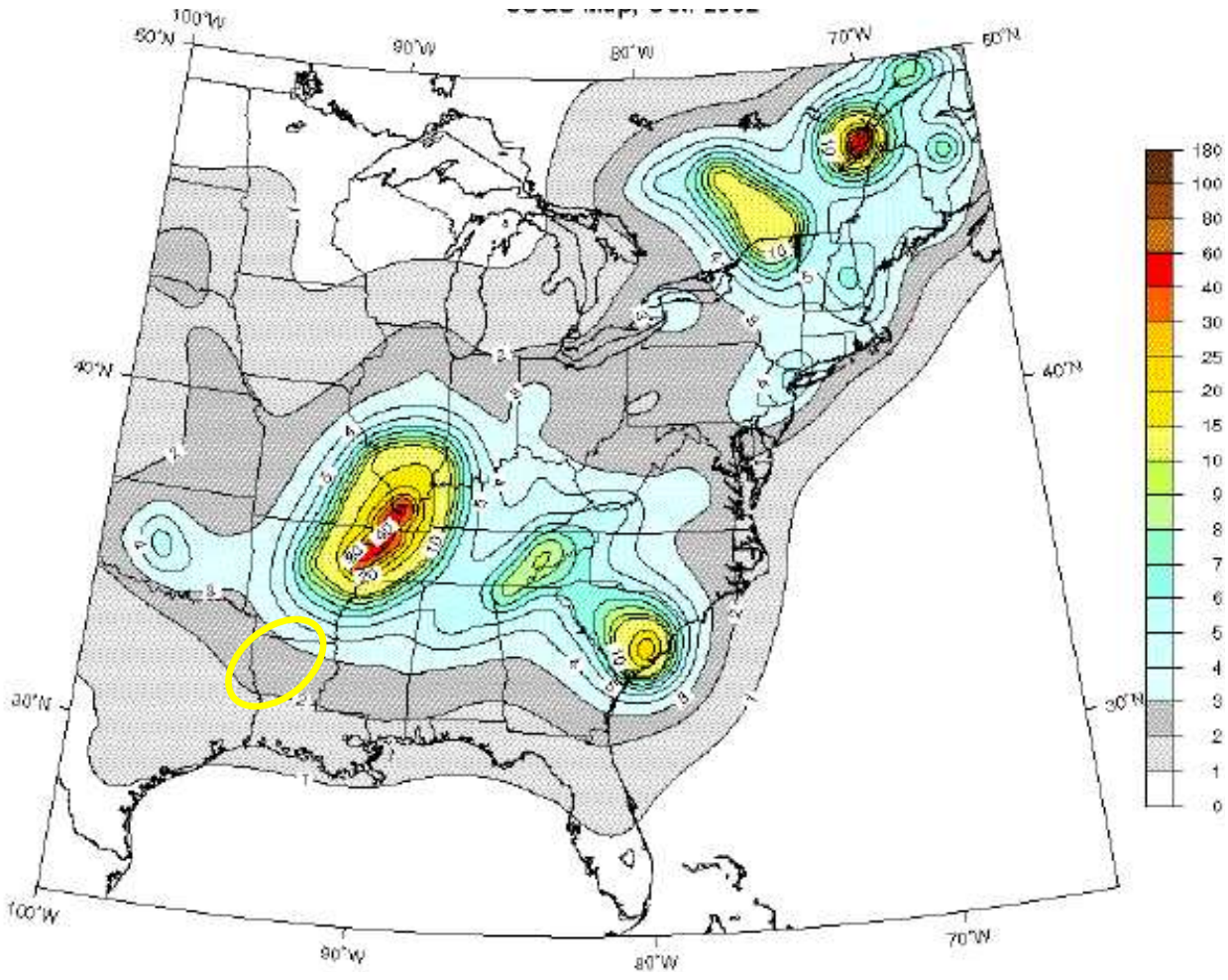
Source: USGS National Seismic Maps

Note: The approximate location of Bossier City is within the yellow oval

While faults throughout the northwestern parishes in Figure 4.9 are thought to be inactive, the New Madrid seismic zone lies just to the north of Louisiana and originates in the region of New Madrid, Missouri. The magnitude of historic earthquakes originating in the New Madrid seismic zone is far greater than that generated by the subsidence fault system in coastal Louisiana. A significant seismic event from the New Madrid seismic zone is more likely to have a far greater impact on Louisiana than that from a seismic event originating in the subsidence fault system.

Based on historic events, the most severe earthquakes in the State are likely to occur in the north (near the Arkansas – Mississippi border), originating from the New Madrid seismic zone, or in the south (near the coast), from the subsidence fault system. Figure 4.10 displays the Peak Ground Acceleration (PGA) and the 10% probability of exceeding normal ground motion in 50 years for the southcentral region of the United States. This regional perspective is necessary to understand the planning regions' close proximity of the New Madrid fault.

Figure 4.10. *Peak Acceleration (5g) with 10% Probability of Exceedance in 50 Years*



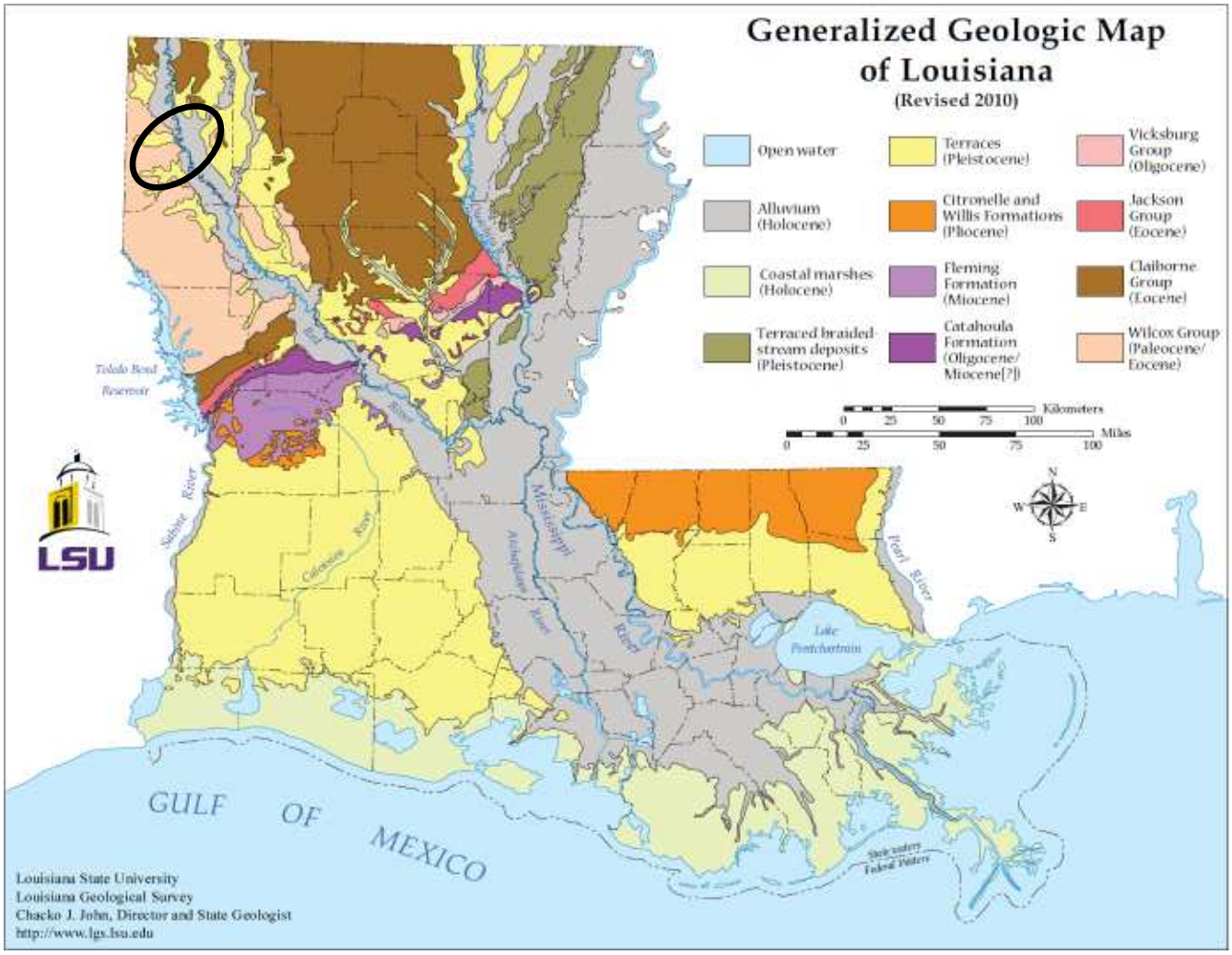
Source: USGS
Note: The approximate location of Bossier City is within the yellow oval

Seismic Structural Safety

Older buildings, oftentimes constructed before building codes were established, are the most likely to be damaged during an earthquake. Buildings one or two stories high of wood-frame construction are considered to be the most structurally resistant to earthquake damage. Older masonry buildings without seismic reinforcement (unreinforced masonry) are the most susceptible to structural failure that may cause injury or death.

The susceptibility of a structure to damage from ground shaking is also related to its underlying foundation material. A foundation of rock or very firm material can intensify short-period motions which affect low-rise buildings more than tall, flexible ones. A deep layer of water-logged soft alluvium can cushion low-rise buildings, but can accentuate the motion in tall buildings. The amplified motion resulting from softer alluvial soils can also severely damage older masonry buildings. Figure 4.11 shows geologic areas in Louisiana.

Figure 4.11. Geologic Map of Louisiana



Source: Louisiana State University, Louisiana Geological Society

Note: The approximate location of Bossier City is within the black oval

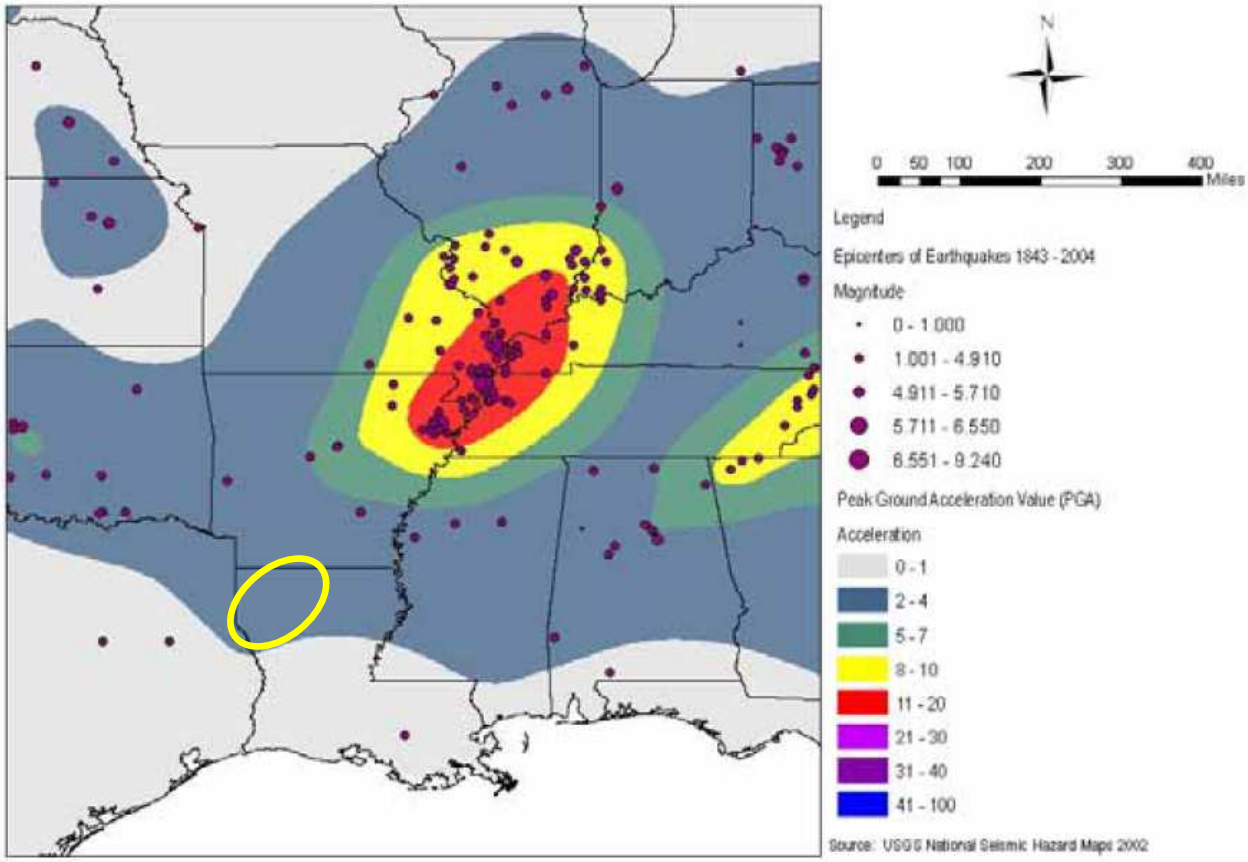
Past Occurrences

A number of earthquakes have occurred over the past 200 years in Louisiana, 44 of which were recorded by USGS (see Table 4.5). Most of the earthquakes were very minor. Figure 4.12 shows the location of the epicenters of all historical earthquakes felt during this period. The two most significant historic earthquakes were the New Madrid earthquakes (1811-1812) and the 1930 earthquake in Donaldsonville in southern Louisiana that measured 4.2 on the Richter scale.

Table 4.5. Louisiana Earthquake History

Event	Date	Latitude	Longitude	Depth (km) to focus of earthquake	Richter Magnitude
1	February 14, 1843	30.00	-90.00	-	-
2	February 15, 1843	30.00	-90.00	-	-
3	April 12,1882	30.00	-90.00	-	-
4	January 22, 1886	30.40	-92.00	-	-
5	February 3, 1905	30.50	-91.10	-	-
6	December 15, 1927	29.00	-89.40	-	3.9
7	July 28, 1929	29.00	-89.40	-	3.8
8	October 19, 1930	30.00	-91.00	-	4.2
9	December 2, 1940	33.00	-94.00	-	-
10	June 28, 1941	32.40	-90.90	-	-
11	September 20, 1947	31.90	-92.70	-	-
12	November 6, 1958	30.00	-90.00	-	-
13	November 19, 1958	30.30	-91.10	-	-
14	October 15, 1959	29.60	-93.10	-	3.8
15	April 24, 1964	31.38	-93.81	1	3.7
16	April 24, 1964	31.30	-93.80	-	2.6
17	April 24, 1964	31.42	-93.81	5	3.7
18	April 24, 1964	31.38	-93.80	5	3.2
19	April 24, 1964	31.30	-93.80	-	2.6
20	April 24, 1964	31.48	-93.79	9	3.2
21	April 24, 1964	31.30	-93.80	-	2.9
22	April 24, 1964	31.30	-93.80	-	2.8
23	April 24, 1964	31.30	-93.80	-	2.6
24	April 25, 1964	31.30	-93.80	-	2.6
25	April 25, 1964	31.30	-93.80	-	2.9
26	April 25, 1964	31.30	-93.80	-	2.9
27	April 26, 1964	31.30	-93.80	-	2.7
28	April 26, 1964	31.55	-93.78	5	3.3
29	April 27, 1964	31.30	-93.80	-	3.2
30	April 28, 1964	31.30	-93.80	-	3.1
31	April 28, 1964	31.40	-93.82	6	3.4
32	April 28, 1964	31.30	-93.80	-	4.4
33	April 28, 1964	31.63	-93.80	14	4.4
34	April 30, 1964	31.50	-93.80	-	3
35	May 2, 1964	31.30	-93.80	-	3.3
36	May 3, 1964	31.30	-93.80	-	3
37	May 7, 1964	31.50	-93.80	-	3.2
38	August 16, 1964	31.40	-93.80	-	2.9
39	August 19, 1964	31.30	-93.80	2.7	-
40	February 13, 1981	30.00	-91.80	-	-
41	February 18, 1981	29.56	-91.46	5	3
42	October 16, 1983	30.24	-93.39	5	3.8
43	June 10, 1994	33.01	-92.67	5	3.2
44	December 20, 2005	30.26	-90.71	5	3

Figure 4.12. Regional Perspective of Earthquakes



Note: The approximate location of Bossier City is within the yellow oval

Historically, major earthquakes have not been an issue for Bossier City. However, minor earthquakes have occurred in the Parish in the past. The HMPC has identified several earthquakes that were felt by area residents and/or caused shaking in Bossier City. The following details on some of these events were compiled from the USGS:

- **1811** – The New Madrid earthquake was one of the largest earthquake events ever to occur in the U.S. Occurring near New Madrid, Missouri, from December 16, 1811, to February 7, 1812, a number of earthquakes originated in this region, with the three strongest earthquakes thought to have magnitudes between 8.4 and 8.7 on the Richter scale. The strongest tremors were felt from New Orleans to Quebec and the course of the Mississippi River was permanently changed. Aftershocks were felt for more than 5 years after the initial series of earthquakes.
- **1895** – Another strong shock centered in southeastern Missouri on October 31, 1895, near Charleston, was felt in Louisiana.
- **1911** – On March 31, 1911, an earthquake centered near the towns of Rison and Warren, Arkansas. Houses swayed and arcticles were thrown from shelves in the epicentral area. The

shock was felt throughout Louisiana, and along the Mississippi River from Memphis to Vicksburg, an area roughly 200 miles north - south by 100 miles.

- **1930** – The largest recorded earthquake event originating in Louisiana occurred in Donaldsonville on October 19, 1930. The earthquake was felt over a 15,000-square-mile area of southeastern Louisiana. An earthquake centered about 60 miles west of New Orleans awakened many people throughout eastern Louisiana at about 6:17 a.m. on October 19, 1930. Maximum intensity reached VI at Napoleonville, where the entire congregation rushed from a church, as the entire building rocked noticeably. Intensity V effects were noticed at Allemands, Donaldsonville, Franklin, Morgan City, and White Castle, where small objects overturned, trees and bushes were shaken, and plaster cracked.
- **1957** – A small portion of northwestern Louisiana felt a number of small shocks from the neighboring area of Texas on March 19, 1957. Maximum intensity was limited to a few broken windows, a clock knocked from a wall, and overturned objects (V) near Gladewater and Marshall, Texas. Felt reports were received from Benton, Keithville, Mooringsport, Shreveport, and Vivian, Louisiana.
- **April 24, 1964 to August 16, 1964 -** Within this time span, a series of earthquakes occurred mostly in Texas near the Texas-Louisiana border, generally between the Toledo Bend Reservoir and the Sam Rayburn Reservoir. Epicentral MM Intensities ranged from IV to VI, and body-wave Magnitudes ranged from 3.0 to 4.0. These earthquakes were felt over small areas, and the epicenters appear to have been shallow, less than 5 kilometers deep. At the time of these events, the Sam Rayburn Reservoir was being filled, and the Toledo Bend Dam was being constructed. A deployment of portable seismograph instrumentation from July to September 1964 recorded more than 70 micro-earthquakes. Earthquake activity in this area abruptly decreased in frequency, intensity, and magnitude after the three-month period, with the last reported event occurring on August 19, 1964. No local earthquakes were recorded after September 1964.
- **2006** – A 5.8 magnitude earthquake in the Gulf of Mexico was felt throughout Louisiana. The earthquake was described by the USGS as a midplate earthquake, the largest and most widely felt recorded in the past three decades in the region.

Likelihood of Future Occurrences

Unlikely– Although Louisiana is not seismically active, it is evident from the historical record that small earthquakes occasionally do occur. The New Madrid seismic zone remains the area most likely to produce earthquakes that could affect Bossier City. Although there have been 44 recorded earthquakes in the Louisiana's 162 years of recorded history (recurrence interval of approximately 27 years), the hazard has been rated unlikely because of the minimal damage that it has caused to the Bossier City planning area.

4.2.4 Flood: General

Hazard/Problem Description

Floods are the most frequent and costly natural disasters in terms of human hardship and economic loss. Floods can cause substantial damage to structures, landscapes, and utilities and can create serious life safety issues. Certain health hazards, including standing water and wet materials in structures that can become breeding grounds for microorganisms such as bacteria, mold, and viruses are also common to flood events. This can cause disease, trigger allergic reactions, and damage materials long after the flood has occurred. When floodwaters contain sewage or decaying animal carcasses, infectious disease becomes a concern. Injuries and fatalities can be decreased, particularly in populated areas, with adequate warning and public education.

Bossier City is susceptible to various types of flood events. The following hazards that threaten the Bossier City planning area have been profiled separately: Section 4.2.5 100/500 –year Flooding, Section 4.2.6 Flash Flooding, and Section 4.2.7 Riverine Flooding.

The failure of a dam, levee or other flood control structure and associated flooding is also a concern to the Bossier City planning area. A catastrophic dam or levee failure could easily overwhelm local response capabilities and require mass evacuations to save lives. Impacts to life safety will depend on the warning time and the resources available to notify and evacuate the public. Major loss of life could result, and there could be associated health concerns as well as problems with the identification and burial of the deceased. This hazard is further addressed in Section 4.2.1 Dam/Levee Failure.

Bossier City Watershed and Drainage Basin

Bossier City is located within the Red River Watershed. The Red River Watershed covers approximately 65,590 square miles in Texas, Oklahoma, Arkansas, and Louisiana, and includes the Bossier City and Bossier Parish (see **Error! Reference source not found.**). The main tributary of this watershed, is the Loggy Bayou, mentioned above.

Bossier City lies in the Flat River Drainage Basin. The Flat River originates in the vicinity of Benton, LA and flows in a southerly direction between the Red River and Red Chute Bayou. The drainage basin consists of the flat alluvial lands of the Red River delta and the urban areas of Bossier City. Interior runoff enters the main stem through numerous bayous and the Flat River continues to be the main drainage outlet for Bossier City. Flows from the upper portions of the Flat River enter into the Red Chute Bayou through the Cutoff Bayou. A dam across the Flat River divides the drainage area into two basins. The Lower Flat River continues its southerly course to its confluence with Red Chute Bayou. The Flat River joins Loggy Bayou, which continues southward and drains into the Red River.

Past Occurrences

Bossier City has a history of flooding, but little definitive data is available for specific floods, particularly on the smaller streams. Historical records are not complete, but do indicate that significant flood events occurred in Bossier City between 1849 and 1908. Table 4.5 lists flood events, and is sorted by highest to lowest flood water levels. The HMPC provided information on more recent flood events, which are detailed below.

Table 4.6. Historical Crests for the Red River in Bossier City, 1849-1908

River Level	Date
45.90 ft	08/10/1849
45.70 ft	05/28/1892
45.10 ft	06/15/1908
44.70 ft	02/08/1890
44.40 ft	04/02/1894
44.10 ft	12/15/1902
43.60 ft	06/09/1905
43.10 ft	03/22/1903
42.70 ft	05/14/1884
41.90 ft	02/03/1889

Source: NOAA Advanced Hydrologic Prediction Service Shreveport Office
http://ahps.srh.noaa.gov/ahps2/hydrograph.php?wfo=shv&gage=svpl1&view=1,1,1,1,1,1,1,1
Note: Flood Stage is 30 feet, Moderate Flood Stage is 31.5 feet, and Major Flood Stage is 33 feet.

April-May 1952 – Flooding occurred as a result of rainfall from April 21st through May 3rd.

April-May 1958 – The highest flood stages since the construction of major flood control works occurred during this flood event. Rainfall during the period of April 25th and May 7th exceeded 14.7 inches in parts of Bossier Parish.

April-May 1966 – The flood was caused by intense rainfall over a 12 day period from April 21st to May 2nd.

November 1973-January 1974 – Flooding occurred as a result of adverse rainfall conditions during the period of November 24th, 1973 through January 28th, 1974 with 11.1 inches of rain recorded in Bossier Parish.

April-May 1979 – Unfavorable rainfall conditions occurred from January to May 1979. A severe storm near the end of this period, from April 20th to May 5th, added to existing flood conditions. 7.8 inches of rain were recorded for this event.

June 1986 – Flooding occurred as a result of tropical storm Bonnie during the period of June 27th through June 29th. Heavy rainfall caused significant flooding in the area of Barksdale Air Force Base along Flat River with 8.9 inches of rain recorded.

April- May 1991 – Extreme rainfall amounts during the period of April 1st through May 6th in Bossier Parish and the surrounding areas resulted in the overtopping and subsequent crevassing of a portion of the Red Chute Bayou Levee. 17.8 inches of rain was recorded in nearby Plain Dealing.

April 10, 1995 - Several streets in Bossier City were flooded by heavy rainfall; 2 to 3 inches were recorded in less than three hours time. No property damage or fatalities were recorded.

August 1, 1996 - Heavy rain resulted in the flooding of five homes in the Tall Timbers Subdivision. Some homes had three to five feet of water inside. Over $25,000 of property damage was recorded. No injuries or fatalities were reported.

February 20, 1997 – Severe flooding was reported in the Tall Timbers Community, with water reported in several homes. Damage estimates were not available, and no fatalities were recorded.

April 4, 1997 - Excessive and rapid rainfall lead to numerous road closures and flooded homes. Affected subdivisions were Northland Estates, Tall Timbers, Cakhill Estates and Lucky Estates. Over $203,000 in property damage was recorded. No injuries or fatalities were reported.

July 15, 2005 – Bossier City was hit by flash flooding during the evening of July 15th. Vehicles stalled in high water due to excessive heavy rainfall. In all, $50,000 in property damage was recorded. No injuries or fatalities were reported.

October 14, 2009 - Excessive heavy rainfall during the middle and latter portion of the month resulted in very high water conditions on the Red Chute Bayou from the Dogwood Trail bridge southward to Sligo, Louisiana and High Island. Extensive sand bagging operations commenced on the Red Chute Bayou during October 25th and continued through month's end in the area between Bossier City and Haughton, Louisiana. Parish emergency management reported that

some $50 million of damages were averted with the sand bagging operations and with the Red Chute - Flat River diversion system. Also, as levees were overtopped along the west edge of Red Chute Bayou, the National Weather Service (NWS) issued a Flash Flood Warning, which was consistent with NWS directives on October 31st. Several area residents assisted with the sand bagging efforts including first responders, correctional center inmates, military personnel from nearby Barksdale Air Force Base, the National Guard. Approximately 2,500 people living in subdivisions along and near the Red Chute Bayou were evacuated. Flood preparedness activities were estimated to have cost between $2 and $3 million alone. Federal Disaster Declarations for both tornado and flooding were approved for Bossier Parish as a result of the storm damage during the month of October. Over $3 million of property damage was sustained.

4.2.5 Flood: 100/500 –year Flood

Priority Hazard: **Yes**

Hazard/Problem Description

The area adjacent to a stream channel is its floodplain. The floodplain most often refers to the area that is inundated by the 1 percent annual chance flood (commonly referred to as the 100-year flood), the flood that has a 1 percent chance in any given year of being equaled or exceeded. The 1 percent annual chance flood is the national minimum standard to which communities regulate their floodplains through the National Flood Insurance Program (NFIP). Bossier City's involvement in the NFIP is described in Section 4.3.3 Vulnerability of the City of Bossier City to Specific Hazards and in Section 5.1.1 Continued Compliance with NFIP. The 0.2 percent annual chance flood (commonly referred to as the 500-year flood) is the flood that has a 0.2 percent chance of being equaled or exceeded in any given year. A 0.2 percent annual chance flood event would be slightly deeper and cover a greater area then a 1 percent annual chance flood event. The potential for flooding can change (and potentially increase) through various land use changes and changes to land surface.

Figure 4.37 The City of Bossier City's 1 percent Annual Chance and .2% Annual Chance Flood in Section 4.3.3 Vulnerability of the City of Bossier City to Specific Hazards shows the planning area's regulatory floodplains.

Floodplain Mapping

FEMA established standards for floodplain mapping studies as part of the NFIP. The NFIP makes flood insurance available to property owners in participating communities adopting FEMA-approved local floodplain studies, maps, and regulations. Floodplain studies that may be approved by FEMA include federally funded studies, studies developed by state, city, and regional public agencies, and technical studies generated by private interests as part of property annexation and land development efforts. Such studies may include entire stream reaches or

limited stream sections depending on the nature and scope of a study. A general overview of floodplain mapping is provided in the following paragraphs.

A Flood Insurance Study (FIS) develops flood-risk data for a community or part of a community; it is used to establish flood insurance rates and to assist the community in its efforts to promote sound floodplain management. The current Bossier City FIS is dated September 26, 2008.

A Flood Insurance Rate Map (FIRM) is developed by FEMA for flood insurance purposes and floodplain management applications. The FIRM designates flood insurance rate zones to direct assignment of premium rates for flood insurance policies. The FIRM delineates 1 percent annual chance and .2 percent annual chance floodplains and floodways. Locations of selected cross sections are also identified; their hydraulic detail are available in the FIS. Land areas that are within the 1 percent annual chance of flooding are called Special Flood Hazard Areas (SFHA) and are labeled as A zones (A, AE, AO, AH, etc.). Bossier City participates in the NFIP and therefore mandatory flood insurance purchase requirements apply to all Zones A (those areas subject to the 1 percent annual chance flood event).

Letters of Map Revision (LOMR) and Letters of Map Amendment (LOMA) address floodplain studies for individual properties or limited stream segments that are conducted after the FIRM is published. LOMR and LOMA updates are made to the FIS or FIRM between their periodic FEMA publications.

Bossier City's FIRM was updated and replaced by a Digital Flood Insurance Rate Map (DFIRM) on September 26, 2008 as part of FEMA's Map Modernization program. The DFIRM development is intended to:

- Incorporate the latest updates (LOMRs and LOMAs),
- Utilize community supplied data,
- Verify the currency of the floodplains and refit them to community supplied base maps,
- Upgrade the FIRMs to a GIS database format to set the stage for future updates and to enable support for GIS analyses and other digital applications, and
- Solicit community participation.

Bossier City's 2008 DFIRM was used for the vulnerability assessment in this plan; the methodology and results of that analysis are in Section 4.3.3 Vulnerability of the City of Bossier City to Specific Hazards.

Likelihood of Future Occurrences

Occasional—The 1 percent annual chance flood event has a recurrence interval of 100 years; the .2 percent annual chance event has a recurrence interval of 500 years.

4.2.6 Flood: Flash Flood

Priority Hazard: **Yes**

Hazard/Problem Description

Flash flooding describes localized floods of great volume and short duration. This type of flood usually results from heavy rainfall on a relatively small drainage area. Precipitation of this sort in Bossier City usually occurs in the winter and spring. Flooding from these intense weather events usually occurs in areas experiencing an increase in runoff from impervious surfaces associated with development and urbanization as well as inadequate storm drainage systems. A change in environment, typically created by human activity or development, can create localized flooding problems inside and outside of natural floodplains by altering or confining natural drainage channels. Heavy rains can overwhelm drainage systems in the City.

Flash floods often require immediate evacuation. Flash flooding is responsible for more US fatalities—more than 140 annually—than any other thunderstorm-associated hazard.

In addition to the major historical flood events described in Section 4.2.4 Flood: General, Bossier City remains at risk to annual localized flooding due to heavy rain and thunderstorms profiled in Section 4.2.11 Severe Weather: Heavy Rain/Thunderstorm/Lightning/High Wind.

Likelihood of Future Occurrences

Likely- Based on historical data and input from the HMPC, flooding events less severe than a 100-year flood and those outside of the 100-year floodplain occur frequently during periods of heavy rains.

4.2.7 Flood: Riverine Flood

Priority Hazard: **Yes**

Hazard/Problem Description

Riverine flooding occurs when a watercourse exceeds its "bank-full" capacity, generally as a result of prolonged rainfall, or rainfall that is combined with already saturated soils from previous rain events. This type of flood occurs in river systems whose tributaries may drain large geographic areas and include one or more independent river basins. Bossier City often experiences flooding, for example, in association with flooding in Oklahoma and Arkansas. The onset and duration of riverine floods may vary from a few hours to many days. Factors that directly affect the amount of flood runoff include precipitation amount, intensity and distribution, the amount of soil moisture, seasonal variation in vegetation, snow depth, and water-resistance of

the surface due to urbanization. In the Bossier City planning area, riverine flooding is largely caused by heavy and continued rains, increased outflows from upstream dams, and heavy flow from tributary streams. This flooding can overwhelm the local waterways as well as the integrity of any flood control structures. The warning time associated with slow rise floods assists in life and property protection.

Likelihood of Future Occurrences

Likely—Based on historical data and input from the HMPC, flooding events less severe than a 1 percent annual chance flood event and those outside of the 100-year floodplain occur frequently during periods of heavy rains.

4.2.8 Severe Weather: General

Severe weather is any destructive weather event. The following hazards occur in the planning area and have been profiled separately: Section 4.2.6 Extreme Heat, Section 4.2.7 Hailstorm, Section 4.2.8 Heavy Rain/Thunderstorm/Lightning/High Wind, and Section 4.2.9 Tornado.

The NCDC has been tracking severe weather since 1950. Their Storm Events Database tracks events on a county or parish basis and contains data on the following: all weather events from 1993 to current (except 6/1993-7/1993); and additional data from the Storm Prediction Center, which includes tornadoes (1950-1992), thunderstorm winds (1955-1992), and hail (1955-1992). This database contains 716 severe weather events (see Table 4.7) that have occurred in Bossier Parish from 1950 through October 2009; these events most usually have direct impact on the planning area. Additional input about these events was provided by the National Weather Service Forecast Office in Shreveport (http://www.srh.noaa.gov/shv/).

Table 4.7. NCDC Severe Weather Event Reports for Bossier Parish 1950-2009

Type	# of Events	Property Loss ($)	Crop Loss ($)	Deaths	Injuries
Drought	5	0	19,000,000	0	0
Excessive/Extreme Heat	8	0	0	20	0
Flash Flood	43	2,278,000	0	0	0
Flood	15	3,332,000	0	0	0
Freeze	1	0	50,000,000	0	1
Hail	277	50,020,000	0	0	0
High Wind	4	283,000	0	1	0
Hurricane / Tropical Storm	2	2,000,000	0	0	0
Ice Storm / Ice Fog	8	184,000,000	0	1	1
Lightning	14	10,506,000	0	0	3
Thunderstorm Winds	284	1,443,000	0	0	1
Tornado	48	301,017,000	0	21	421
Urban / Small Stream Flooding	4	0	0	0	0
Winter Weather	3	0	0	0	0
Totals*	**716**	**554,879,000**	**69,000,000**	**43**	**427**

Source: National Climatic Data Center Storm Events Database, www4.ncdc.noaa.gov/cgi-win/wwcgi.dll?wwEvent~Storms
*Losses reflect totals for all impacted areas

NCDC data was supplemented with data from the Hazards Research Lab at the University of South Carolina's Spatial Hazard Events and Losses Database for the United States (SHELDUS). SHELDUS is a county-level data set for the United States that tracks natural hazard events and associated property and crop losses, injuries, and fatalities from 1960 through 2008. From 1960 to 1995, only those events that generated more than $50,000 in damage were included in SHELDUS.

SHELDUS contains information on 188 severe weather events that occurred in Bossier Parish between 1960 and 2007. Table 4.7 summarizes these events.

Table 4.8. SHELDUS Severe Weather Event Reports for the Bossier Parish, 1960-2008

Type	# of Events	Property Loss ($)	Crop Loss ($)	Deaths	Injuries
Drought	2	-	1,882,350	0	0
Flooding (including hurricane, tropical storm, severe storm, thunderstorm -related)	19	7,162,336	1,178,125	0	9
Hail (associated with lightning, severe stormf/thunderstorm, wind)	34	10,812,563	2,500	1	3
Heat	9	-	85,938	13	0

Hurricane	7	8,724,698	1,136,720	0	276
Lightning (including severe storm, thunderstorm, wind - related)	18	10,459,740	181	0	3
Severe Storm (including thunderstorm, tornado, wind, winter weather - related0	41	1,423,791	9,813	1	8
Tornado	16	62,785,800	-	9	362
Wind	14	1,079,214	-	0	0
Winter Weather	28	16,111,586	229,402	1	1
Totals*	188	118,559,729	4,525,028	25	661

Source: SHELDUS, Hazards Research Lab, University of South Carolina, www.sheldus.org/
*Events may have occurred over multiple cities; damage may represent only a fraction of the total event damage and may not be specific to Bossier Parish and Bossier City

The NCDC and SHELDUS tables above summarize severe weather events that occurred in Bossier Parish. Only a few of the events resulted in state and federal disaster declarations. It is important to note that different data sources described above capture different events during the same time period, and may also capture different information about the same events. While the HMPC recognizes these inconsistencies, they see the value this data provides in depicting the Parish's "big picture" hazard environment.

As previously mentioned, all of Bossier City's state and federal disaster declarations have been a result of severe weather. For this plan, severe weather is broken down as follows:

- Extreme Heat
- Hailstorm
- Heavy Rain/Thunderstorm/Lightning/High Wind
- Tornado

4.2.9 Severe Weather: Extreme Heat

Priority Hazard: **No**

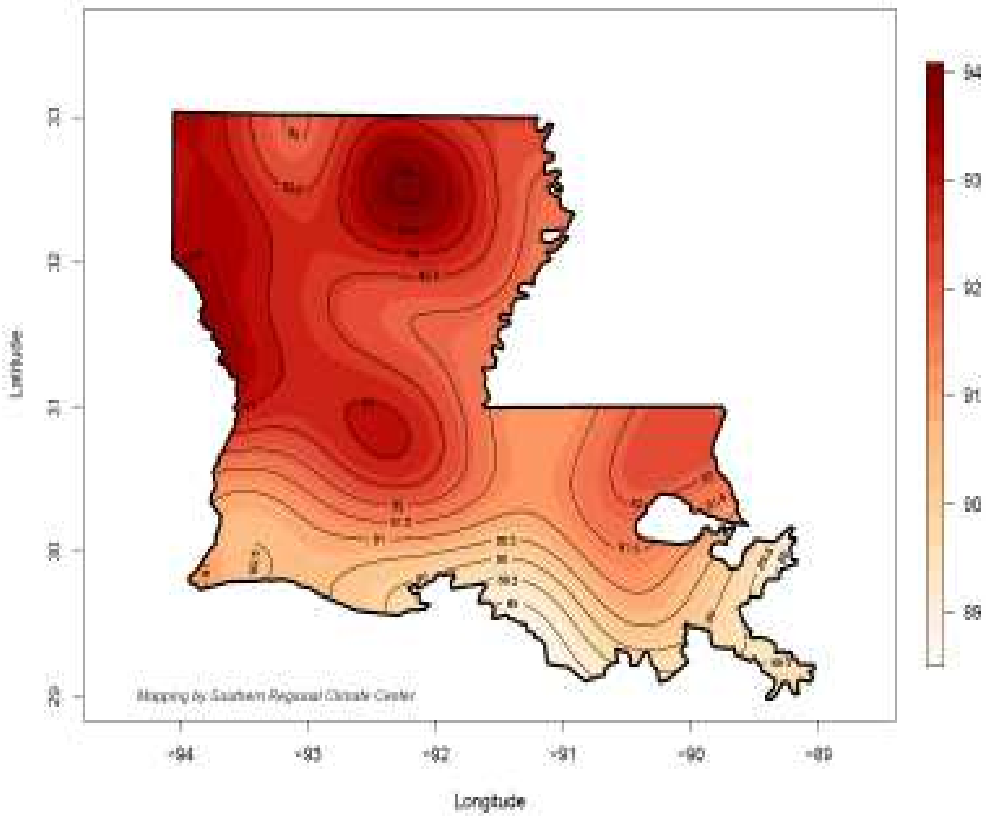
Hazard/Problem Description

Extreme heat refers to temperatures that hover 10 degrees or more above the average high temperature for the region and lasts for several weeks. Extreme heat events can have severe impacts on human health, natural ecosystems, and economic sectors such as agriculture. On average, about 175 Americans die as a result of extreme heat. Illness occurs when heat taxes the body beyond its abilities; after extended exposure to extreme heat, the body cannot compensate for fluids and salt lost through perspiration. Small children, the elderly, patients with chronic

medical conditions, overweight people, and alcoholics are particularly susceptible to heat-related conditions.

Bossier City begins to experience hot weather in May each year, and the heat continues throughout the summer months. According to the Southern Regional Climate Center, the average high temperature for Bossier City in July is 93.3°F (see Figure 4.14).

Figure 4.13. Average July High Temperatures in Louisiana (Based on 1971-2000 Normals)



NOAA's heat alert procedures are based on heat index values. The heat index, sometimes referred to as apparent temperature, is a measure of how hot it 'feels' when relative humidity is added to the actual air temperature. For example, if the air temperature is 96°F and the relative humidity is 65%, the heat index is 121°F (see Figure 4.14).

Figure 4.14. NOAA's Heat Index Chart

Temperature (°F)

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

Likelihood of Heat Disorders with Prolonged Exposure or Strenuous Activity

Caution Extreme Caution Danger Extreme Danger

Source: National Weather Service
IMPORTANT: Since heat index values were devised for shady, light wind conditions, exposure to full sunshine can increase heat index values by up to 15°F. Also, strong winds, particularly with very hot, dry air, can be extremely hazardous.
Note on the Heat Index Chart shaded zone above 105°F. This corresponds to a level that may cause increasingly severe heat disorders with continued exposure and/or physical activity.

NOAA and the NWS Shreveport office issue alerts when excessive heat events are forecasted and predicted. These products are issued when an excessive heat event is occurring, is imminent, or has a very high probability of occurrence. The warning is used for conditions posing a threat to life or property. The NWS has entered into agreements with the Arkansas, Louisiana, and Texas Offices of Emergency Management/ Services to issue Emergency Messages on NOAA Weather Radio and NOAA Weather Wire. Because of Bossier City's close proximity to Shreveport, residents should act in response to these alerts. The NWS can issue the following alerts:

- A **Heat Warning** is issued when an excessive heat event is expected in the next 12-24 hours. A warning is issued when the heat index is expected to be 100°F or more for 2 or more consecutive days.

- A **Heat Advisory** is issued when the heat index is expected to be between 104°F and 109°F for 2 or more consecutive days.

Past Occurrences

The HMPC identified the following events related to extreme heat in the Bossier City planning area:

May 18, 1998 - A woman working as a seamstress in her apartment in Bossier City was found dead; the death was determined to be heat related.

June 1998 - June 1998 suffered prolonged and excessively high temperatures making it the 3rd hottest month on record. The average temperature for the month was 84.9°F, which was 5.5°F above normal. The average maximum temperature was 96.0°F (normal is 89.7°F) and the average minimum was 73.7°F (normal is 69.0°F). A total of 27 days were 100.0°F degrees or higher and 5 days reached 105.0°F degrees and higher. In total, nine fatalities were attributed to this period of extreme heat.

June 12, 2006 - A Bossier City man was doing yard work outdoors when he began to suffer headache, nausea and fatigue. He was found passed out in his bathtub that night. He was taken to a local hospital where it was later confirmed that he died of a heat stroke.

August 8, 2006 - A 75 year old man was found dead in his home where he was living alone. The air conditioner was not on and it was extremely hot inside the home. The outside air temperature reached 97.0°F on the day the man was found.

August 4, 2008 - Heat across the region reached temperatures in excess of 100.0°F during the afternoon hours. The heat resulted in the death of a 75 year old woman who was found in her home.

Likelihood of Future Occurrences

Highly Likely—Extreme heat is highly likely to continue to occur annually in the planning area.

4.2.10 Severe Weather: Hailstorm

Priority Hazard: **No**

Description

A hailstorm is a storm event, oftentimes associated with other severe weather, where hailstones fall. Hailstones, often abbreviated to 'hail,' forms when updrafts carry raindrops into extremely cold upper portions of the atmosphere; the rain drops freeze into ice. Hail falls when it becomes heavy enough to overcome the strength of the updraft and is pulled by gravity towards the earth. The process of falling, thawing, moving up into the updraft and refreezing before failing again may repeat many times, increasing the size of the hailstone. Usually hailstones are less than 2"

in diameter, but have been reported much larger and may fall at speeds of up to 120 mph. Hailstorms occur throughout the spring, summer, and fall in the region, but are more frequent in late spring and early summer. These events are often associated with thunderstorms that may also cause high winds and tornadoes. Hail causes nearly $1 billion in damage to crops and property each year in the United States. If hail more than 1 inch is produced in a thunderstorm, the NWS qualifies the storm as 'severe'. Vehicles, roofs of buildings and homes, and landscaping are most commonly damaged by hailstorms.

The National Weather Service classifies hail by diameter size, and corresponding household object size. Table 4.8 indicates the hailstone measurements utilized by the National Weather Service.

Table 4.9. Hailstone Measurements

Average Diameter	Corresponding Household Object
.25 inch	Pea
.5 inch	Marble/Mothball
.75 inch	Dime/Penny
.875 inch	Nickel
1.0 inch	Quarter
1.5 inch	Ping-pong ball
1.75 inch	Golf-Ball
2.0 inch	Hen Egg
2.5 inch	Tennis Ball
2.75 inch	Baseball
3.0 inch	Teacup
4.0 inch	Grapefruit
4.5 inch	Softball

Source: National Weather Service

Hailstorms occur during severe storms, which are regional in nature. The amount, size, and duration of hail can vary significantly during a single storm and have a wide range of impacts. Hail can fall anywhere in Bossier City. The extent of impacts ranges from limited, where a single area within Bossier City is affected, to significant, where more than 50% of the City is impacted.

Previous Occurrences

The NCDC database records 277 hail events in Bossier Parish from 1950 through 2009. 22 of those storms reported hailstones at least 2 inches in diameter. Several selected incidents are profiled below. These selections illustrate the severity of the hail hazard for the jurisdiction and are representative of the range and risk, but are not comprehensive.

March 25, 1993 – Hail approximately 0.88 inches in diameter fell in Bossier City in the Golden Meadows subdivision.

April 5, 1994 - Hail approximately 0.88 inches in diameter fell in Bossier City.

April 22, 1995 - Devastating hail storm moved out of Caddo Parish and moved into Bossier Parish producing hail reported to be as big as softballs, across Louisiana Downs in northern Bossier City. Hail as large as 4.5 inches in diameter fell, causing approximately 50 million dollars in damage.

November 1, 1995 - Hail of approximately 1.75 inches in diameter was reported in Bossier City. Numerous reports of damage to vehicles inside the City were recorded by local insurance companies.

January 23, 1996 - Hail approximately 0.5 inches in diameter fell in Bossier City.

March 24, 1996 - Hail approximately 0.88 inches in diameter fell in Bossier City.

April 20, 1996 - Hail approximately 0.5 inches in diameter fell in Bossier City.

July 24, 1996 - Hail approximately 1.0 inches in diameter fell in Bossier City.

August 1, 1996 - Hail approximately 1.0 inches in diameter fell in Bossier City.

October 21, 1997 - - Hail approximately 0.75 inches in diameter fell in Bossier City in the Green Acres subdivision. Property damages estimates were unavailable. No injuries of deaths were recorded.

November 5, 1997 - Hail approximately 0.75 inches in diameter fell in Bossier City.

January 11, 1998 - Hail approximately 0.88 inches in diameter fell in Bossier City.

February 19, 1998 - Hail approximately 0.75 inches in diameter fell in Bossier City.

February 27, 1999 - Hail approximately 1.0 inches in diameter fell in Bossier City.

May 5, 1999 - Hail approximately 0.75 to 1.75 inches in diameter fell in Bossier City.

March 18, 2000 - Hail approximately 2.75 inches in diameter fell in Bossier City.

March 26, 2000 - Hail approximately 0.75 inches in diameter fell in Bossier City.

March 29, 2000 - Hail approximately 1.75 inches in diameter fell in Bossier City.

May 13, 2003 - Hail approximately 0.75 to 1.75 inches in diameter fell in Bossier City.

April 7, 2004 - Hail approximately 0.88 inches in diameter fell in Bossier City in the Golden Meadows subdivision.

June 16, 2005 - Hail approximately 2.75 inches in diameter fell in Bossier City.

November 15, 2005 - Hail approximately 1.00 inches in diameter fell in Bossier City.

March 27, 2007 – Hail approximately .75 inches in diameter fell in Bossier City. Strong winds aloft allowed supercell thunderstorms to develop, some of which produced tornadoes

April 25, 2007 - Hail approximately 1.75 inches in diameter fell in Bossier City. An outbreak of severe weather occurred across portions of northeast Texas and northwest Louisiana during the early morning hours and afternoon hours of April 25th, resulting in thunderstorms producing large hail and damaging thunderstorm wind gusts.

Likelihood of Future Occurrences

Highly Likely - The planning area experiences an average of 4-5 days of significant hail per year. The record of previous occurrences provides a useful reference for hailstorms that produced significant size stones and/or caused damage. There have been 277 severe incidents in Bossier Parish since 1950, a span of 59 years.

4.2.11 Severe Weather: Heavy Rain/Thunderstorm/Lightning/High Wind

Priority Hazard: **Yes**

Hazard/Problem Description

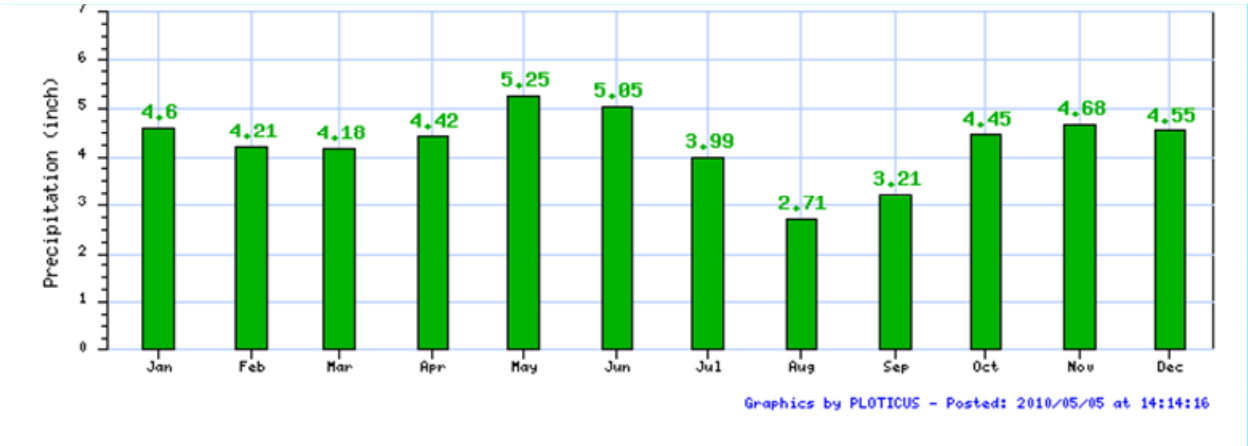
Storms in the Bossier City planning area are typically characterized by heavy rain accompanied by strong winds, and sometimes lightning and hail (hail is profiled separately in Section 4.2.10). A thunderstorm is classified as severe when it contains one or more of the following phenomena: hail that is 1 inch or greater, winds in excess of 50 knots (57.5 mph), or a tornado (profiled in Section 4.2.12). Approximately 10 percent of the thunderstorms that occur each year in the United States are classified as severe. Short-term, heavy storms can cause both widespread flooding and extensive localized drainage issues in the Bossier City planning area. Lack of adequate drainage systems has become more of an issue as population grows in the area.

The hazards profiled in this section will discussed separately, but so often are associated with each other in a weather event. Heavy rains and severe storms occur in the Bossier City planning area primarily during the late fall, winter, and spring, but have been documented every month of the year. Of the 11 federal disaster declarations in Table 4.1, four have been from severe storms.

Heavy Rain

Precipitation data from the Bossier City – Shreveport Airport Weather Station, for the period of record of 1948 to 2007, is summarized in Figure 4.15. Average annual precipitation in Bossier City is 52.1 inches per year. The highest recorded annual precipitation was 82.0 inches in 1991; the highest recorded precipitation for a 24-hour period is 12.3 inches on July 24-25, 1933.

Figure 4.15. Shreveport's Monthly Total Precipitation



Source: Southern Regional Climate Center, www.srcc.lsu.edu/

According to information from the NCDC and the Southern Regional Climate Center, the majority of precipitation in northern Louisiana is produced by storms during the spring, fall, and winter months. Precipitation during the summer months is in the form of rain showers and is less common.

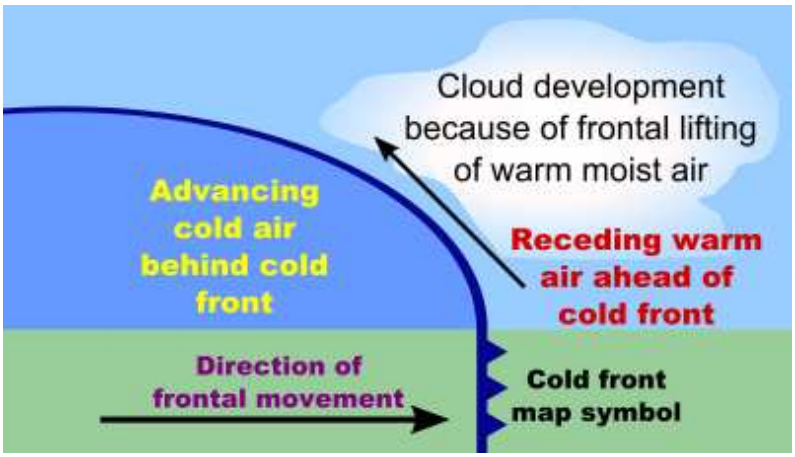
The El Niño Southern Oscillation (ENSO) weather phenomenon is the warm phase of a temperature oscillation in the Pacific Basin's water and atmosphere. During this phase, heat and moisture are released into the upper atmosphere, creating precipitation. El Niño alters the course of the jet stream - pushing it farther south than usual. According to NOAA, El Niño winters tend to be wetter than normal in the Southeastern United States, and contribute to flooding along the Gulf Coast. Storms that originate in the Gulf of Mexico typically track northeast on the southern jet stream, bringing rain as well as ice and snow to the Gulf states. The ENSO occurs on average every five years, over a period which varies from three to seven years.

Thunderstorm

All thunderstorms are dangerous, and most are accompanied by lightning, tornadoes, strong winds, hail, and flash flooding. Thunderstorms are responsible for the development and formation of many severe weather phenomena, posing great hazards to the population and landscape. Damage that results from thunderstorms is mainly inflicted by downburst winds, large hailstones, and flash flooding caused by heavy precipitation.

Thunderstorms result from the rapid upward movement of warm, moist air, typically along the boundary of a cold front (see Figure 4.16). The warm air moves upward, cools, condenses, and forms cumulonimbus clouds that can reach heights of greater than 35,000 ft. As the rising air reaches its dew point, water droplets and ice form and begin falling. As the droplets fall, they collide with other droplets and become larger. The falling droplets create a downdraft of air that spreads out at Earth's surface and causes the strong winds typically associated with thunderstorms.

Figure 4.16. Formation of a Thunderstorm



Source: NASA. http://rst.gsfc.nasa.gov/Sect14/Sect14_1c.html

Warm, humid conditions are favorable for the development of thunderstorms. The average single cell thunderstorm is approximately 15 miles in diameter and lasts less than 30 minutes at a single location. However, thunderstorms, especially when organized into clusters or lines, can travel intact for distances exceeding 600 miles.

The National Weather Service issues the following two types of alerts for severe thunderstorms:

A **Severe Thunderstorm Watch** is issued when a severe thunderstorm is likely to occur. Citizens are urged to watch the sky and stay tuned to NOAA Weather Radio, commercial radio, or television for information. Severe Thunderstorm Watches are issued by the Storm Prediction Center in Norman, OK.

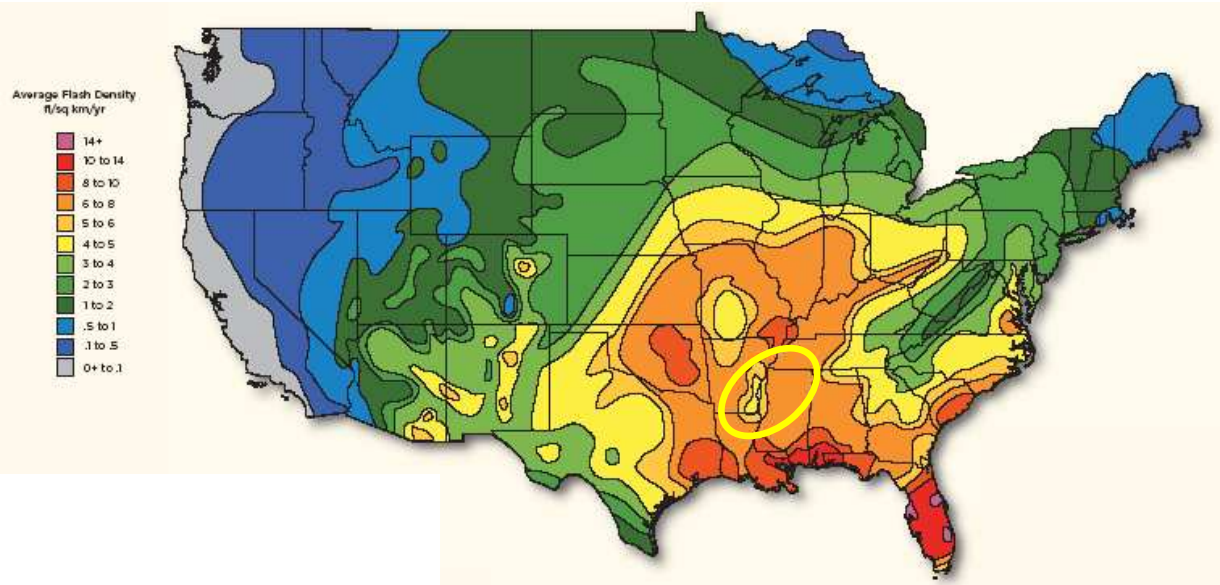
A **Severe Thunderstorm Warning** is issued when severe weather has been reported by spotters or indicated by radar. Warnings indicate imminent danger to life and property to those in the path of the storm. Severe Thunderstorm Warnings are issued by the National Weather Service in Shreveport.

Lightning

Lightning is an electrical discharge between positive and negative regions of a thunderstorm. A lightning flash is composed of a series of strokes, typically about four. Thunderstorms and lightning are usually accompanied by precipitation. Events called dry thunderstorms, however, produce lightning with no delivery of precipitation. In the United States, an average of 300 people are injured and 80 people are killed each year by lightning. Although most lightning victims survive, people struck by lightning often report a variety of long-term, debilitating symptoms.

Depending upon cloud height above ground and changes in electric field strength between cloud and earth, the discharge either stays within the cloud or makes direct contact with the earth. If the field strength is highest in the lower regions of the cloud, a downward flash may occur from cloud to earth. Using a network of lightning detection systems, the United States monitors an average of 22 million strokes of lightning from the cloud-to-ground every year. Figure 4.20 depicts the average number of lightning strikes for Bossier City and the rest of the United States. Bossier City receives 5-6 lightning flashes per square kilometer (13-15 lightning flashes per square mile).

Figure 4.17. National Lightning Flash Density Map



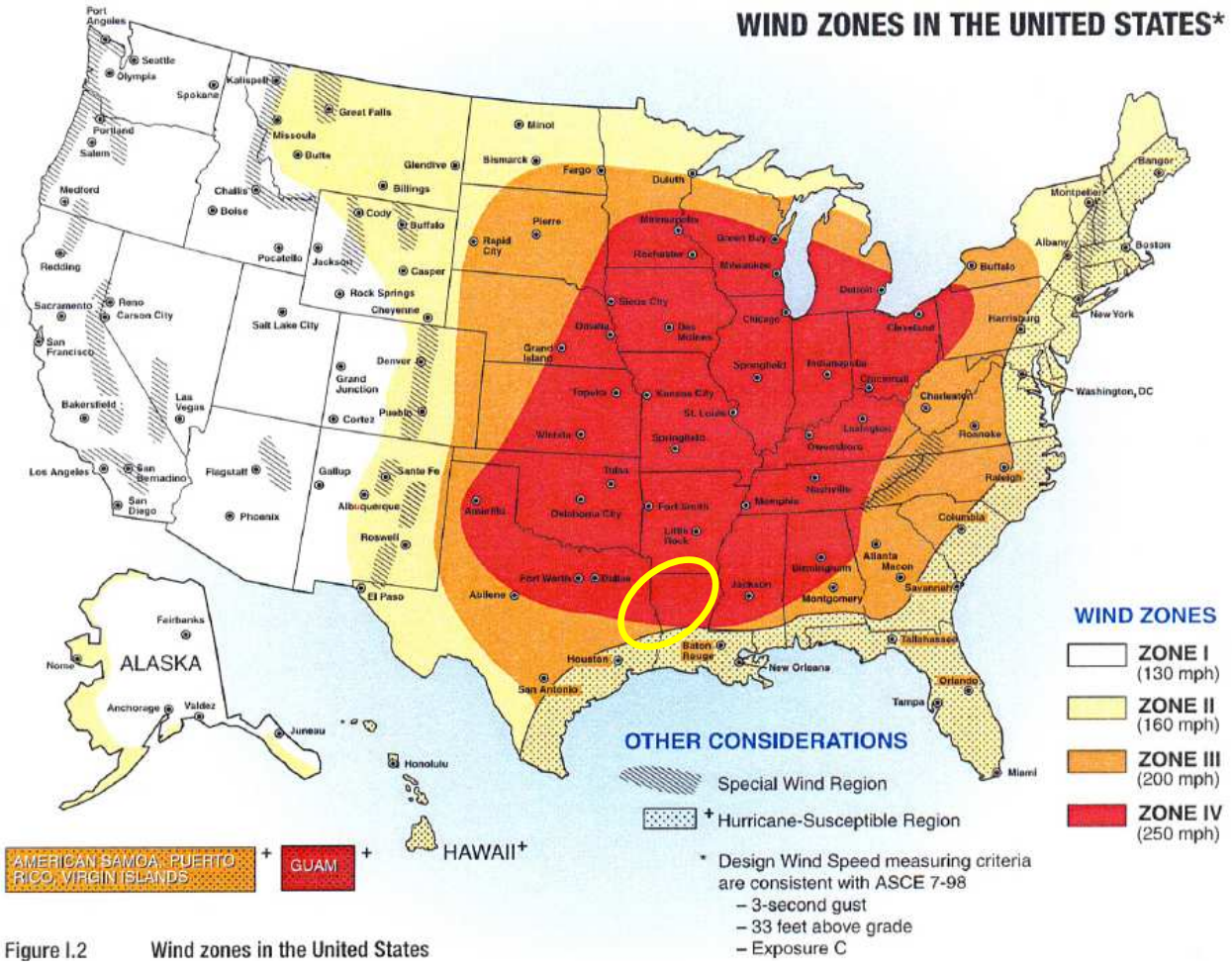
Source: NOAA's Lightning and Safety Program (http://www.lightningsafety.noaa.gov/more.htm)

Note: The approximate location of Bossier City is within the yellow oval

Winds

High winds often accompany severe thunderstorms and can cause significant property damage, threaten public safety, and have adverse economic impacts from business closures and power loss. Bossier City typically experiences straight-line winds, which can overturn mobile homes, tear roofs off of houses, topple trees, snap power lines, shatter windows, and sandblast paint from cars. Other associated hazards include utility outages, arcing power lines, debris blocking streets, dust storms, and an occasional structure fire. Strong winds, when combined with saturated ground conditions, can down very mature trees. Figure 4.18 illustrates the wind zones in the United States.

Figure 4.18. United States Wind Zones



Source: FEMA, http://www.fema.gov/plan/prevent/saferoom/tsfs02_wind_zones.shtm

Note: The approximate location of Bossier City is within the yellow oval

The National Weather Service issues the following four types of alerts for wind hazards:

A **Lake Wind Advisory** is issued for sustained winds ≥ 15 mph.

A **High Wind Watch** is issued when there is a potential for sustained winds > 40 mph.

A **High Wind Warning** is issued for sustained winds > 40 mph.

A **Wind Advisory** is issued for sustained winds of 30-40 mph.

Past Occurrences

Severe weather events associated with heavy rain/thunderstorm/lightning/wind are summarized in Table 4.7 and Table 4.8 in Section 4.2.8 Severe Weather: General. Further descriptions of major thunderstorm, lightning and wind events in Bossier City follow.

Heavy Rain/Thunderstorm Events[1]

April 10, 1995 - Several streets in Bossier City were flooded by 2-3 inches of rainfall in less than three hours.

April 22, 1995 - Widespread heavy rain (4-8 inches) fell across much of Northern Louisiana, producing flash flooding that closed numerous roadways. Urban flooding was noted in many parts of neighboring Shreveport with several homes being evacuated in low lying areas.

April 4, 1997 - Heavy rainfall in a short period of time led to numerous inundated city streets. Roads were barricaded and closed, with cars stalled and stranded in three to four feet of water.

May 27, 2000 – Streets flooded and closed throughout the city due to heavy rainfall.

July 15, 2005 – Excessive rainfall led to inundated roads and stalled vehicles.

June 20, 2007 - Large hail, heavy rainfall, and damaging thunderstorm gusts occurred across northeast Texas and northwest Louisiana.

May 14, 2008 - Excessive heavy rainfall began on May 13th and continued into the early morning of May 14th.

Lightning Events

April 10, 1995 - Lightning hit a house on Anita Street.

April 22, 1995 - Lightning destroyed a power transformer and caused a power outage in the southern part of Bossier City.

[1] Many of the heavy rain events are also profiled in the flood section, as these heavy rains often cause flash flooding.

August 30, 1995 - A lightning storm struck transformers in the city, causing power failure to over 4,000 residences.

April 22, 1997 - Three people were injured with minor burns when lightning hit the Barksdale Air Force Base Weapons Complex.

March 12, 2002 - Lightning caused a fire at the 8th Air Force Headquarters on Barksdale Air Force Base. The fire burned for more than 12 hours causing major damage to the third floor of the structure.

December 23, 2002 - Lightning struck a home in the Carriage Oaks Subdivision and started a fire; the home's attached garage and contents suffered the most damage.

May 14, 2008 - Lightning struck the Green Acres Village Apartments on Airline Drive in Bossier City. An 8 unit building was heavily damaged; its second floor was destroyed.

Wind Events

April 22, 1997 - Winds recorded by observers at the Barksdale AFB in Bossier City were clocked at 144 mph. Trees and power lines were toppled. 50% of Bossier City lost power for several days.

April 26, 1999 - 80 knot winds struck Bossier City. Several trees and a fence were blown down.

May 31, 2001 - Thunderstorm winds of 70 knots struck Bossier City. Several large trees were snapped or uprooted; some fell on houses and cars. There was extensive damage to homes in the Shady Grove Subdivision.

March 4, 2004 - Thunderstorm winds of 57 knots struck Bossier City; trees and power lines were downed throughout the city.

August 27, 2005 - Thunderstorm winds of 53 knots struck Bossier City. Greenacres Middle School suffered partial roof damage. Trees and power lines were downed as well.

November 27, 2005 - – Thunderstorm winds of 58 knots struck Bossier City. Car and apartment windows were blown out at the Cordova Apartments, and trees and power lines were blown down throughout the city.

February 24, 2007 - A vigorous upper level storm system moved into the southern plains and lower Mississippi Valley during the morning and afternoon hours of the 24th. Damaging thunderstorm wind gusts caused extensive damage on the northeast side of Bossier City near Hwy 80 and Industrial Drive.

March 27, 2007 - An upper level storm system moved across the region that produced supercell thunderstorms and some tornadoes. Associated wind gusts and large hail downed several trees southeast of town.

June 26, 2007 – Sporadic strong winds and lightning associated with thunderstorms downed several trees and power lines across portions of northeast Texas and northwest Louisiana. One tree was downed along with four light poles along interstate 20 on the east side of Bossier City.

March 18, 2008 - Strong low level winds nearing 60 knots downed trees and power lines across portions of northeast Texas as well as northwest Louisiana. Approximately 3,700 customers were without power across Caddo and Bossier Parishes during the height of the power outage period.

June 3, 2009 - A cold front pushed south into Bossier City on June 3rd, producing scattered to numerous thunderstorms. Several storms became severe during the afternoon, producing damaging winds and hail. Power lines were downed along Benton Road.

July 16, 2009 – Thunderstorm winds of 52 knots struck Bossier City. Widespread showers and thunderstorms developed across northeast Texas, southwest Arkansas, and northern Louisiana. These storms produced widespread wind damage and large hail.

Likelihood of Future Occurrences

Highly Likely—Heavy rain, thunderstorms, lightning, and wind are well-documented seasonal occurrences that will continue to occur annually in Bossier City.

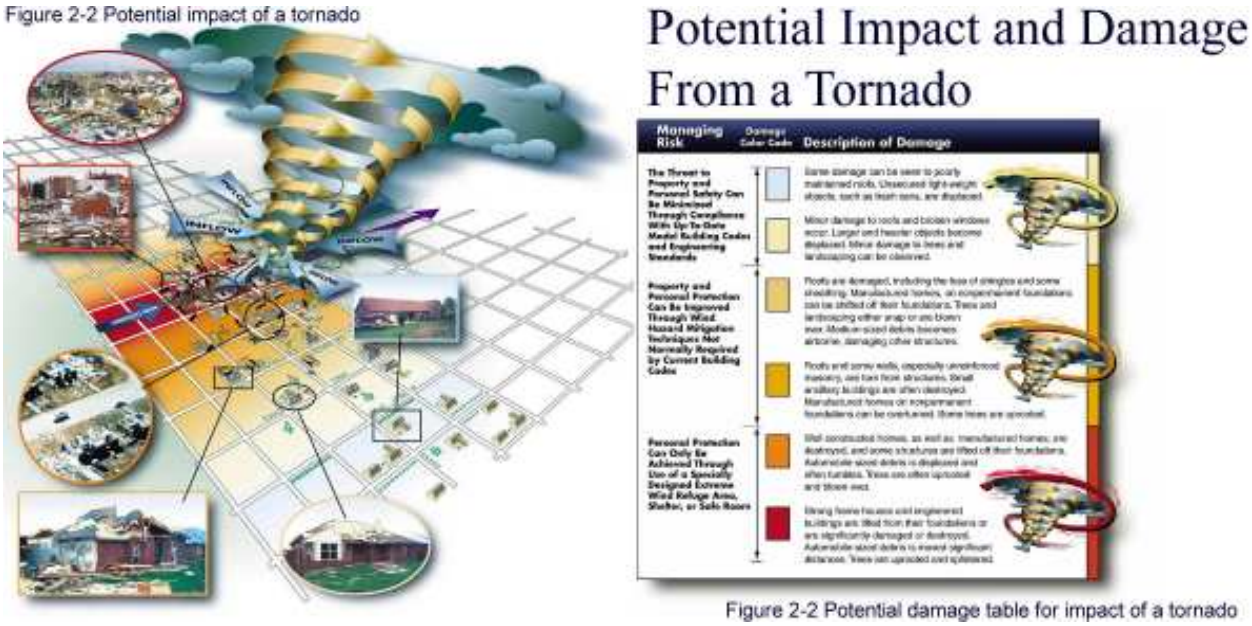
4.2.12 Severe Weather: Tornado

Priority Hazard: **Yes**

Hazard/Problem Description

Tornadoes are another severe weather hazard that affects Bossier City. Tornadoes form when cool, dry air sits over warm, moist air. Tornadoes are rotating columns of air marked by a funnel-shaped downward extension of a cumulonimbus cloud whirling at destructive speeds of up to 300 mph, usually accompanying a thunderstorm. Tornadoes are the most powerful storms that exist. They can have the same pressure differential that fuels 300-mile-wide hurricanes across a path only 300 yards wide or less. Figure 4.19 illustrates the potential impact and damage from a tornado.

Figure 4.19. Potential Impact and Damage from a Tornado



Source: FEMA: *Building Performance Assessment: Oklahoma and Kansas Tornadoes*

Prior to February 1, 2007, tornado intensity was measured by the Fujita (F) scale. This scale was revised and is now the Enhanced Fujita scale. The scales are sets of wind estimates (not measurements) based on damage. The new scale provides more damage indicators (28) and associated degrees of damage, allowing for more detailed analysis and better correlation between damage and wind speed. It is also more precise because it takes into account the materials affected and the construction of structures damaged by a tornado. Table 4.10 shows the wind speeds associated with the Enhanced Fujita Scale ratings. The Enhanced Fujita Scale's damage indicators and degrees of damage can be found online at www.spc.noaa.gov/efscale/ef-scale.html.

Table 4.10. Enhanced Fujita Scale

Enhanced Fujita (EF) Scale	Enhanced Fujita Scale Wind Estimate (mph)
EF0	65-85
EF1	86-110
EF2	111-135
EF3	136-165
EF4	166-200
EF5	Over 200

Source: National Oceanic and Atmospheric Administration Storm Prediction Center, www.spc.noaa.gov/faq/tornado/ef-scale.html

Tornadoes can cause damage to property and loss of life. While most tornado damage is caused by violent winds, most injuries and deaths result from flying debris. Property damage can include damage to buildings, fallen trees and power lines, broken gas lines, broken sewer and water mains, and the outbreak of fires. Agricultural crops and industries may also be damaged or destroyed. Access roads and streets may be blocked by debris, delaying necessary emergency response.

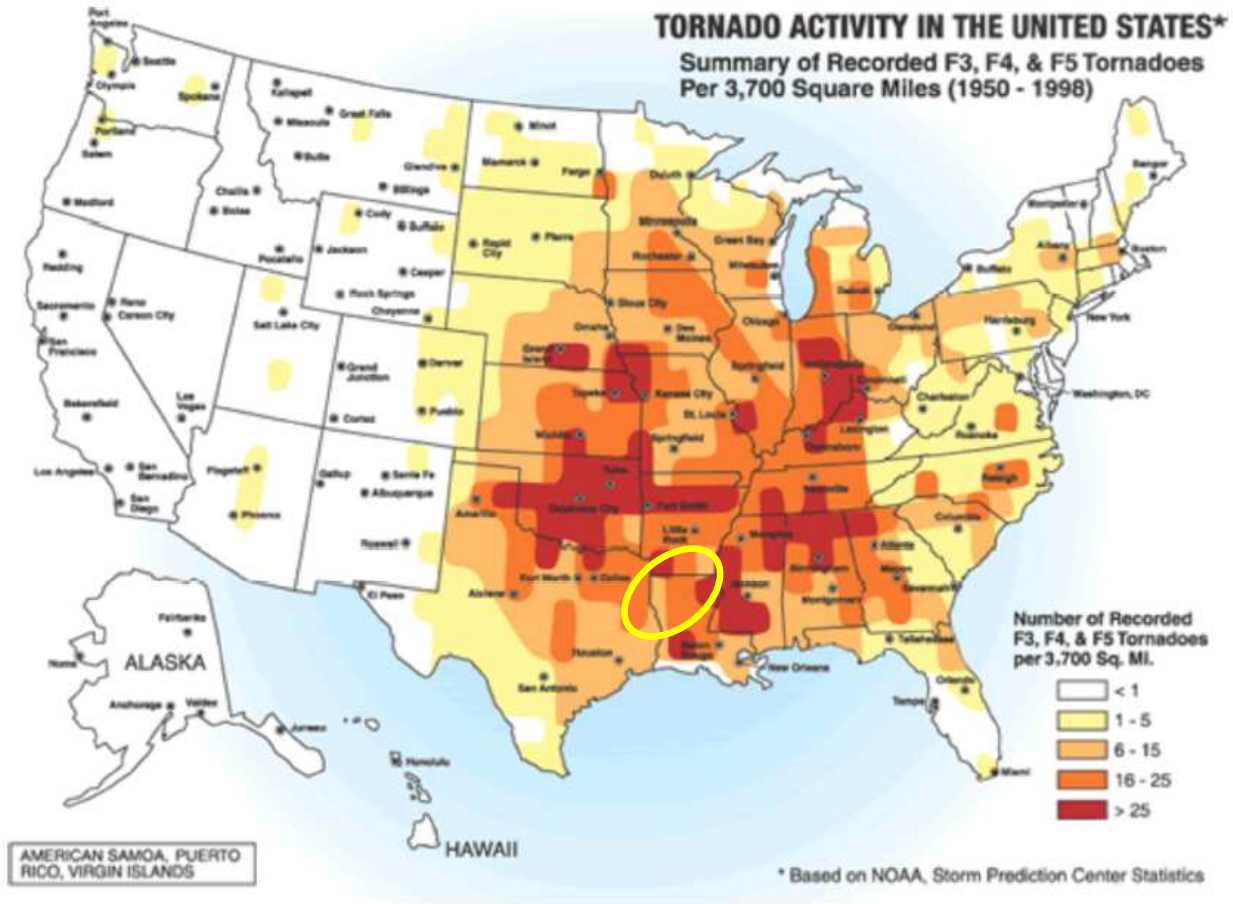
The National Weather Service issues the following two alerts for tornadoes:

- A **Severe Tornado Watch** indicates when and where severe tornadoes are likely to occur. Citizens are urged to watch the sky and stay tuned to NOAA Weather Radio, commercial radio, or television for information. Severe Tornado Watches are issued by the Storm Prediction Center in Norman, OK.
- A **Severe Tornado Warning** is issued when severe weather has been reported by spotters or indicated by radar. Warnings indicate imminent danger to life and property to those in the path of the storm. Severe Tornado Warnings are issued by the National Weather Service in Shreveport.

Past Occurrences

Based on NCDC data from 1950 to 1994, Louisiana ranks 11th among the 50 states for frequency of tornadoes, 13th for fatalities, 16th for injuries, and 15th for cost of damages. Figure 4.20 shows tornado frequency of the strongest and most violent (EF3, EF4, and EF5) tornadoes by state using NOAA data from 1950 to 1998.

Figure 4.20. Tornadoes in the United States, 1950-1998



Source: FEMA. http://www.fema.gov/plan/prevent/saferoom/tsfs02_torn_activity.shtm

Note: The approximate location of Bossier City is within the yellow oval

According to the HMPC, the planning area is prone to relatively strong thunderstorms, sometimes accompanied by funnel clouds and tornadoes. While tornadoes do occur occasionally, most often they are weak, ranking EF0 or EF1. However, there have been 19 tornadoes of higher intensity, causing greater amounts of property damage. Documented incidents of tornadoes in Bossier Parish from the NCDC Storm Events Database are listed in Table 4.11 and Figure 4.39 City of Bossier City Tornado Tracks and Touchdowns shows locations of many of those storms.

Table 4.11. Bossier Parish Tornadoes, 1950-2009

Type	# of Events	Property Loss ($)	Crop Loss ($)	Deaths	Injuries
Tornado: F0	4	5,000	0	0	0
Tornado: F1	24	2,852,000	0	0	14
Tornado: F2	8	10,885,000	0	0	2
Tornado: F3	8	30,325,000	0	3	12
Tornado: F4	3	256,950,000	0	18	393
Totals	**47**	**301,017,000**	**0**	**21**	**421**

Source: National Climatic Data Center Storm Events Database, www4.ncdc.noaa.gov/cgi-win/wwcgi.dll?wwEvent~Storms

February 12, 1950 – An F4 tornado struck the Bossier City area. The tornado caused 9 deaths and 37 injuries in and around Bossier City. Property damage was estimated at 250,000 dollars. The length of this tornado was estimated to be 82.6 miles. It caused 18 deaths, 77 injuries, and over a million dollars in damage.

December 3, 1978 - An F4 tornado touched down on the eastern bank of the Red River in Bossier City, Louisiana at approximately 1:50 A.M. (CST). The twister cut a path a .5 miles wide and nearly 4 miles long through the heart of Bossier City. Extensive damage was done to the Heart of Bossier Shopping Center, the Airline Drive corridor, the now-defunct Highway 80 entertainment district, and the Meadowview and Swan Lake subdivisions. Two young girls were killed when a car was thrown through their bedroom wall. 266 were injured during this tornado. Estimated damages were 250 million dollars.

January 23, 1996 – An F2 tornado struck Bossier City. A tornado touched down in south Shreveport just east of the Lucian Airport, moved across the airport and continued northeast across the southeast section of the city. Several retirement homes and numerous housing subdivisions were severely damaged. Thirty utility poles were destroyed leaving 10,000 customers without power.

April 3, 1999 - An F4 tornado struck Bossier City. 227 homes or businesses suffered either major damage or were destroyed. Roofs were missing on many homes and brick homes were leveled. One brick home was totally missing, leaving only the slab. Numerous large oak and pine trees uprooted or snapped near the bases. 7 deaths, 90 injuries, and 6.7 million dollars of property damage were attributed to this storm.

April 23, 2000 – The Easter Sunday Tornado Outbreak of April 23, 2000 produced 28 tornadoes across the four state region, the largest documented tornado outbreak in one day for this area. Although there were a large number of tornadoes that day, there was no loss of life. Four tornado touchdowns were noted across Caddo and Bossier Parishes with this outbreak. Two of these tornadoes impacted portions of Shreveport, causing moderate to severe damage in the northern and southern sections of town. The tornado that struck North Shreveport developed over Cross Lake (as a waterspout) and moved onto land (as a tornado), eastward into Downtown Shreveport,

causing F1 damage. A second tornado (F2) developed near Greenwood and tracked eastward into South Shreveport (near Stagecoach Rd.), destroying several homes and causing extensive damage across South Shreveport, before crossing the Red River into Southern Bossier Parish. This tornado intensified as it cross the river (F3), causing severe damage just south of Elm Grove. In addition, golfball to softball sized hail had been reported over much of Shreveport and Bossier City as these storms rolled through. Fortunately, no deaths or injuries were reported in Bossier City, but property damage exceeded one million dollars. This tornado also struck Elm Grove and Plain Dealing, causing 4.3 million dollars in damage and injuring one.

February 24, 2007 – An EF1 tornado struck Bossier City. The number of damaged structures was between 40 and 60 homes. The extent of damage ranged from a few shingles blow off some homes to substantial roof loss on other homes. Most of the homes that sustained damage had only roof shingles blown off. The damage path was located on the north side of Bossier City, north of Interstate 220, in the Hickory Ridge and Carriage Oaks subdivisions. The damage path was approximately one mile in length and 250 yards wide. The damage path ran parallel to Hickory Ridge Rd. and Lake Side Rd., beginning near Coach Rd. and ending near Coy Rd., in Bossier City. No injuries or fatalities were reported.

April 9, 2009 – An EF2 tornado struck Bossier City. This storm developed over eastern Harrison County about 6 miles northwest of Waskom. This tornado first touched down about one half mile west of FM 134, continuing east across FM 9 about 3 miles north of Waskom, before entering western Caddo Parish. Numerous trees were uprooted and snapped, especially east of FM 9, and across Highway 169. This tornado followed North Lakeshore Drive, with numerous homes damaged, some of which had their roofs partially removed. In addition, one of the homes was moved off of its foundation. Near I-220 and Blanchard Road, 12 empty railroad cars were blown off the track, with intermittent damage along Blanchard Road going into downtown Shreveport. Large tree limbs and power lines were downed; road signs were downed as well. The tornado crossed the Red River south of the Diamond Jacks Casino, where numerous homes were damaged due to trees between Arthur Ray Teague Parkway and Barksdale Blvd. On Barksdale Blvd, numerous power poles were downed, many businesses damaged, and the west gate of Barksdale Air Force Base was damaged. The storm did 2.5 million dollars worth of damage to the Barksdale Air Force Base including to the west gate, the golf course, fitness center and Chapel Two. Approximately 80 trees were uprooted around the main base. The tornado lifted in eastern Bossier Parish along Highway 157 south of Haughton. This tornado was rated an EF2, with winds of around 120 mph, and the most extensive damage found in the Lakeview Subdivision on the north side of Cross Lake in Caddo Parish. The total path length from Harrison County Texas through Bossier Parish was 38.5 miles. The path width fluctuated through this continuous track, varying from between 100 to 400 yards.

October 29, 2009 - The events of October 28-30, 2009 began as a very strong upper level low pressure system moving across the Texas/Oklahoma Panhandles on the 28th. Moisture began to return to the region as the low level winds increased ahead of this system, and scattered showers began to develop across the region in the early hours of the 29th. Showers and thunderstorms

increased ahead of the cold front. The National Weather Service in Shreveport issued the first Tornado Warning of the event at around 1 pm on the 29th. Flash flooding became a problem by the late afternoon of the 29th, as the thunderstorms continued to move over. As the cold front began moving through the region, the tornadic threat transitioned into a full-blown flash flooding event. The cold front stalled over Deep East Texas, Northwest Louisiana, and Southwest Arkansas overnight and into the 30th. Widespread flash flooding was reported across areas of North Louisiana during this time. The rainfall also aggravated and worsened flooding that was ongoing across North Louisiana.

Likelihood of Future Occurrences

Likely - 47 tornadoes occurred over 59 years in Bossier Parish, one tornado every 1.25 years on average, and an 80 percent chance of a tornado occurring in any given year. Historical tornado activity within the planning area indicates that the area will likely continue to experience the formation of funnel clouds and weak tornadoes during adverse weather conditions. The actual risk to the City is dependent on the nature and location of any given tornado.

4.2.13 Soil Hazard: General

Soil erosion and instability constitute a hazard that can produce social and economic loss of great consequence. The hazard is less catastrophic and has a slower onset than other hazards discussed in this plan, but the affect can be equally or more destructive to life and property. The following hazards have been profiled separately: Section 4.2.14 Stream Bank Erosion/Stability and Section 4.2.15 Subsidence. Stream bank erosion is a natural process; acceleration of this process leads to a disproportionate sediment supply, stream channel instability, land loss, habitat loss and other adverse effects. Subsidence occurs both naturally and through man-driven or technologically exacerbated circumstances, such as through oil and gas extraction.

4.2.14 Soil Hazard: Stream Bank Erosion/Stability

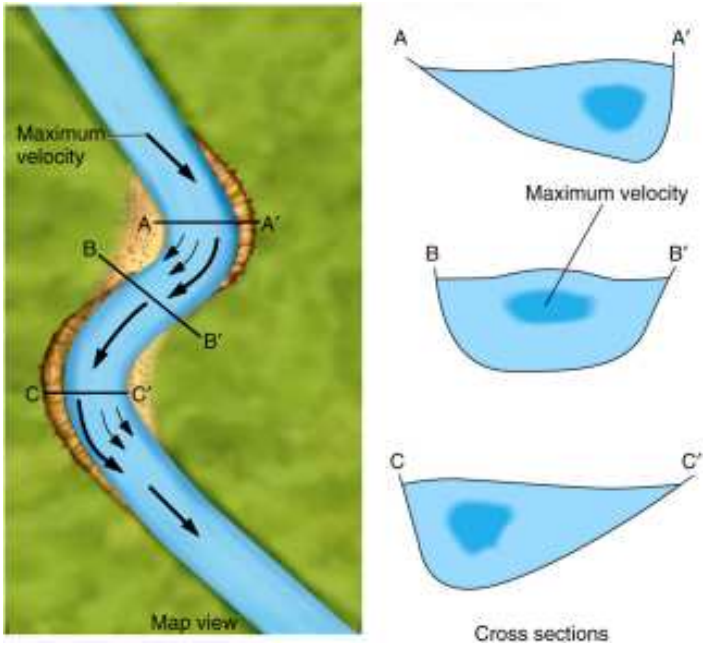
Priority Hazard: **No**

Hazard Profile/Description

A stream is any flowing body of water (brook, creek, stream, river). Stream flow is expressed as volume per unit time, usually cubic meters per second, cubic feet per second, sometimes cubic kilometers per second, or acre-feet per second or day. Stream flow varies tremendously with time. Short term controls include rainfall, snowmelt, and evaporation conditions. Long term controls include land use, soil, groundwater state, and rock type.

Streams erode by a combination of direct stream processes, like down cutting and lateral erosion, and indirect processes, like mass-wasting accompanied by transportation. Water tends to move downstream in slugs that extend all the way across a channel. When the channel bends, water on the outside of the bend (the cut-bank) flows faster and water on the inside of the bend (the point) flows slower. This distribution of velocity results in erosion occurring on the outside of the bend (cut) and deposition occurring on the inside of the bend.

Figure 4.21. Meanders and Stream flows



Stream bank erosion processes, although complex, are driven by two major components: stream bank characteristics (erodibility) and hydraulic/gravitational forces. Many land use activities can affect both of these components and lead to accelerated bank erosion. The vegetation rooting characteristics can protect banks from fluvial entrainment and collapse, and also provide internal bank strength. When riparian vegetation is changed from woody species to annual grasses and/or forbs, the internal strength is weakened, causing acceleration of mass wasting processes. Stream bank aggradation or degradation is often a response to stream channel instability (see Figure 4.22). Since bank erosion is often a symptom of a larger, more complex problem, the long-term solutions often involve much more than just bank stabilization. Numerous studies have demonstrated that stream bank erosion contributes a large portion of the annual sediment yield.

Figure 4.22. Remnant "River Pedestals" Indicating High Rates of Lateral Erosion

Source: Watershed Assessment of River Stability & Sediment Supply (WARSSS)

Determining the cause of accelerated streambank erosion is the first step in solving the problem. When a stream is straightened or widened, streambank erosion increases. Accelerated streambank erosion is part of the process as the stream seeks to re-establish a stable size and pattern. Damaging or removing streamside vegetation to the point where it no longer provides for bank stability can cause a dramatic increase in bank erosion. A degrading streambed results in higher and often unstable, eroding banks. When land use changes occur in a watershed, such as clearing land for agriculture or development, runoff increases. With this increase in runoff the stream channel will adjust to accommodate the additional flow, increasing streambank erosion. Addressing the problem of streambank erosion requires an understanding of both stream dynamics and the management of streamside vegetation.

The Bossier City Ditch suffers from ongoing instability and erosion of channel embankments. Bossier City, the City Engineering Office, Louisiana Department of Transportation and Development, and the Bossier Levee District have embarked on a project to pave the Ditch to mitigate future instability and erosion issues on the Ditch.

Past Occurrences

Slopes along the east bank of the Flat River have begun to erode and slide, threatening homes located along the top bank of the river. The Bossier Levee District is currently implementing river stabilization projects in this area.

More detail of the stream bank erosion/stability issues listed above can be found in Section 4.4.4.

Probability of Future Occurrence

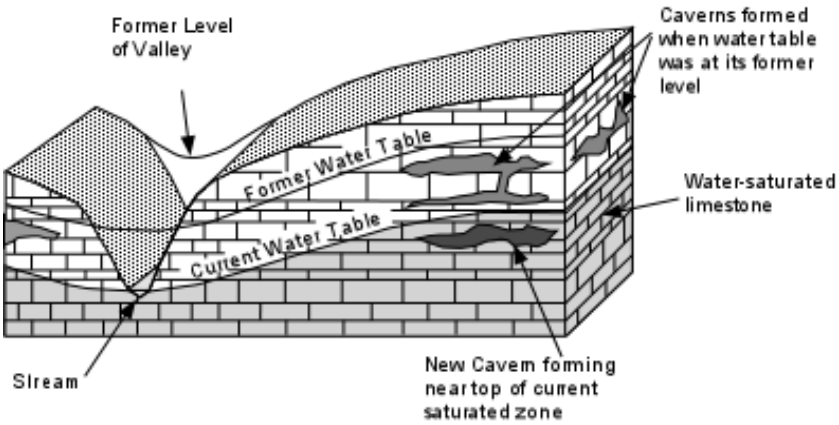
Likely – Stream bank erosion and stability issues are an ongoing hazard. Although mitigation measures are being implemented to reduce the impacts of the hazard in Bossier City, it will continue to occur along those stream banks that are not paved or stabilized.

4.2.15 Soil Hazard: Subsidence

Hazard Profile/Description

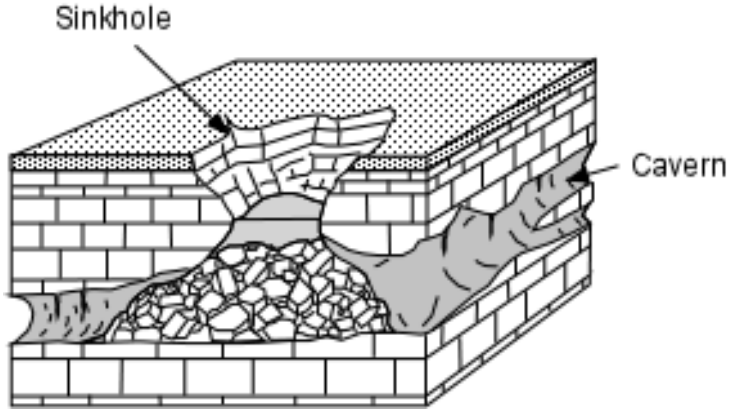
Land subsidence is the sinking of the land over manmade or natural underground voids. Natural causes of subsidence occur when water in the ground dissolves minerals and other materials in the earth, creating pockets or voids (see Figure 4.23). When the void can no longer support the weight of the earth above it, it collapses, causing a sinkhole depression in the landscape (see Figure 4.24). Often, natural subsidence is associated with limestone erosion, but may also occur with other water-soluble minerals. Man-driven or technology-exacerbated subsidence conditions are associated with the lowering of water tables, extraction of natural gas, or subsurface mining activities (see Figure 4.25). As the underground voids caused by these activities settle or collapse, subsidence occurs on the surface. The most common type of sudden collapse is due to erosion of underground soil or rock caused by leaking human-made sewer pipes or water mains. This rarely destroys large areas, but can be so large as to swallow a vehicle.

Figure 4.23. Subsidence Caused by Changes in Water Table



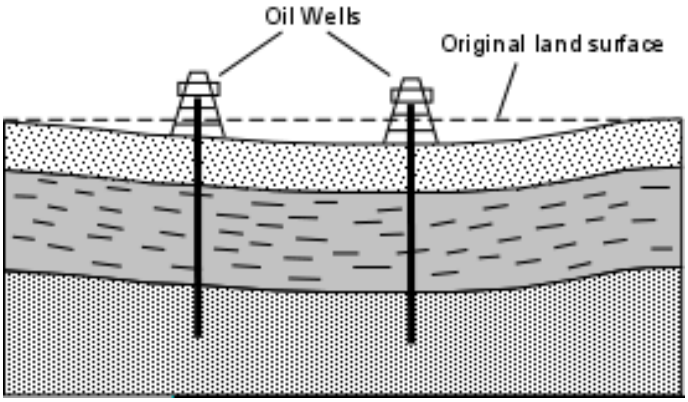
Source: Murck, Barbara W., Brian J. Skinner, and Stephen C. Porter, 1997, Dangerous Earth, An Introduction to Geologic Hazards. 299 pp.

Figure 4.24. Sinkhole Caused by Collapse of an Underground Cavern



Source: Tulane University; http://www.tulane.edu/~sanelson/geol204/subsidence.htm

Figure 4.25. Subsidence Caused by Oil Extraction



Source: Tulane University; http://www.tulane.edu/~sanelson/geol204/subsidence.htm

Subsidence can create two distinct problems in Bossier City: (1) by lowering elevations, subsidence may make structures more vulnerable to flooding; and (2) by destabilizing elevations, subsidence undermines the accuracy of surveying benchmarks (including those affecting levee heights, coastal restoration programs, surge modeling, BFEs, and other engineering inputs) which can contribute to additional flooding problems if construction occurs at lower actual elevations than anticipated or planned.

Due to the extraction of oil and gas in Bossier City (see Figure 4.33), there is risk of subsidence. It is predicted that there will be approximately 50 oil and gas wells in the City of Bossier City in the next 10 years; the potential for subsidence is likely to increase.

Past Occurrences

Subsidence has not been identified as a significant contributor to direct disaster damages in Bossier City to date.

Likelihood of Future Occurrence

Unlikely - Subsidence rates can vary greatly over time and geographic location, and there is no clear consensus on appropriate Bossier City rates to use for planning and design purposes.

4.2.16 Tropical Storm/Hurricane

Priority Hazard: **Yes**

Hazard Profile/Description

The terms "hurricane" and "typhoon" are regionally specific names for a strong "tropical cyclone." A tropical cyclone is the generic term for a non-frontal large scale low-pressure system over tropical or sub-tropical waters with organized convection (i.e. thunderstorm activity) and definite cyclonic surface wind circulation.

Tropical cyclones with maximum sustained surface winds of less than 17 m/s (34 kt, 39 mph) are called "tropical depressions." Once the tropical cyclone reaches winds of at least 17 m/s (34 kt, 39 mph) they are typically called a "tropical storm" and assigned a name. If winds reach 33 m/s (64 kt, 74 mph), then they are called:

- Hurricane (the North Atlantic Ocean, the Northeast Pacific Ocean east of the dateline, or the South Pacific Ocean east of 160E)
- Typhoon (the Northwest Pacific Ocean west of the dateline)
- Severe Tropical Cyclone (the Southwest Pacific Ocean west of 160E or Southeast Indian Ocean east of 90E)
- Severe Cyclonic Storm (the North Indian Ocean)
- Tropical Cyclone (the Southwest Indian Ocean)

As tropical depressions intensify, they become classified into separate categories according to the criteria set forth in Table 4.12.

Table 4.12. Classification of Hurricanes

Stage of Development	Criteria
Tropical Depression (development)	Maximum sustained surface wind speed is < 39 mph
Tropical Storm	Maximum sustained surface wind speed ranges from 39 - <74 mph
Hurricane	Maximum sustained surface wind speed is at least 74 mph
Tropical Depression (dissipation)	Decaying stages of a cyclone in which maximum sustained surface wind speed has dropped below 39 mph

Source: NOAA

The distinguishing feature of a hurricane is the eye around which winds rotate. The eye, the storm's core, is an area of low barometric pressure that is generally 10 to 30 nautical miles in diameter. The surrounding storm may be 100 to 500 miles in diameter.

The Saffir/Simpson Hurricane Scale is used to classify storms by numbered categories (see Table 4.13). Hurricanes are classified as Categories 1 through 5 based on central pressure, wind speed, storm surge height, and damage potential.

Table 4.13. Saffir/Simpson Hurricane Scale

Storm Category	Central Pressure	Sustained Winds	Storm Surge	Potential Damage
1	> 980 mbar	74 - 95 mph	4 – 5 ft	Minimal
2	965 – 979 mbar	96 - 110 mph	6 – 8 ft	Moderate
3	945 – 964 mbar	111 – 130 mph	9 – 12 ft	Extensive
4	920 – 944 mbar	131 – 155 mph	13 – 18 ft	Extreme
5	< 920 mbar	> 155 mph	> 18 ft	Catastrophic

Hurricanes involve both atmospheric and hydrologic characteristics; those associated with hurricanes that could affect Bossier City include:

- High Winds
- Tornadoes
- Flooding

High Winds

The intensity of a landfalling hurricane is expressed in terms of categories that relate wind speeds and potential damage. According to the Saffir-Simpson Hurricane Scale in Table 4.13, a Category 1 hurricane has lighter winds compared to storms in higher categories. A Category 4 hurricane would have winds between 131 and 155 mph and, on the average, would be expected to significantly more damage than the Category 1 storm. Depending on circumstances, less intense storms may still be strong enough to produce damage, parcticularly in areas that have not prepared in advance.

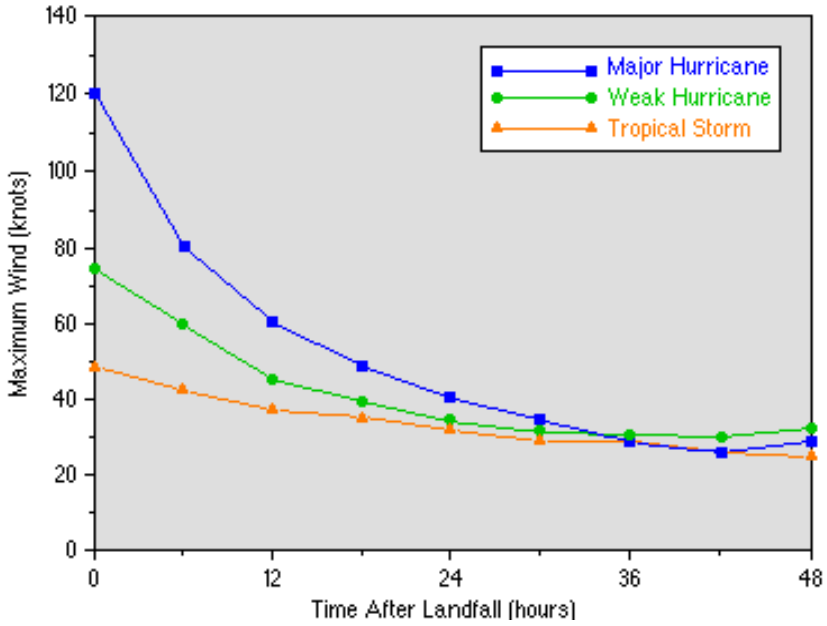
Hurricane force winds can easily destroy poorly constructed buildings and mobile homes. Debris such as signs, roofing material, and small items left outside become flying missiles in

hurricanes. Extensive damage to trees, towers, water and underground utility lines (from uprooted trees), and fallen poles cause considerable disruption.

High-rise buildings are also vulnerable to hurricane force winds, parcticularly at higher levels, since wind speed tends to increase with height. Recent research suggests you should stay below the tenth floor, but still above any floors at risk for flooding. It is not uncommon for high-rise buildings to suffer a great deal of damage due to windows being blown out. Consequently, the areas around these buildings can be very dangerous.

The strongest winds usually occur in the right side of the eyewall of the hurricane. Figure 4.26 shows that the sustained winds in a hurricane usually decrease at a relatively constant rate after landfall. Wind speed usually decreases significantly within 12 hours, and by approximately half after 24 hours. Therefore, the faster the forward speed of a landfalling hurricane, the further the inland penetration of hurricane force winds. Nonetheless, winds can stay above hurricane strength well inland. Hurricane Hugo (1989), for example, battered Charlotte, North Carolina (175 miles inland) with gusts to nearly 100 mph. Hurricane Katrina produced hurricane force winds as far north as I-20 (180 miles inland).

Figure 4.26. Sustained Hurricane Wind Speeds over Time



Source: National Hurricane Center
Note: The figure shows how wind speed rapidly decreases once a tropical cyclone reaches land. Part of the reason for this is that the roughness of the terrain increases friction, slowing the air. Another reason is that once the storm is over land, it is usually cut off from the heat and moisture sources that sustain it. However, wind gusts (as opposed to the sustained winds shown in the graph) may actually increase because the greater turbulence over land mixes faster air to the surface in short bursts.

Tornadoes

Tornadoes and tornadic activity is profiled in Section 4.2.12. Hurricanes can also produce tornadoes that add to the storm's destructive power. Tornadoes are most likely to occur in the right-front quadrant of the hurricane. However, they are also often found elsewhere embedded in the rainbands, well away from the center of the hurricane.

Some hurricanes do not produce tornadoes, while others develop multiple ones. Studies have shown that more than half of the landfalling hurricanes produce at least one tornado. Hurricane Buelah (1967) spawned 141 tornadoes according to one study. In general, tornadoes associated with hurricanes are less intense than those that occur as a standalone event. Nonetheless, the effects of tornadoes, added to the larger area of hurricane force winds, can produce substantial damage.

There is currently no way to predict exactly which storms will spawn tornadoes or where they will touch down. Doppler radar systems have greatly improved the warning capability, but the technology usually provides lead times from only a few minutes up to about 30 minutes. Consequently, preparedness is critical.

Inland Flooding

Hurricanes produce storm surges, tornadoes, and often the most deadly of all - inland flooding. While storm surge is always a potential threat, more people have died from inland flooding since 1970. Intense rainfall is not directly related to the wind speed of tropical cyclones. In fact, some of the greatest rainfall amounts occur from weaker storms that drift slowly or stall over an area. Inland flooding can be a major threat to communities hundreds of miles from the coast as intense rain falls from these huge tropical air masses.

Tropical Storm Allison (2001) produced extremely heavy rainfall and catastrophic floods in the Houston, Texas area. Allison then acquired subtropical characteristics and continued to produce heavy rainfall and flooding near its track from Louisiana eastward to North Carolina, and then northward along the U.S. east coast to Massachusetts. Forty-one deaths were directly related to the heavy rain, flooding, tornadoes, and high surf. Damage estimates reported by FEMA were near $5 billion, with approximately $4.8 billion in the Houston metropolitan area alone.

In a study looking at U.S. tropical cyclones from 1970 to 1999, freshwater flooding accounted for 59% of deaths. 63% of total U.S. tropical cyclone deaths occurred in inland areas. About 23% of total deaths occur to people who drown in, or attempting to abandon, their cars. Freshwater floods have also resulted in 78% of the childhood fatalities.

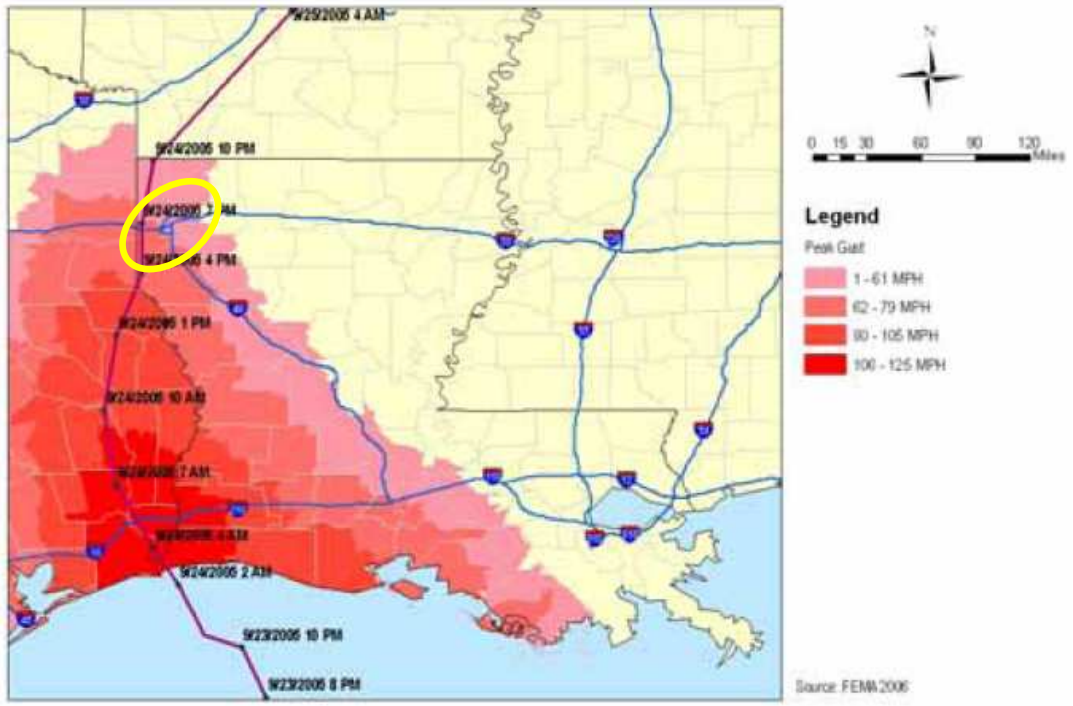
Past Occurrences

Since 1886, 31 hurricanes have made direct landfall. The State received 16 Presidential Disaster Declarations for hurricanes from 1965 to 2007. Only four hurricanes have made landfall in Louisiana as major hurricanes of category 4 or 5 intensity; unnamed hurricanes in 1909 and 1915, Hurricane Audrey in 1957, and Hurricane Camille in 1969. Hurricane Katrina, despite the devastation it caused, made landfall as a category 3 hurricane.

Historically, hurricanes have not been an issue for Bossier City, due to its location inland from the Gulf of Mexico. However, hurricanes that make landfall and weaken to tropical storms do affect Bossier City. The HMPC and the NCDC identified tropical storms that were felt by residents and/or caused damage in Bossier City. Details on some of these events follow.

September 24, 2005 - Hurricane Rita came on shore across the Southeast Texas/Southwest Louisiana coast and moved north northeast across East Central Texas and North Central Louisiana during the morning and afternoon hours of September 24, 2005. All of Northwest and North Central Louisiana remained on the east side of the eyewall as the storm moved northward and experienced strong tropical storm force winds (see Figure 4.27). Damage was consisted of downed trees and power lines, as well as structural damage to homes, businesses, and automobiles from downed trees. Many residents of Northwest and North Central Louisiana lost power during the height of the storm.

Figure 4.27. Hurricane Rita Winds



Note: The approximate location of Bossier City is within the yellow oval

September 1, 2008 - Hurricane Gustav moved into the southeast Louisiana coast during the early morning hours of September 1st. The storm continued a steady northwestward motion into east central Louisiana and northwest Louisiana during the evening hours of September 1st. The storm was downgraded to a tropical storm just before entering east central Louisiana. Wind gusts approached 70 mph and as the storm continued to move to the northwest, tropical storm force winds affected much of east central and west central Louisiana which downed numerous trees and power lines. Power was out across many locations and several trees fell on top of homes and automobiles.

Likelihood of Future Occurrence

Likely – Tropical storms reaching Bossier City from the Gulf of Mexico have a recurrence interval of less than 10 years.

4.2.17 Winter Storm/Extreme Cold

Priority Hazard: **Yes**

Hazard Description

Winter snow storms can include heavy snow, ice, and blizzard conditions. Heavy accumulations of ice can bring down trees, electrical wires, telephone poles and lines, and communication towers. Communications and power can be disrupted for days until the damage can be repaired. Even small accumulations of ice may cause extreme hazards to motorists and pedestrians.

Winter storms typically form along a front generally following the meandering path of the jet stream. These storms, called mid-latitude cyclones or extra-tropical cyclones, differ from hurricanes in that they move from west to east as opposed to east to west. These weather patterns carry cold air from Canada and the Rockies into the southern U.S. The origins of the weather patterns that cause winter storms in Louisiana are affected by differences in temperature and pressure, moisture availability, and wind direction, as well as weather systems in the Atlantic Ocean and Gulf of Mexico. Many low pressure areas give rise to exceptionally heavy rain and widespread flooding. Conditions worsen as the temperature drops, rain turns to ice, and accumulation of ice begins to occur.

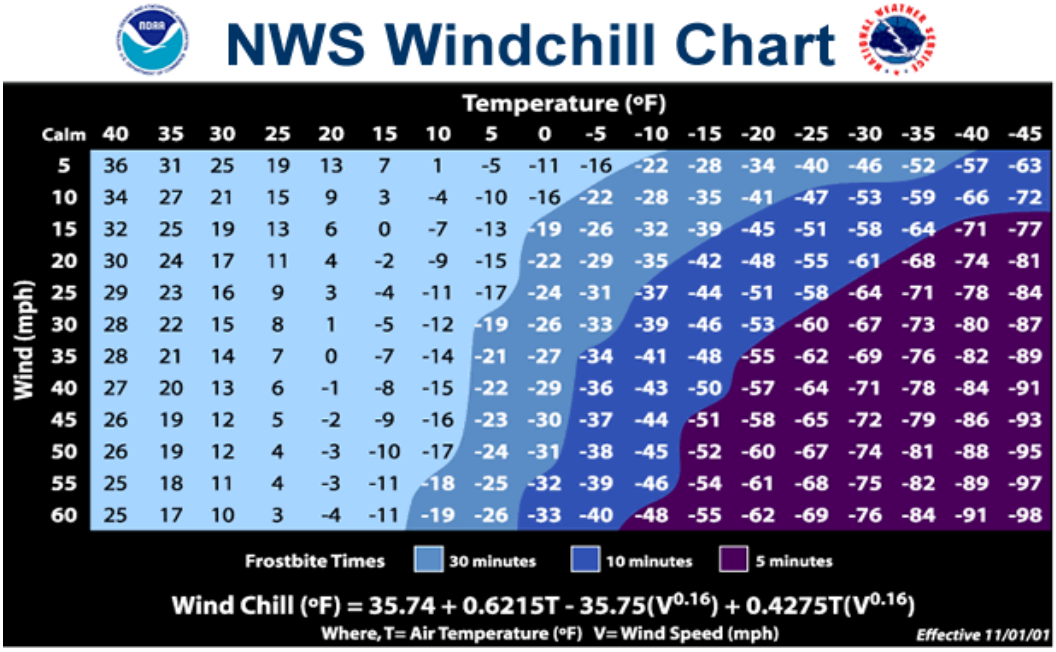
NOAA describes the jet streams that carry storm systems across the United States as narrow bands of strong wind in the upper atmosphere that follow the boundaries between hot and cold air masses. These boundaries are most pronounced during the winter months, when the jet streams travel to their southernmost position over the United States and surrounding water.

Extreme Cold

Extreme cold often accompanies a winter storm or is left in its wake. It is most likely to occur in the winter months of December, January, and February. Prolonged exposure to the cold can cause frostbite or hypothermia and can become life-threatening. Infants and the elderly are most susceptible. Pipes may freeze and burst in homes or buildings that are poorly insulated or without heat. Extreme cold can disrupt or impair communications facilities.

In 2001, the NWS implemented an updated Wind Chill Temperature index (see Figure 4.28). This index was developed to describe the relative discomfort/danger resulting from the combination of wind and temperature. Wind chill is based on the rate of heat loss from exposed skin caused by wind and cold. As the wind increases, it draws heat from the body, driving down skin temperature and eventually the internal body temperature.

Figure 4.28. National Weather Service Wind Chill Chart



Source: National Weather Service

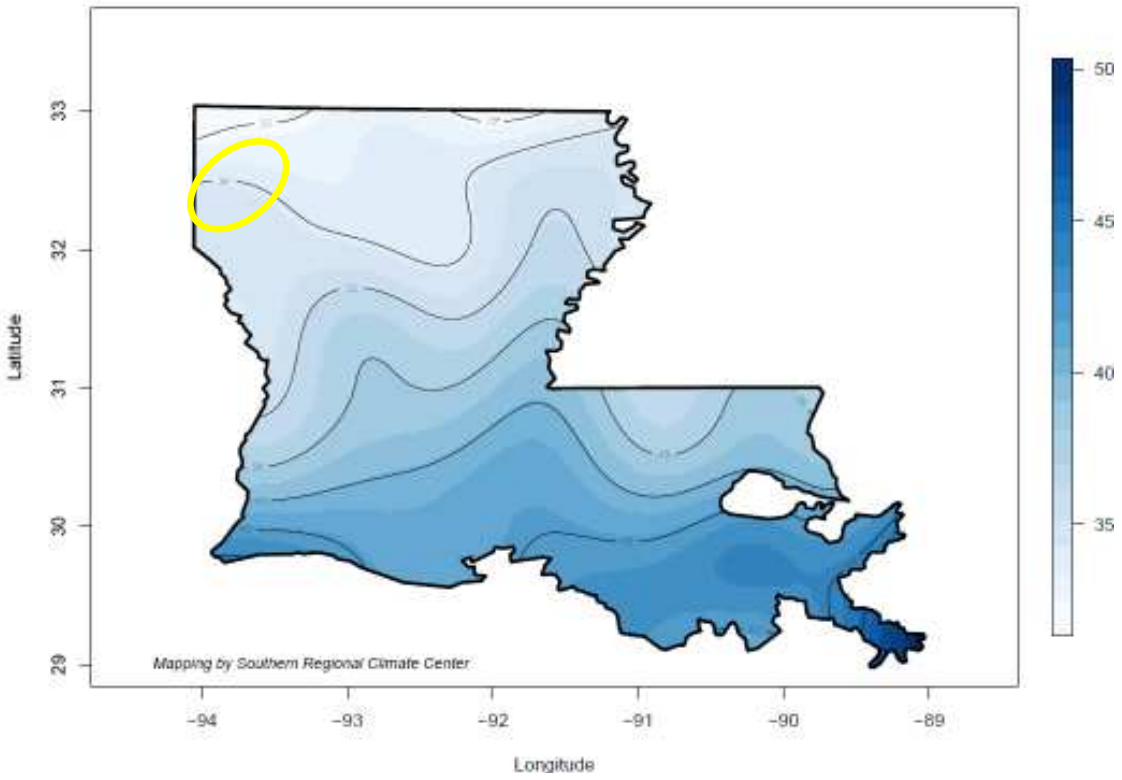
Bossier City begins to experience cold weather in November of each year, and the cold continues throughout the winter months. According to the Southern Regional Climate Center, the average high and low temperatures for Bossier City in January are 56.2°F and 36.5°F (see Figure 4.17), respectively. Figure 4.29 shows the average January low temperatures for the State of Louisiana.

The National Weather Service can issue the following alerts regarding low wind chill:

- A **Wind Chill Advisory** is issued when wind chill is 9F to -14F with sustained winds of 10 mph for 2 hours or more.

- A **Wind Chill Warning** is issued when chill is -15F or lower with sustained wind of 10mph or more for any period of time.

Figure 4.29. Average January Low Temperatures in Louisiana (Based on 1971-2000 Normals)



Note: The approximate location of Bossier City is within the yellow oval

When weather pattern and conditions are conducive to winter storm conditions, the National Weather Service issues the following watches and warnings:

- A **Winter Weather Advisory** is issued for winter weather significant to the public but not a severe threat to life and property.
- A **Winter Storm Watch** is issued when a winter storm is possible in the area in the next 12 to 48 hours.
- A **Winter Storm Warning** is issued when a winter storm is occurring or will occur in your area in the next 12 hours.
- A **Blizzard Warning** is issued when sustained winds or frequent gusts of 35 miles per hour or greater and considerable amounts of falling or blowing snow (reducing visibility to less than a quarter mile) are expected to prevail.
- A **Freeze Warning** is required for 1st and possibly 2nd freezing event for an area; this usually ensues in fall and spring.
- A **Hard Freeze Warning** is issued when temperatures below 19° F are expected.

- An **Ice Storm Warning** is issued when there are significant, damaging or dangerous accumulations of freezing rain or freezing drizzle (≥0.25").

Past Occurrences

A number of winter storms have occurred in Bossier City, two of which resulted in federal disaster declarations (see Table 4.1). The HMPC and the NCDC identified several storms that affected area residents in Bossier City. Details on some of these events follow.

March 14, 1993 - North and northwest winds 40 mph with gusts to 55 mph were common across the central and southeast coastal zones of Louisiana on March 12th and 13th. A widespread, damaging freeze occurred on March 14th. Total agricultural losses are estimated to be about $8.9 million. No deaths occurred in Bossier City; however, a homeless man in New Orleans froze to death in a city park.

February 10, 1994 - A severe ice storm developed over Louisiana, as well as adjacent states, in the early morning hours of February 10. Freezing rain spread across much of the north third of Louisiana during the following 12 hours, and at times was accompanied by thunderstorms which produced the most severe icing problems. The combination of gusty winds and icing of one to two inches thick snapped power lines, power poles, or caused tree limbs to snap which subsequently broke power lines. From newspaper accounts over 100,000 persons in north Louisiana were without electrical power on February 10 and 11. The Forest Service reported that 256,000 acres of forest were damaged by icing. The ice storm damage was approximated at $13.5 million.

January 6, 1997 - An arctic cold front swept southeast from the northern Plains into the lower Mississippi Valley on January 6 bringing icy temperatures across the region. This warm moisture laden air rode over the freezing ground temperatures resulting in widespread freezing rain, sleet, and snow. Numerous power outages occurred from iced power lines and tree limbs across power lines.

January 12, 1997 - With arctic air over northern Louisiana, an upper level storm system moved out of central Texas drawing copious amounts of moisture northward from the Gulf of Mexico. Several interstates were closed including I-220 north of Shreveport and I-49 from I-20 in Shreveport to Alexandria, La. The ice led to numerous traffic accidents and a few isolated power outages.

December 22, 1998 – A shallow dome of arctic air spread across northern Louisiana while low pressure formed in the northern Gulf of Mexico. The result was widespread freezing rain, sleet and freezing drizzle. The ice accumulated mainly across exposed surfaces such as trees and power lines as well as bridges and overpasses. Over a quarter million people were without power, some for over a week.

January 26, 2000 - Moisture laden air from the Gulf of Mexico moved northward and overran freezing surface temperatures producing an ice storm across the region. Ice accumulations of one to four inches left upwards of 30,000 homes without power due to ice covered tree limbs which snapped and dropped power lines. Hundreds of chicken houses and carports collapsed from the weight of the ice and snow.

December 12, 2000 - An arctic airmass spilled southward out of the central plains and into the lower Mississippi Valley. Ice accumulations on average of one inch were common north and west of a line from Mansfield and Arcadia to Farmerville LA. An estimated 235,000 residents lost power from snapped power lines. Upwards of 29 transmission lines atop "H" shaped steel towers were snapped due to the weight of the ice. One man was killed and another injured when a tree limb laden with ice fell on them. Numerous traffic accidents were reported from ice covered roads and bridges. In the Shreveport - Bossier metropolitan area, more than 205 streets were either blocked or partially blocked by limbs and fallen trees. Much of northwest Louisiana was declared a disaster area.

December 24, 2000 - Some of the northern Parishes in north Louisiana experienced their second ice storm in as many weeks while others who missed out on the first storm experienced widespread icing problems. Freezing rain accumulations ranged from 1/4 to near 1 inch mainly north of Interstate 20. The Shreveport - Bossier metropolitan area were not heavily affected by this second storm but widespread power outages were reported across Minden, Homer, Arcadia, Farmerville, Ruston, and Monroe Louisiana. 50,000 residents lost power due to ice accumulations on power lines and fallen trees and snapped trees limbs broken power lines.

February 19, 2006 - Much of the region was entrenched in an arctic air mass during the weekend of the 18th through the 20th. A weak storm system moved into the southern plains and into the lower Mississippi valley with light freezing rain and freezing drizzle falling across much of the region. Ice accumulations were very light, mainly less than one quarter of an inch across most places. While road surfaces remained wet from ground warmth, most elevated bridges and overpasses saw some ice accumulation which resulted in numerous traffic accidents. Many elevated bridges and overpasses had to be closed due to the ice accumulation.

March 7, 2008 - A stationary front extended across northeast Texas and southwest Arkansas during the afternoon of March 6th and extended southward on March 7th. A strong upper level storm system moved eastward from the Texas Hill country overnight with rain transitioning into a brief period of sleet followed by moderate to heavy snow at times across the region. Widespread one to three inches of snow was reported across the northern half of northeast Texas, southeast Oklahoma, southwest Arkansas, and northwest and north central Louisiana late on March 6th and through the day on March 7th. Two inches of snow measured in northern Bossier City.

December 23, 2008 - A shallow arctic air mass moved into the region a few days earlier resulting in near to slightly below freezing temperatures across much of northern Louisiana. Ice

froze to elevated bridges and overpasses which in turn, resulted in several vehicle accidents. Light freezing rain and freezing drizzle accumulated on bridges and overpasses across the area. Interstate 20, Interstate 220, as well as Interstate 49 were parcticularly hard hit and had the be closed for a short time because of several vehicle accidents across the city of Shreveport.

January 7, 2010 - An arctic air mass moved southward out of the Central Plains across southern Arkansas, southeast Oklahoma, northeast Texas and northwest Louisiana. This air mass was accompanied by strong north winds which resulted in wind chill advisories. The elongated period of bitterly cold temperatures resulted in widespread freezing and bursting of pipes across the region. Many residents had to deal with either low water pressure or periods of no water at all as many city and county/parish water lines burst as well.

Likelihood of Future Occurrence

Likely – Winter storms and extreme cold weather in Bossier City have a recurrence interval of less than every 10 years.

4.2.18 Natural Hazards Summary

Table 4.14 summarizes the results of the hazard identification and hazard profile for the Bossier City planning area based on the hazard identification data and input from the HMPC. For each hazard profiled in Section 4.2, this table includes the likelihood of future occurrence and whether the hazard is considered a priority hazard (priority hazards are highlighted) for the Bossier City planning area.

Table 4.14. Hazard Identification/Profile Summary and Determination of Priority Hazard

Hazard	Likelihood of Future Occurrence	Priority Hazard
Dam/Levee Failure	Occasional	Yes
Drought	Occasional	No
Earthquake	Unlikely	No
Flood		
100/500 -year Flood	Occasional	Yes
Flash Flood	Likely	Yes
Riverine Flood	Likely	Yes
Severe Weather		
Extreme Heat	Highly Likely	No
Hailstorm	Highly Likely	No
Heavy Rain/Thunderstorm/Lightning/ Wind	Highly Likely	Yes

Hazard	Likelihood of Future Occurrence	Priority Hazard
Tornado	Likely	Yes
Soil Hazard		
Stream Bank Erosion/Stability	Likely	No
Subsidence	Unlikely	No
Tropical Storm/Hurricane	Likely	Yes
Winter Storm/Extreme Cold	Likely	Yes

Source: Data Collection Guide, HMPC

The HMPC determined that dam/levee failure, flood (100/500 –year, flash and riverine), heavy rain/thunderstorm/lightning/wind, tornado, tropical storms/hurricanes, and winter storms are the priority hazards in the planning area. The assets at risk and estimated potential losses associated with these hazards are discussed in Section 4.3 Vulnerability Assessment. Only those hazards determined to be priority hazards are discussed further in this plan.

4.3 Vulnerability Assessment

Requirement §201.6(c)(2)(ii): [The risk assessment shall include a] description of the jurisdiction's vulnerability to the hazards described in paragraph (c)(2)(i) of this section. This description shall include an overall summary of each hazard and its impact on the community.

Requirement §201.6(c)(2)(ii)(A): The plan should describe vulnerability in terms of the types and numbers of existing and future buildings, infrastructure, and critical facilities located in the identified hazard areas.

Requirement §201.6(c)(2)(ii)(B): [The plan should describe vulnerability in terms of an] estimate of the potential dollar losses to vulnerable structures identified in paragraph (c)(2)(i)(A) of this section and a description of the methodology used to prepare the estimate.

Requirement §201.6(c)(2)(ii)(C): [The plan should describe vulnerability in terms of] providing a general description of land uses and development trends within the community so that mitigation options can be considered in future land use decisions.

With Bossier City's hazards identified and profiled, the HMPC conducted a vulnerability assessment to describe the impact that each hazard would have on the City. The vulnerability assessment quantifies, to the extent feasible using best available data, assets at risk to natural hazards and estimates potential losses. This section focuses on the risks to the City as a whole.

This vulnerability assessment followed the methodology described in the FEMA publication *Understanding Your Risks—Identifying Hazards and Estimating Losses*. The vulnerability assessment first describes the total vulnerability and values at risk and then discusses vulnerability by hazard.

Data used to support this assessment included the following:

- City GIS data (hazards, base layers)
- FEMA's HAZUS-MH MR4 GIS-based inventory data
- Written descriptions of inventory and risks provided by the Hazard Mitigation Planning Committee
- Existing plans and studies, including the 2006 Bossier City Local Hazard Mitigation Plan and the Louisiana State Hazard Mitigation Plan
- Personal interviews with planning team members and staff from the City

4.3.1 The City of Bossier City's Vulnerability and Assets at Risk

As a starting point for analyzing the planning area's vulnerability to identified hazards, the HMPC used a variety of data to define a baseline against which all disaster impacts could be

compared. This section describes significant assets at risk in the planning area. Data used in this baseline assessment included:

- Total values at risk
- Critical facility inventory
- Historic, cultural, and natural resources
- Growth and development trends

Total Values at Risk

Parcel and associated assessor's valuation data was requested from Bossier Parish to use as the inventory of development in Bossier City for this plan. Access to that data was denied, so the basis of inventory used (and described below) is a less accurate dataset.

The following data from HAZUS-MH MR4 (released in August 2009) is derived from U.S. Census Bureau Housing and Development data. Table 4.16 shows building counts, value, and contents value, sorted by occupancy type. This data should only be used as a guideline to overall values in the City, as the information has some limitations.

Table 4.15. The City of Bossier City Building Count, Building and Contents Value by Occupancy Type

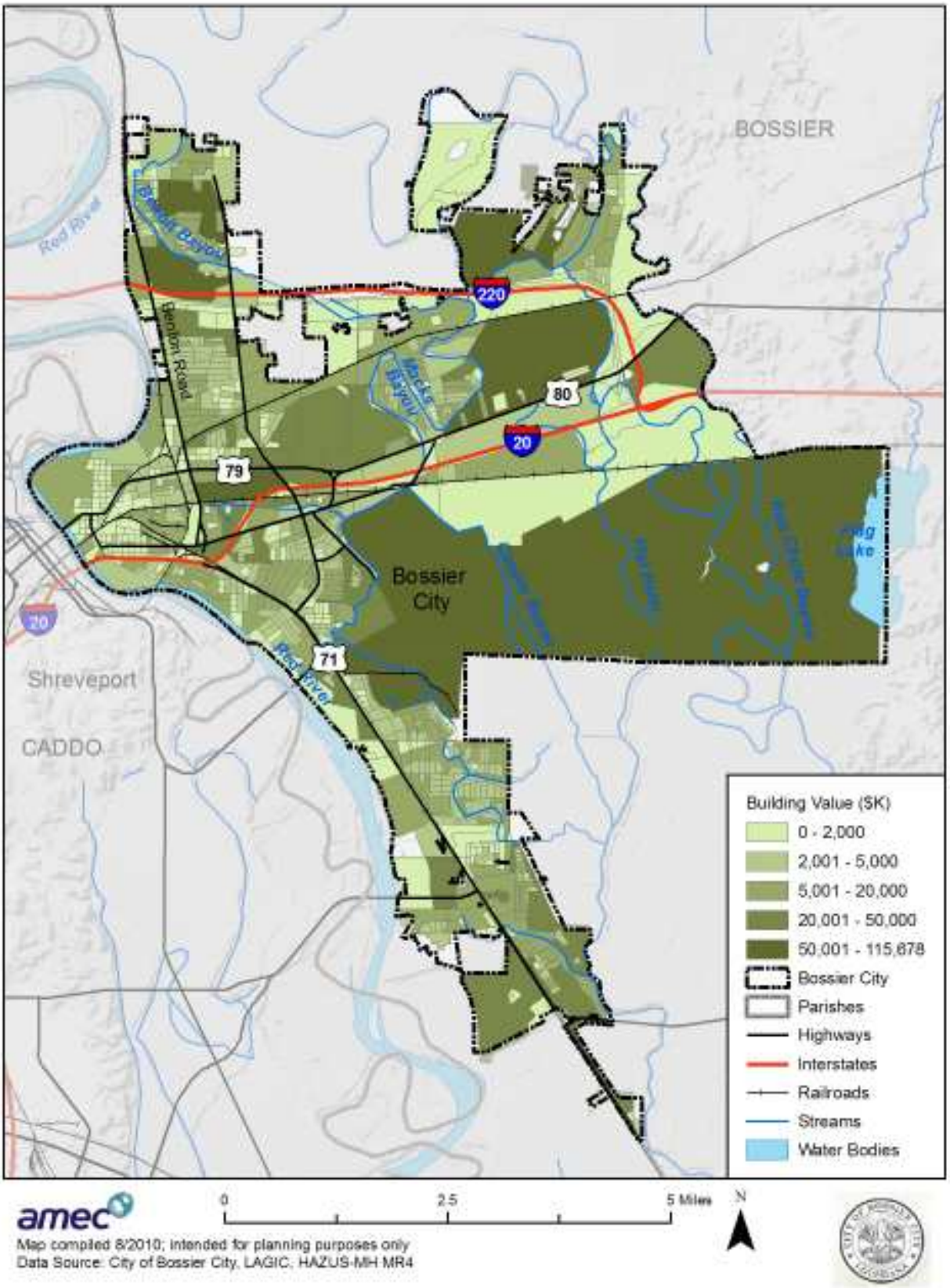
Occupancy Type	Building Count	Building Value	Contents Value
Residential	19,428	$ 3,122,474,000	$ 1,561,885,000
Commercial	1,115	$ 639,296,000	$ 670,839,000
Industrial	267	$ 104,708,000	$ 139,227,000
Agricultural	49	$ 5,718,000	$ 5,718,000
Religious	97	$ 67,787,000	$ 67,787,000
Governmental	59	$ 42,018,000	$ 43,693,000
Educational	27	$ 13,742,000	$ 15,058,000

Occupancy Type	Building Count	Building Value	Contents Value
Total	**21,042**	**$ 3,995,743,000**	**$ 2,504,207,000**

Source: HAZUS-MH MR4

Figure 4.30 shows the building value listed above, by census block, in the City of Bossier City.

Figure 4.30. The City of Bossier City's Building Inventory by Census Block



Critical Facility Inventory

Of significant concern with respect to any disaster event is the location of critical facilities in the planning area. A critical facility is any property that, if adversely affected during a hazard event, would result in severe consequences to public health and safety. For the purposes of this plan, critical facilities are categorized as Tier 1 or Tier 2.

Tier 1 critical facilities are more essential for the functioning of Bossier City. These critical facilities include, but are not limited to:

- Police stations, fire stations, vehicle and equipment storage facilities, emergency operations centers, and other facilities that are needed for response and recovery activities before, during, and after a hazard event;
- Public and private utility facilities that are vital to maintaining or restoring normal services to affected areas before, during, and after a hazard event;
- Hospitals, nursing homes, and housing likely to have occupants who may not be sufficiently mobile to avoid injury or death during a hazard event;
- Structures or facilities that produce, use, or store highly volatile, flammable, explosive, toxic, and/or water-reactive materials;
- Schools, dams, juvenile detention centers and other key publicly or privately controlled resources essential to public health and safety and to the minimal operations of the economy and government.

Tier 2 critical facilities are important, but are less essential for the functioning of Bossier City than are the Tier 1 critical facilities. Tier 2 critical facilities include, but are not limited to:

- Casinos, and other facilities that create the tax base for the community;
- Churches;
- Public buildings, including post offices, arenas, libraries, building maintenance and other public facilities that are significant to the community's operation.
- Grocery stores, hardware stores, and other stores that carry provisions for residents' basic needs.

An inventory of critical facilities in the planning area based on data from the City of Bossier City GIS is provided in Table 4.16 and Table 4.17 illustrated in Figure 4.31.

Table 4.16. The City of Bossier City's Tier 1 Critical Facility Inventory

Facility Type	Name	Address
Fire Stations	Fire Station 7	5900 Shed RD
Fire Stations	Fire Station 8	2001 River Bend DR
Fire Stations	Fire Station 9	2621 Brownlee RD
Fire Stations	Fire Station 2	1101 Waller AVE
Fire Stations	Fire Station 3	2800 Northside DR

Fire Stations	Fire Station 4	4300 Parkway DR
Fire Stations	Fire Station 5	915 Meadowview DR
Fire Stations	Fire Station 6	700 Barksdale BLVD
Fire Stations	Bossier City FireTraining Center/EOC	5850 Shed RD
Fire Stations	Swan Lake Fire Station (#5)	971 Swan Lake Rd.
Fire Stations	Riverfront Fire Station (#6)	420 Riverside Dr.
Fire Stations	Fire Department 'Rescue Boat Facility'	3133 Arthur Ray Teague Parkway
Government Buildings	Caddo-Bossier OHSEP	1511 Doctors DR
Government Buildings	Bossier Parish Dept. Of Social Services	3808 Kilpatrick DR
Government Buildings	Bossier Parish Tax Assessor	700 Benton RD
Government Buildings	Bossier City Chamber Of Commerce	710 Benton RD
Government Buildings	Bossier Levee District	3404 Industrial DR
Hospitals / Medical Centers	Willis-Knighton Health Center	2400 Hospital DR
Hospitals / Medical Centers	Southwest Medical Center	4900 Medical DR
Hospitals / Medical Centers	Riverview Care Center	4820 Medical DR
Hospitals / Medical Centers	Red River Behavioral Center	2800 Melrose AVE
Hospitals / Medical Centers	Promise Specialty Hospital	2525 Viking DR
Hospitals / Medical Centers	Outpatient Physical Therapy	2450 Hospital DR
Hospitals / Medical Centers	Med-Express	2539 Viking DR
Hospitals / Medical Centers	Christus Schumpert Hospital	2105 Airline DR
Hospitals / Medical Centers	Caddo-Bossier Drug Abuse Center	1525 Fullilove DR
Hospitals / Medical Centers	Bossier Orthopedic Specialist	2005 Airline DR
Nursing Homes	The Arbor and Terrace Of Bossier	4770 Brandon BLVD
Nursing Homes	Pilgram Manor North	1524 Doctors DR
Nursing Homes	Morning Star Retirement Community	2540 Beene BLVD
Nursing Homes	Guest House Of Bossier	2901 Douglas DR
Nursing Homes	Garden Court Nursing Center	4405 Airline DR
Nursing Homes	Colonial Oaks Nursing Center	4921 Medical DR
Nursing Homes	Bossier Council On Aging	706 Bearkat DR
Police Facilities	LA State Police Troop G	5300 Industrial DR EXT
Police Facilities	Hooter Park Head Start Center	1519 Hooter Park DR
Police Facilities	Bossier Parish Sheriff Sub Station	2510 Viking DR
Police Facilities	Bossier Police Training Center	1549 E Texas ST
Police Facilities	Johnny Gray Jones Youth Shelter & Detention Center	4815 Shed RD
Schools	Waller Elementary School	1130 Patricia DR
Schools	Sun City ElementarySchool	4230 Van Deeman ST
Schools	Stockwell Place Elementary School	5801 Shed RD
Schools	Rusheon Middle School	2401 Old Minden RD
Schools	Red River Marine Institute	2890 Douglas DR
Schools	Plantation Park Elementary School	2410 Plantation DR
Schools	Parkway High School (abandoned)	4301 Panther DR
Schools	Meadowview Elementary School	4312 Shed RD
Schools	Kerr Elementary School	1700 Airline DR
Schools	Greenacres Middle School	2220 Airline DR
Schools	Curtis Elementary School	5600 Barksdale BLVD
Schools	Cope Middle School	4814 Shed RD
Schools	Central Park Elementary School	900 Central Park DR
Schools	Christ The King School	323 McCormick ST
Schools	Butler Elementary School	541 Detroit ST
Schools	BPCC South Complex	2900 Douglas DR
Schools	Bossier Parish Community College	6220 E Texas ST
Schools	Bossier Parish Educational Research Center	3228 Barksdale BLVD
Schools	Bossier Parish School Board Evaluation Center	2500 Viking DR

Schools	Bossier LifeSkills Center	415 Monroe ST
Schools	Bossier High School	777 Bearkat DR
Schools	Bossier Elementary School	1000 Traffic ST
Schools	Bellaire Elementary School	1310 Bellaire BLVD
Schools	Airline High School	2801 Airline DR
Schools	Apollo Elementary School	2400 Viking DR
Water / Wastewater Treatment	Red River Waste WaterTreatment Plant	3512 Barksdale BLVD
Water / Wastewater Treatment	Northeast Bossier Treatment Plant	8000 Shed RD
Water / Wastewater Treatment	Bossier City Water Treatment Plant	1400 Hamilton RD

Source: The City of Bossier City GIS

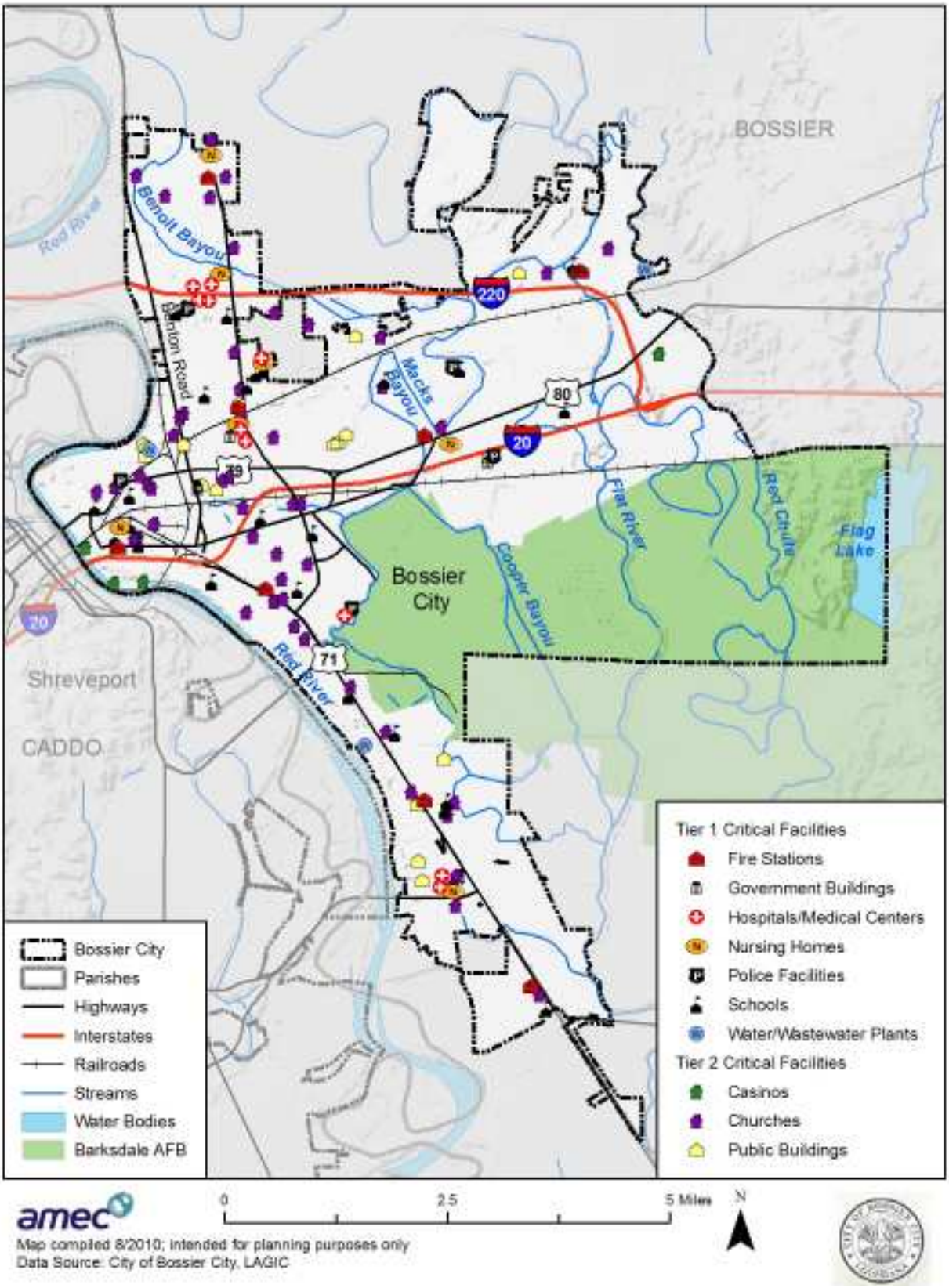
Table 4.17. The City of Bossier City's Tier 2 Critical Facility Inventory

Facility Type	Name	Address
Casinos	Horseshoe Casino	711 Horseshoe BLVD
Casinos	Isle of Capri Casino	711 Isle of Capri BLVD
Casinos	Harrah's Louisiana Downs	8000 E Texas ST
Casinos	Boomtown Casino	300 Riverside DR
Churches	Waller Baptist Church	456 Waller AVE
Churches	Temple Baptist Church # 2	1301 Martin LN
Churches	Stonewall Baptist Church	807 Eatman ST
Churches	Stockwell Missionary Baptist Church	2201 Stockwell RD
Churches	ST. Jude's Catholic Church	3800 Viking DR
Churches	ST. George's Episcopal Church	1959 Airline DR
Churches	South Bossier Church Of The Nazarene	535 Modica ST
Churches	Shady Grove Baptist Church	4227 Van Deeman ST
Churches	Riverside Baptist Church	1714 Jimmie Davis HWY
Churches	Pre-School First Baptist Church Of Bossier City	2801 Beckett ST
Churches	Open Door Bible Church	950 Swan Lake RD
Churches	Mount Nebo Baptist Church	700 Hamilton RD
Churches	Korean Nazarene Church	4901 Medical DR
Churches	Korean Presbyterian Church	1180 Dudley LN
Churches	Heritage Baptist Church	5580 Barksdale BLVD
Churches	Hope Assembly Of God	3012 Shed RD
Churches	Immanuel Lutheran Church	2565 Airline DR
Churches	John Knox Presbyterian Church	1944 Airline DR
Churches	Harvest Temple Church	1633 Benton RD
Churches	Hall Of Jehovah's Witnesses	1814 Benton RD
Churches	Good Hope Baptist Church	4220 Barksdale BLVD
Churches	First Weslyan Church	3200 Schuler DR
Churches	First United Methodist Church	201 John Wesley BLVD
Churches	First United Pentecostal Church	2833 Viking DR
Churches	First Church Of The Nazarene	326 Edwards ST
Churches	First Baptist Church Of Bossier City	2810 E Texas ST
Churches	First Christian Church Of Bossier City	2205 Shed RD
Churches	Fellowship United Methodist Church	4750 Barksdale BLVD
Churches	Family Worship Center	4204 Airline DR
Churches	Faith Temple Assembly Of God	4350 Panther DR
Churches	Evergreen Ministries	4400 Viking DR
Churches	Church Of Jesus Christ	310 Wellington DR
Churches	Church Of Christ Carriage Oaks	5661 Shed RD
Churches	Central Baptist Church	2225 Airline DR
Churches	Christ ApostolicTabernacle	4320 Shed RD
Churches	Christ Community Church	1013 Gould DR
Churches	Christ The King Church	425 McCormick ST

Churches	Calvary Temple Church	1000 St Charles ST
Churches	Bountiful Blessings	408 Bennett ST
Churches	Bossier CME Church	616 Thompson ST
Churches	Bossier City First Church Of God	4601 Airline DR
Churches	Bossier Baptist Church	809 Hamilton RD
Churches	Bossier Baptist Temple	2329 Broadway DR
Churches	Bossier Church Of Christ	2917 Foster ST
Churches	Bellaire Baptist Church	1210 Bellaire BLVD
Churches	Ban Suk Korean Baptist Church	2219 Brownlee RD
Churches	Barksdale Baptist Church	2535 Barbara ST
Churches	Barksdale United Methodist Church	1465 Patricia DR
Churches	Asbury United Methodist Church	3200 Airline DR
Churches	Airline Baptist Church	4007 Airline DR
Churches	Airline Drive Church Of Christ	2125 Airline DR
Churches	All People's Assembly Of God	2366 Barksdale BLVD
Public Buildings	U.S. Post Office, Airline Contract Station	2801 Northside DR
Public Buildings	U.S. Post Office, Main Office	1500 Benton RD
Public Buildings	U.S. Post Office, Plantation Branch	4310 Barksdale BLVD
Public Buildings	Reeves Marine	2000 Reeves Marine DR
Public Buildings	Public Works	3223 Old Shed RD
Public Buildings	Office Of Motor Vehicles	3802 Kilpatrick DR
Public Buildings	Northwest La Developmental Center	5401 Shed RD
Public Buildings	Municipal Complex / Civic Center	620 Benton RD
Public Buildings	Centurytel Center / Multi-Purpose Arena	2000 Centurytel Center DR
Public Buildings	Bossier Press Tribune	4250 Viking DR
Public Buildings	Bossier Parish Centeral Library	2206 Beckett ST
Public Buildings	Bossier City Recycling Center	3301 Old Shed RD
Public Buildings	Bossier City Animal Control	3217 Old Shed RD
Public Buildings	Bossier City Building Maintenance	1403 Hamilton RD
Public Buildings	Bossier City Building Maintenance	1503 Hamilton RD
Public Buildings	Bossier City Central Warehouse	1375 Hamilton RD
Public Buildings	Bossier Arts Council	630 Barksdale BLVD
Public Buildings	Aulds South Bossier City Branch Library	3950 Wayne AVE

Source: The City of Bossier City GIS

Figure 4.31. The City of Bossier City's Critical Facilities



Historic, Cultural, and Natural Resources

Assessing the vulnerability of Bossier City to disaster also involves inventorying the historic, cultural, and natural assets of the area. This step is important for the following reasons:

- The community may decide that these types of resources warrant a greater degree of protection due to their unique and irreplaceable nature and contribution to the overall economy.
- If these resources are impacted by a disaster, knowing so ahead of time allows for more prudent care in the immediate aftermath, when the potential for additional impacts are higher.
- The rules for reconstruction, restoration, rehabilitation, and/or replacement are often different for these types of designated resources.
- Natural resources can have beneficial functions that reduce the impacts of natural hazards, for example, wetlands and riparian habitat help absorb and attenuate floodwaters.

Historic and Cultural Resources

Bossier City has a stock of historically significant homes, public buildings, and landmarks. To inventory these resources, the HMPC collected information from a number of sources. The Louisiana Department of Culture, Recreation, and Tourism (CRT) was the primary source of information. The CRT is responsible for the administration of federally and state mandated historic preservation programs to further the identification, evaluation, registration, and protection of Louisiana's irreplaceable archaeological and historical resources.

- The **National Register of Historic Places** is the Nation's official list of cultural resources worthy of preservation. The National Register is part of a national program to coordinate and support public and private efforts to identify, evaluate, and protect historic and archeological resources. Properties listed include districts, sites, buildings, structures, and objects that are significant in American history, architecture, archeology, engineering, and culture. The National Register is administered by the National Park Service, which is part of the U.S. Department of the Interior.

Historical resources included in the programs above are identified in Table 4.18.

Table 4.18. The City of Bossier City's Historical Resources

Name (Landmark Plaque Number)	National Register	Date Listed
Barksdale Field Historic District	X	04/13/1992
Bossier City Municipal Building	X	03/28/2002
Bossier High School (777 Bearcat Dr)	X	09/30/2004
Bossier High School (322 Colquitt St)	X	08/31/1998
Cashpoint Plantation House	X	08/11/1982
Hughes House	X	10/22/1996

Source: National Register of Historic Places. http://nrhp.focus.nps.gov/natreghome.do?searchtype=natreghome

The National Park Service administers two programs that recognize the importance of historic resources, specifically those pertaining to architecture and engineering. While inclusion in these programs does not give these structures any sort of protection, they are valuable historic assets. There are currently no Historic American Building Survey (HABS) or Historic American Engineering Record (HAER) buildings in Bossier City.

It should be noted that these lists may not be complete, as they may not include all properties currently in the nomination process and not yet listed. Additionally, as defined by the National Environmental Policy Act (NEPA), any property over 50 years of age is considered a historic resource and is potentially eligible for the National Register. Thus, in the event that the property is to be altered, or has been altered, as the result of a major federal action, the property must be evaluated under the guidelines set forth by NEPA. Structural mitigation projects are considered alterations for the purpose of this regulation.

Other Historic and Cultural Resources

Native Americans have lived in northwest Louisiana for thousands of years. The oldest known site is in Bienville Parish and may date to the time of the pyramids in Egypt. In the last millennium the primary inhabitants of the area were tribal units of the Caddoan Confederacy, a plains Indian culture kin to the Sioux and Cheyenne nations. The Caddoans believed that Caddo Lake, located in Caddo Parish to the west of Bossier Parish, was the "navel of the world." The primary difference between the Caddoan peoples and the other plains tribes was that, while they followed the buffalo herds far to the north and then south as the seasons progressed, the Caddoans settled down and became hunter-gatherers and farmers. There are literally thousands of Caddoan sites in northwest Louisiana.

The State of Louisiana Division of Archaeology keeps a detailed list of all known archaeological sites, both Native American and later occupation sites. These may be as varied as plantation homes, early industrial sites, Civil War defenses, or pioneer homesteads. The list is not available to the general public to protect the sites from looting or damage.

Generally speaking, Caddoan sites are found on natural levees and on the Pleistocene Terraces. In some cases, Caddoan villages may have been several miles long, and this is sometimes the case in Bossier Parish. Additionally, due to massive flooding deposits which may have covered naturally occurring levees, some sites may be located in flat lands that do not appear to have archaeological potential. In some instances, even burial or ceremonial mounds have been completely covered by large flooding events and lie beneath the surface of pasture or crop land.

Research during the past decade has led to the discovery of several important archaeological sites within and adjacent to Bossier City. The Red River opposite the Cane's Landing park area has yielded a historic 19th Century shipwreck that may be the Confederate warship, the C.S.S. Grand Duke. The existence of Confederate defensive fortifications has been found in the same area, and the locations of large forts have been identified near Bossier High School and on East Texas

Street. Researchers have also been working to find four Confederate submarines thought to be in Bossier Parish or Caddo Parish.

The area of the first settlement in Bossier City was centered on the Long-Allen or Texas Street Bridge and extended east to Traffic Street. For most of the 19th Century and the early portion of the 20th Century, this was the nexus of Bossier industry and residences. As Bossier City grew, it developed first in an eastward axis along Texas Street and then north and south from this area. Barksdale Air Force Base created a blocking factor for growth and the city began to grow north around the base and also south, hugging its boundary.

The earliest portion of the city's settlement changed character during the Great Depression and turned from commercial and industrial to residential. By the end of the 20th Century, the early character of "Old Bossier" had almost been forgotten. Now, as this area is undergoing redevelopment by the casinos and the River Walk Entertainment District, studies have shown a richly diversified past.

The area from Traffic Street to the river and from Texas Street to Wyche Street contains the core of this early development. The earliest industry was the Austro-American Stave and Lumber Company, which included a saw mill, a churn factory and a lumber yard. It also had its own railroad spur, which is sometimes mistakenly referred to as the levee along the riverfront. The railroad berm is cut in several places. There were also bulk oil businesses, dry cleaners, printers, and corner gas stations that were part of grocery stores.

All of these historic sites have the potential for containing research possibilities for urban archaeologists. They also share a common threat for hazardous materials and chemicals that must be examined before development can take place. This evaluation falls under the U.S. Environmental Protection Agency's Brownfields program and also the National Historic Preservation Act. Each development or encroachment should have a cultural resources survey conducted. This survey must be performed by a registered professional archaeologist and should be performed in accordance with Section 106 of the National Historic Preservation Act.

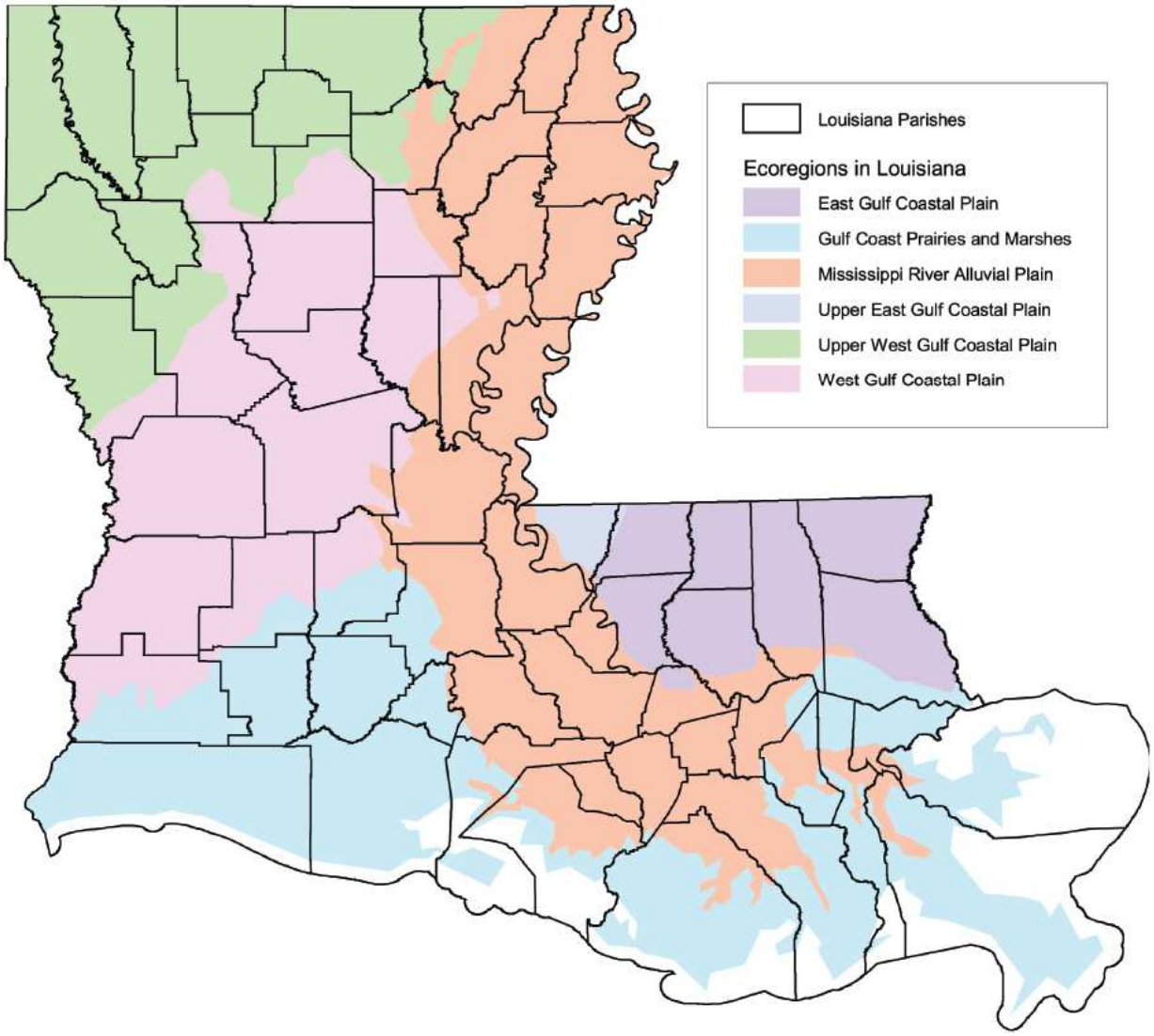
Natural Resources

Natural resources are important to include in benefit-cost analyses for future projects and may be used to leverage additional funding for mitigation projects that also contribute to community goals for protecting sensitive natural resources. Awareness of natural assets can lead to opportunities for meeting multiple objectives. For instance, protecting wetlands areas protects sensitive habitat as well as stores and reduces the force of floodwaters.

One of Bossier's greatest assets is its natural setting. Along the Red River and a multitude of bayou tributaries are pockets of untouched, natural habitat worthy of preserving through conservation easements and other methods. These assets offer a number of identifiable benefits, including improved water quality, increased flood storage capacity, increased open space, and natural buffers between land uses. Areas considered among Bossier City's natural resources

include: Red River, Willow Chute Bayou, Red Chute Bayou, Flat River and other bayou tributaries (Mack's Bayou, Cooper Bayou, Allison Bayou, Alligator Bayou Fifi Bayou, Connell Bayou, Racetrack Bayou, St. Charles Bayou), and other sensitive lands.

Figure 4.32. Louisiana Eco-regions



Vegetation

Bossier City contains many tree and plant species that are defined as sensitive by the state Natural Heritage Program. The intent of the City is to plant additional trees and to maintain existing street, park and other public and private trees to enhance the City's overall character and sense of place. The Louisiana Natural Heritage Program (LNHP), within the LA Department of Wildlife and Fisheries (LDWF), gathers, organizes, and distributes standardized, detailed

information on the biological diversity across Louisiana. Table 4.19 summarizes sensitive plant communities reported in Bossier Parish and Bossier City by LHNP.

Table 4.19. Bossier City's Sensitive Plant Communities

Type	Rarity Rank*	Ecological System	Description
Bayhead Swamp/ Forested Seep	S3 G3?	CES203.505 Southern Coastal Plain Seepage Swamp and Baygall; CES203.372 West Gulf Coastal Plain Seepage Swamp and Baygall	Bayhead swamps develop in broad, shallow braided drains, or along margins of creeks with little or no creek banks, or are found in deep depressional areas in flatwoods, or the headwaters of creeks in sandy, acidic uplands across Louisiana. Bayheads are seasonally to semi-permanently saturated or flooded Forested seeps occur typically in association with mixed pine-hardwood forests, on hillsides, to the base of slopes. Forested seeps are continually moist due to constant seepage forced to the surface by an underlying impervious layer (clay pan or sandstone)
Bottomland Hardwood Forest	S4 G4G5	CES203.065 Red River Large Floodplain Forest.	Forested, alluvial wetlands occupying broad floodplain areas flanking large river systems.
Calcareous Forest	S2 G2?Q	CES203.379 West Gulf Coastal Plain Southern Calcareous Prairie; CES203.378 West Gulf Coastal Plain Pine-Hardwood Forest.	Occurs on calcareous substrata in the uplands of central, western and northwest Louisiana
Calcareous Prairie	S1 G1	CES203.379 West Gulf Coastal Plain Southern Calcareous Prairie	Small, naturally treeless areas ranging in size from less than one acre, up to 80 or more acres. Occur in a mosaic with calcareous forests

Type	Rarity Rank*	Ecological System	Description
Hardwood Flatwoods	S2S3 G2G3	CES203.548 West Gulf Coastal Plain Nonriverine Wet Hardwood Flatwoods; CES203.193 Lower Mississippi River Flatwoods; CES203.557 East Gulf Coastal Plain Southern Loblolly-Hardwood Flatwood; CES203.278 West Gulf Coastal Plain Pine-Hardwood Flatwoods.	Wet hardwood flatwoods occur on hydric soils on poorly drained flats and depressions.
Hardwood Slope Forest	S3S4 G4	CES203.280 West Gulf Coastal Plain Mesic Hardwood Forest; CES203.378 West Gulf Coastal Plain Pine-Hardwood Forest	Occur on slopes (often steep) rising out of small stream floodplains
Mixed Hardwood-Loblolly Pine Forest	S4 G4	CES203.378 West Gulf Coastal Plain Pine-Hardwood Forest	Evenly distributed in a variety of ecological settings statewide on broad ridgetops and gentle side slopes in terrace uplands; on middle and lower slopes between uplands and stream bottoms; and at the heads of drainages along small, intermittent streams
Shortleaf Pine-Oak, Oak-Hickory Forest	S2S3 G2G3	CES203.378 West Gulf Coastal Plain Pine-Hardwood Forest; CES203.506 East Gulf Coastal Plain Interior Shortleaf Pine-Oak Forest	Occurs on dry hills, principally in central and northern Louisiana, although it may occur sporadically in the Florida Parishes

Type	Rarity Rank*	Ecological System	Description
Small Stream Forest	S3 G3	CES203.559 East Gulf Coastal Plain Small Stream and River Forest; CES203.487 West Gulf Coastal Plain Small Stream and River Forest	Narrow wetland forests occurring along small rivers and large creeks that are seasonally flooded for brief periods
Western Xeric Sandhill Woodland	S2S3 (S1 - Florida Parishes)/ G2G3	CES203.056 West Gulf Coastal Plain Sandhill Oak and Shortleaf Pine Forest and Woodland	Developed on deep Tertiary marine sands (parcticularly of the Sparta formation in northwest Louisiana) and also on Pleistocene stream terraces

Source: Louisiana Department of Wildlife and Fisheries – Louisiana Natural Heritage Program
*GLOBAL ELEMENT RANKS:
G1 = critically imperiled globally because of extreme rarity (5 or fewer known extant populations) or because of some factor(s) making it especially vulnerable to extinction
G2 = imperiled globally because of rarity (6 to 20 known extant populations) or because of some factor(s) making it very vulnerable to extinction throughout its range
G3 = either very rare and local throughout its range or found locally (even abundantly at some of its locations) in a restricted range (e.g., a single physiographic region) or because of other factors making it vulnerable to extinction throughout its range (21 to 100 known extant populations)
G4 = apparently secure globally, though it may be quite rare in parts of its range, especially at the periphery (100 to 1000 known extant populations)
G5 = demonstrably secure globally, although it may be quite rare in parts of its range, especially at the periphery (1000+ known extant populations)
GH = of historical occurrence throughout its range; i.e., formerly part of the established biota, with the possibility that it may be rediscovered (e.g., Bachman's Warbler)
GU = possibly in peril range-wide, but status uncertain; need more information
G? = rank uncertain. Or a range (e.g., G3G5) delineates the limits of uncertainty
GQ = uncertain taxonomic status
GX = believed to be extinct throughout its range (e.g., Passenger Pigeon) with virtually no likelihood that it will be rediscovered
T = subspecies or variety rank (e.g., G5T4 applies to a subspecies with a global species rank of G5, but with a subspecies rank of G4)

Special-Status Species

To further understand natural resources that may be parcticularly vulnerable to a hazard event, as well as those that need consideration when implementing mitigation activities, it is important to identify at-risk species (i.e., endangered species) in the planning area. An endangered species is any species of fish, plant life, or wildlife that is in danger of extinction throughout all or most of its range. A threatened species is a species that is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range. Both endangered and threatened species are protected by law and any future hazard mitigation projects are subject to these laws. Candidate species are plants and animals that have been proposed as endangered or threatened but are not currently listed.

Information from the U.S. Fish and Wildlife Service and the Louisiana Natural Heritage Program, a program that inventories the status and locations of rare plants and animals in Louisiana, was combined to create an inventory of special-status species in Bossier City. Table 4.20 lists national and state endangered, threatened, rare, and candidate species in Bossier City by species type.

Table 4.20. The City of Bossier City's Sensitive Plant and Animal Species

Scientific Name	Common Name	State Rank	Global Rank
Aimophila aestivalis	Bachman's Sparrow	S3	G3
Ammocrypta clara	Western Sand Darter	S2	G3
Anemone berlandieri	Ten petal thimbleweed	S2	G4?
Camassia scilloides	Atlantic Camas	S3	G4G5
Carex decomposita	Cypress-knee Sedge	S3	G3
Carex meadii	Mead's Sedge	S3	G4G5
Cirsium engelmannii	Cirsium Terraenigrae	SU	G4
Coreopsis palmata	Stiff Tickseed	S2	G5
Cypress-tupelo swamp	Cypress-tupelo Swamp	S4	G3G5
Cypripedium kentuckiense	Southern Lady's-slipper	S1	G3
Dodecatheon meadia	Common Shooting-star	S2	G5
Eleocharis wolfii	Wolf Spikerush	S3	G3G4
Erythronium albidum	White Trout-lily	S2	G5
Forested seep	Forested Seep	S3	G3?
Forestiera ligustrina	Upland Swamp Privet	S3	G4G5
Haliaeetus leucocephalus	Bald Eagle	S2N,S3B	G5
Helenium campestre	Old Field Sneezeweed	S1	G4
Houstonia purpurea var. calycosa	Purple Bluet	S2	G5T5
Isotria verticillata	Large Whorled Pogonia	S3	G5
Koeleria macrantha	June grass	S1	G5
Lindheimera texana	Texas Yellow-star	S1	G5
Marshallia caespitosa var. signata	Barbara's Buttons	S1	G4T4
Mirabilis albida	Pale Umbrella-wort	S2	G5
Mixed hardwood-loblolly forest	Mixed Hardwood-loblolly Forest	S4	G3G4
Monotropa hypopithys	American Pinesap	S2	G5
Mustela frenata	Long-tailed Weasel	S2S4	G5
Nemastylis geminiflora	Prairie Pleat-leaf	S2S3	G4
Oenothera pilosella ssp. sessilis	Meadow Evening Primrose	S1?	G5T2Q
Oenothera rhombipetala	Four-point Evening Primrose	S	G4G5
Phlox pilosa ssp. ozarkana	Downy Phlox	S	G5TNR

Scientific Name	Common Name	State Rank	Global Rank
Picoides borealis	Red-cockaded Woodpecker	S2	G3
Quercus arkansana	Arkansas Oak	S2	G3
Quercus macrocarpa	Burr Oak	S1	G5
Ratibida pinnata	Yellow Coneflower	S2?	G5
Rudbeckia triloba	Three-lobed Coneflower	S3	G5
Sanguinaria canadensis	Bloodroot	S2	G5
Silene stellata	Starry Campion	S2	G5
Solanum dimidiatum	Western Horse-nettle	S2S3	G5
Solidago auriculata	Eared Goldenrod	S4	G4
Sterna antillarum athalassos	Interior Least Tern	S1B	G4T2Q
Symphyotrichum drummondii var. texanum	Texas Aster	S1?	G5TNR
Taenidia integerrima	Yellow Pimpernell	S2	G5
Thalictrum revolutum	Windflower	S1	G5
Trillium recurvatum	Reflexed Trillium	S2	G5
Triosteum angustifolium	Yellowleaf Tinker's-weed	S2	G5
Triphora trianthophora	Nodding Pogonia	S2	G3G4
Viola pubescens	Downy Yellow Violet	S1	G5
Vireo gilvus	Warbling Vireo	S1B	G5
Waterbird Nesting Colony	Waterbird Nesting Colony	SNR	GNR
Zigadenus nuttallii	Nuttall Death Camas	S1	G5

Source: Louisiana Natural Heritage Program

*GLOBAL ELEMENT RANKS:

G1 = critically imperiled globally because of extreme rarity (5 or fewer known extant populations) or because of some factor(s) making it especially vulnerable to extinction

G2 = imperiled globally because of rarity (6 to 20 known extant populations) or because of some factor(s) making it very vulnerable to extinction throughout its range

G3 = either very rare and local throughout its range or found locally (even abundantly at some of its locations) in a restricted range (e.g., a single physiographic region) or because of other factors making it vulnerable to extinction throughout its range (21 to 100 known extant populations)

G4 = apparently secure globally, though it may be quite rare in parts of its range, especially at the periphery (100 to 1000 known extant populations)

G5 = demonstrably secure globally, although it may be quite rare in parts of its range, especially at the periphery (1000+ known extant populations)

GH = of historical occurrence throughout its range; i.e., formerly part of the established biota, with the possibility that it may be rediscovered (e.g., Bachman's Warbler)

GU = possibly in peril range-wide, but status uncertain; need more information

G? = rank uncertain. Or a range (e.g., G3G5) delineates the limits of uncertainty

GQ = uncertain taxonomic status

GX = believed to be extinct throughout its range (e.g., Passenger Pigeon) with virtually no likelihood that it will be rediscovered

T = subspecies or variety rank (e.g., G5T4 applies to a subspecies with a global species rank of G5, but with a subspecies rank of G4)

**STATE ELEMENT RANKS:

S1 = critically imperiled in Louisiana because of extreme rarity (5 or fewer known extant populations) or because of some factor(s) making it especially vulnerable to extirpation

S2 = imperiled in Louisiana because of rarity (6 to 20 known extant populations) or because of some factor(s) making it very vulnerable to extirpation

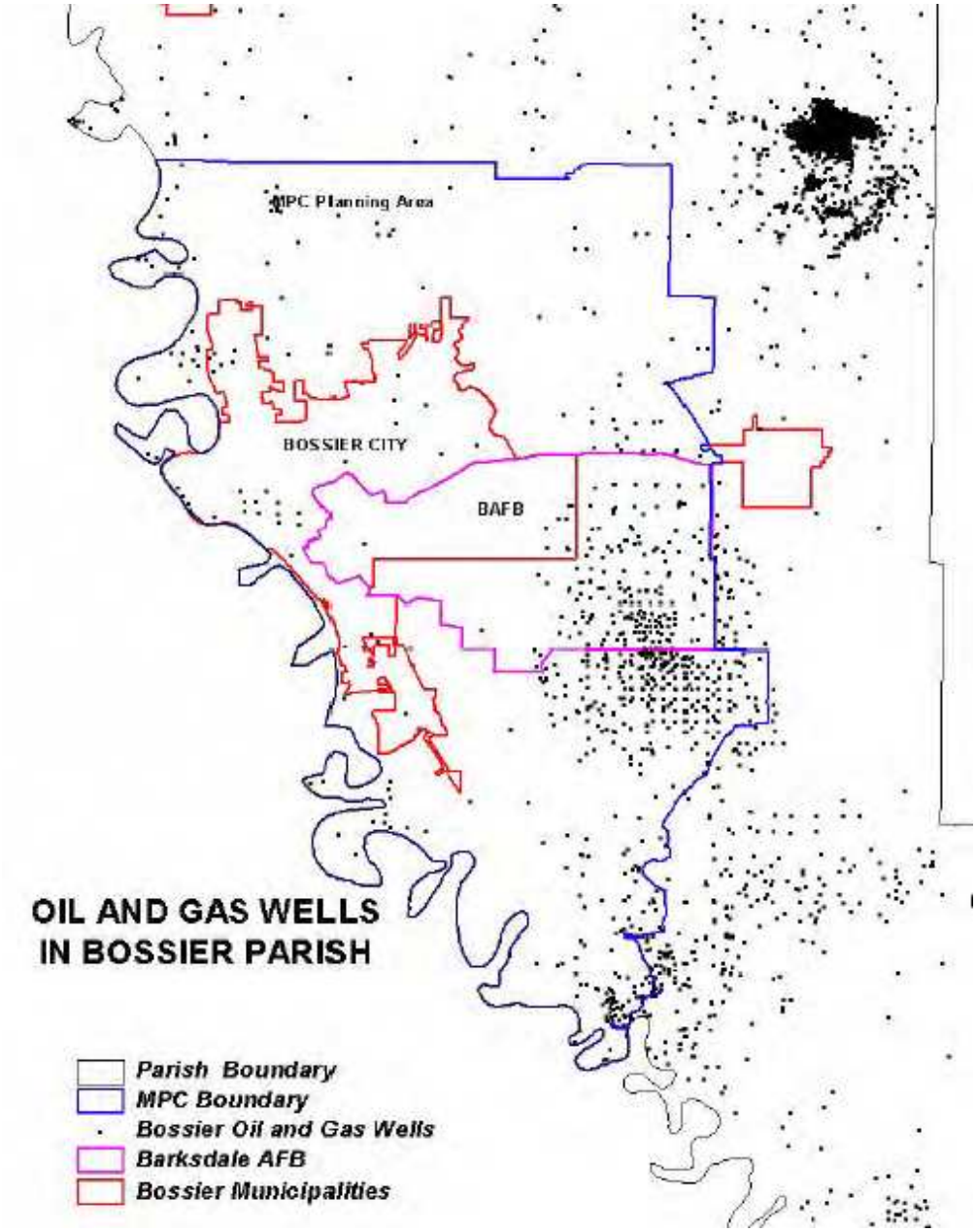
S3 = rare and local throughout the state or found locally (even abundantly at some of its locations) in a restricted region of the state, or because of other factors making it vulnerable to extirpation (21 to 100 known extant populations)
S4 = apparently secure in Louisiana with many occurrences (100 to 1000 known extant populations)
S5 = demonstrably secure in Louisiana (1000+ known extant populations)
(B or N may be used as qualifier of numeric ranks and indicating whether the occurrence is breeding or nonbreeding)
SA = accidental in Louisiana, including species (usually birds or butterflies) recorded once or twice or only at great intervals hundreds or even thousands of miles outside their usual range
SH = of historical occurrence in Louisiana, but no recent records verified within the last 20
years; formerly part of the established biota, possibly still persisting
SR = reported from Louisiana, but without conclusive evidence to accept or reject the report SU = possibly in peril in Louisiana, but status uncertain; need more information SX = believed to be extirpated from Louisiana
SZ = transient species in which no specific consistent area of occurrence is identifiable

Petroleum Resources

Oil and gas exploration began in northwest Louisiana shortly after 1910. Several oil and gas fields have been discovered in Bossier Parish, and there are also an extraordinary number of "wildcat" wells. These are wells not associated with an established field.

There are three extensive fields in and near the MPC Planning area. These are the Elm Grove, Sligo and Bellevue fields. The Sligo field extends well into the eastern reservation of Barksdale Air Force Base. There are several wells operating within the corporate limits of Bossier City. Some of these are located within the "Old Bossier" area of the city and are still actively producing today. These are shown in Figure 4.33.

Figure 4.33. Oil and Gas Wells in Bossier City and Bossier Parish



Source?

4.3.2 Growth and Development Trends

As part of the planning process, the HMPC looked at changes in growth and development, both past and future, and examined these changes in the context of hazard-prone areas, and how the changes in growth and development affect loss estimates and vulnerability. Information from the Bossier City Comprehensive Land Use and Development Master Plan and the US Census Bureau form the basis of this discussion.

Current Status and Past Development

In 2008, the US Census Bureau's American Community Survey estimated that Bossier City's population was 58,409. This was an increase of 3.5 percent from the 2000 census population of 56,461. Bossier City, along with the entire state of Louisiana, has experienced widely varying rates of population growth in recent decades. For example, Bossier City had a 22 percent growth rate during the 1970s, which fell to less than four percent in the 1980s, and then rebounded to seven percent in the 1990s. The population of the City of Bossier City is concentrated in the western part of the City, along the Red River. Table 4.21 and Table 4.22 illustrate past growth in Bossier City population and housing units. The average household size in 2009 was estimated at 2.4, and the average family size 3.0.

Table 4.21. Bossier City's Population Growth 1970-2009

	1970	1980	1990	2000	2009
Total	41,595	50,817	52,721	56,461	58,409
Change	-	9,222	1,904	3,740	1,948
Percent Change (%)		22.2%	3.7%	7.1%	3.5%

Source: Bossier Comprehensive Land Use and Development Master Plan

Table 4.22. Bossier City's Growth in Housing Units 2000-2008

2000 # of Housing Units	2008 Estimated # of Housing Units	Estimated Percent Change 2000-2009
23,026	26,287	14.2%

Source: US Census Bureau

Future Development

As indicated in the previous section, Bossier City has been steadily growing over the last four decades, and this growth is projected to continue at a slowing pace through the middle of the century. Figure 4.34 shows the population projections for the City through 2020.

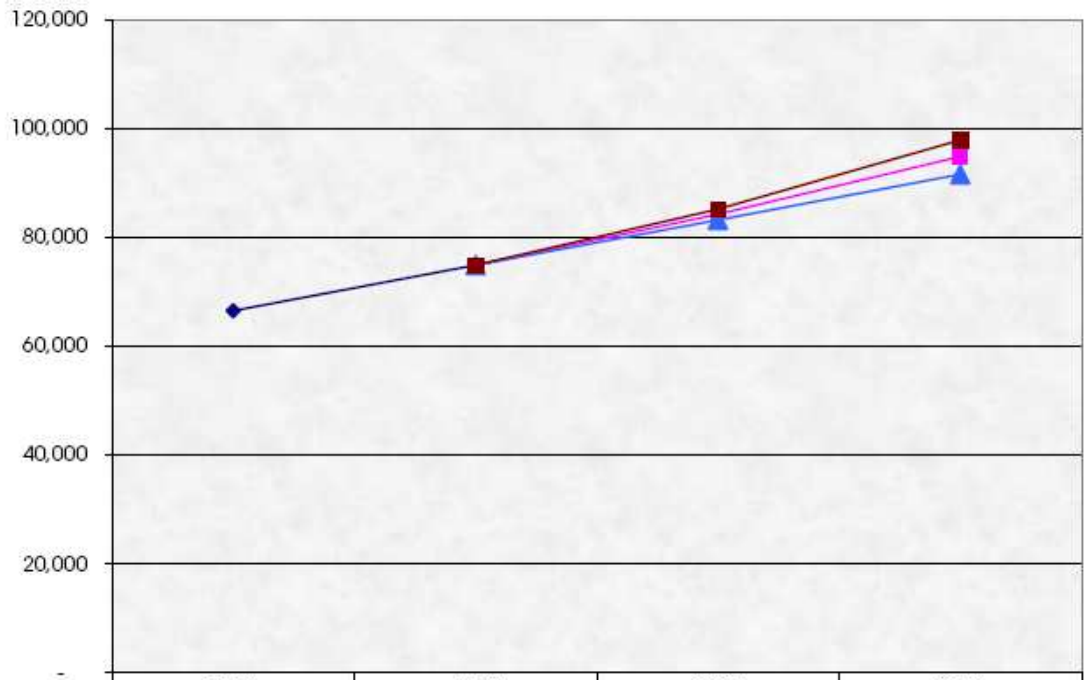
The outlook for Bossier City continues to be bright, but it also offers significant challenges. The population of the area is expected to continue to grow, but many of the areas available for new housing and urban development intrude upon the natural and aesthetic ecosystem of the area. The gaming industry will continue to be a significant employer in the region, but like other tourism-oriented industries, may significantly suffer during economic downturns. The military base will likely continue to play a key role in the community; however, coordination with base commanders will be crucial to maintaining a healthy relationship. Noise pollution from the base may be a factor in future land development decisions. Housing development will continue as the population grows, but it may not be affordable and located appropriately to serve all residents in the City.

Bossier City's transportation infrastructure is of great importance to the future growth of Bossier City and Bossier Parish. The Red River, now navigable to the Port of Shreveport-Bossier, offers

the promise of new business ventures in manufacturing and warehousing. Bossier's central location offers the possibility of a wide range of new businesses including warehousing, material distribution centers, corporate regional headquarters, and major retail corporations. Other businesses invariably are created to support large employers and these provide an even greater growth potential. Successful measured growth in Bossier City and Bossier Parish can, in part, be obtained by the acquisition of such businesses.

Population projections developed specifically for the Metropolitan Planning Commission (MPC) Planning Area (which generally extends five miles beyond the corporate limits into Bossier Parish.) for purposes of long-range planning indicate that the Bossier metropolitan area will continue to grow at a strong pace over each of the next two decades. As shown in Figure 4.34, the projections for 2020 range from 91,500 to nearly 98,000 persons, depending on the projection technique used. Again, these estimates are not for Bossier City alone, but the planning area described above.

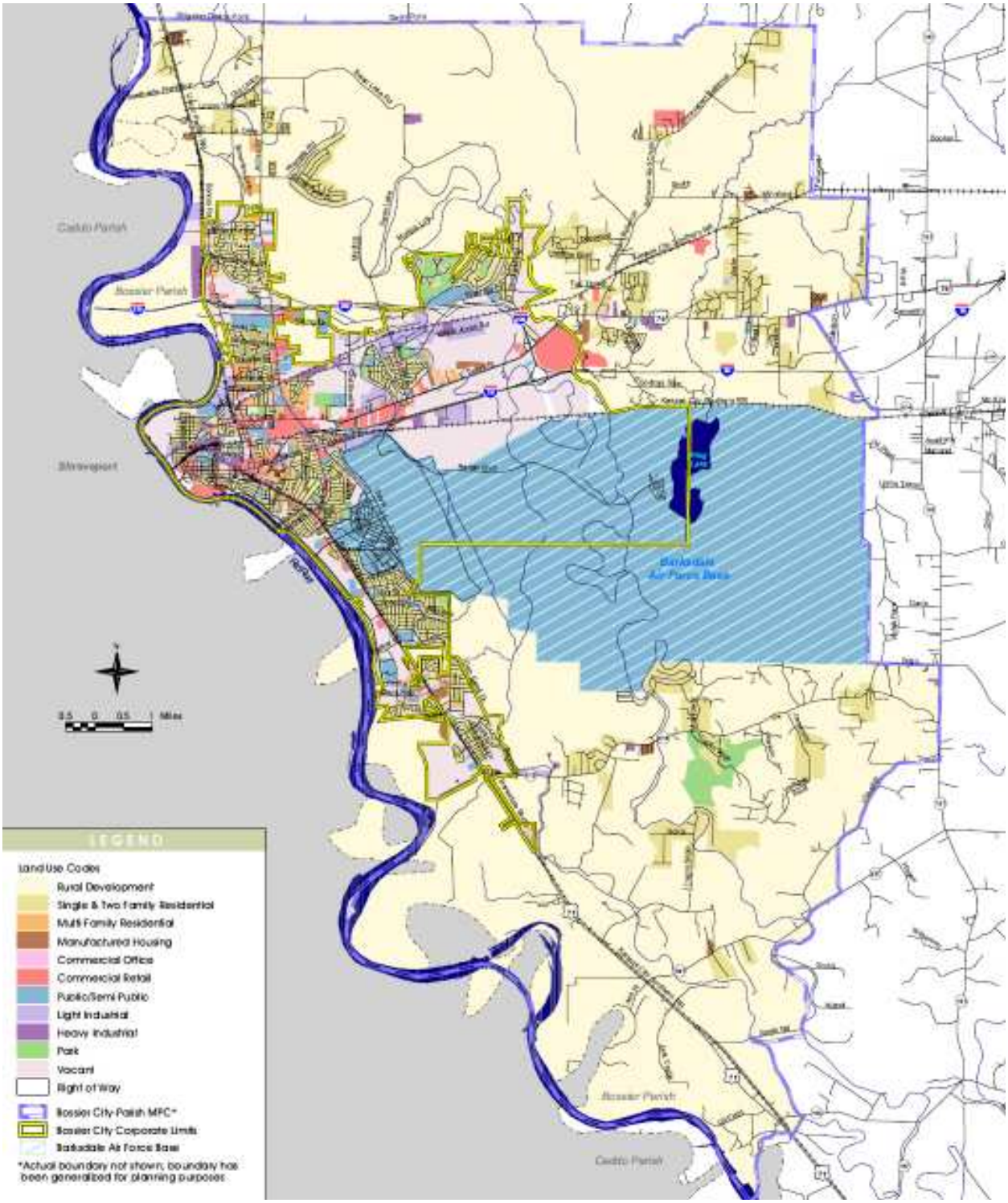
Figure 4.34. Population Projection Scenarios for the Bossier City Planning Area



	1990	2000	2010	2020
Historical	66,479	74,836		
Exponential		74,836	84,244	94,834
Linear Regression		74,836	83,193	91,550
Geometric		74,836	85,154	97,855

Source Bossier Comprehensive Land Use and Development Master Plan
Note: Population estimates are for the MPC, which generally extends five miles beyond the corporate limits into Bossier Parish.

Figure 4.35. Bossier City's Current Land Use



Source: Bossier City Master Plan

Future Development Summary

Need population growth estimates

The Bossier City Comprehensive Land Use and Development Master Plan provides a vision for future physical growth, economic development, and associated challenges in the Bossier City planning area. The main goals of the Plan are the following:

- Promote efficient, long term growth within the MPC Planning Area and outside of sensitive development areas.
- Encourage preservation and sensitive utilization of natural areas, particularly floodplains, wetlands, the Red River and its tributaries.
- Promote the conservation of natural resources through parks and recreation land acquisition, open space preservation, and environmentally sensitive planning.
- Encourage the preservation of open space to reflect the unique resources of Bossier's natural environment and to enhance the community's livability, aesthetic quality, and natural beauty.
- Develop an on- and off-street network of pedestrian and bicycle ways throughout the MPC planning area.
- Promote pedestrian and bicycle pathways as a viable alternative to automobile traffic, particularly when tied to a public transportation system.
- Develop a comprehensive flood and stormwater management program to eliminate or mitigate floodplain and localized flooding, stormwater quality issues, and bank erosion within the master plan study area.
- Preserve flood prone areas and other natural resources to the extent practicable through use of alternative development techniques, and design residential areas to minimize flooding problems and create amenities.

More specific information on the Bossier City Comprehensive Land Use and Development Master Plan is 4.4.1 Bossier City's Regulatory Mitigation Capabilities.

4.3.3 Vulnerability of the City of Bossier City to Specific Hazards

The Disaster Mitigation Act regulations require the HMPC to evaluate the risks associated with each of the priority hazards identified in the planning process. A vulnerability analysis (either quantitative or qualitative) is provided for each of the hazards identified as a priority hazard in Section 4.2.18 Natural Hazards Summary. The vulnerability and potential impacts from priority hazards that do not have specific mapped areas nor the data to support additional vulnerability analysis are discussed in more general terms. The hazards evaluated further as part of this vulnerability assessment include:

- Dam/Levee Failure
- 100/500 –year Flood
- Flash Flood
- Riverine Flood
- Heavy Rain/Thunderstorm/Lightning/Wind
- Tornado
- Tropical Storm/Hurricane
- Winter Storm/Extreme Cold

An estimate of the vulnerability of the City to each identified hazard, in addition to the estimate of likelihood of future occurrence, is provided for each of the hazard-specific sections that follow. A definition of likelihood of future occurrence can be found in Section 4.2 Hazard Profiles. Vulnerability is measured in general, qualitative terms and is a summary of the potential impact based on past occurrences, spatial extent, and damage and casualty potential. It is categorized into the following classifications:

Vulnerability rating: need more detail. Re-assess for each hazard.

- **Extremely Low**—The occurrence and potential cost of damage to life and property is very minimal to nonexistent.
- **Low**—Minimal potential impact. The occurrence and potential cost of damage to life and property is minimal.
- **Medium**—Moderate potential impact. This ranking carries a moderate threat level to the general population and/or built environment. The potential damage is more isolated and less costly than a more widespread disaster.
- **High**—Widespread potential impact. This ranking carries a high threat to the general population and/or built environment. The potential for damage is widespread. Hazards in this category may have occurred in the past.
- **Extremely High**—Very widespread and catastrophic impact.

Vulnerability can be quantified in those instances where there is a known, identified hazard area, such as a mapped floodplain. In these instances, the numbers and types of buildings subject to

the identified hazard can be counted and their values tabulated. Further, other information can be collected in regard to the hazard area, such as the location of critical community facilities (e.g., a fire station), historic structures, and valued natural resources (e.g., an identified wetland or endangered species habitat). This information portrays the impact, or vulnerability, of that area to that hazard.

Vulnerability to Dam/Levee Failure

Likelihood of Future Occurrence: **Occasional**
Vulnerability: **Medium**

Dam or levee failure flooding can occur as the result of partial or complete collapse of an impoundment, and often results from prolonged rainfall and flooding. The primary danger associated with dam or levee failure is the high velocity flooding of those properties downstream of the dam. Section 4.2.1 Dam/Levee Failure describes the dam and levee inventory in the Bossier City planning area.

A dam or levee failure can range from a small, uncontrolled release to a catastrophic failure. Vulnerability to dam or levee failures is generally confined to the areas subject to inundation downstream of the facility. Secondary losses would include loss of the multi-use functions of the facility and associated revenues that accompany those functions.

Methodology

The DFIRM was acquired from the City of Bossier City. Included in the DFIRM is an 'X Protected by Levee' Zone. Figure Figure 4.36 shows that zone, and Table X lists the critical facilities that fall within that zone. The 'X Protected by Levee' Zone is located on the Barksdale Air Force Base and in the southern portion of Bossier City.

Dam and levee failure flooding would vary in the City depending on which structure fails and the nature and extent of the failure and associated flooding. This flooding presents a threat to life and property, including buildings, their contents, and their use. Large flood events can affect lifeline utilities (e.g., water, sewerage, and power), transportation, jobs, tourism, the environment, agricultural industry, and the local and regional economies.

Figure 4.36. The City of Bossier City's 'X Protected by Levee' Zone

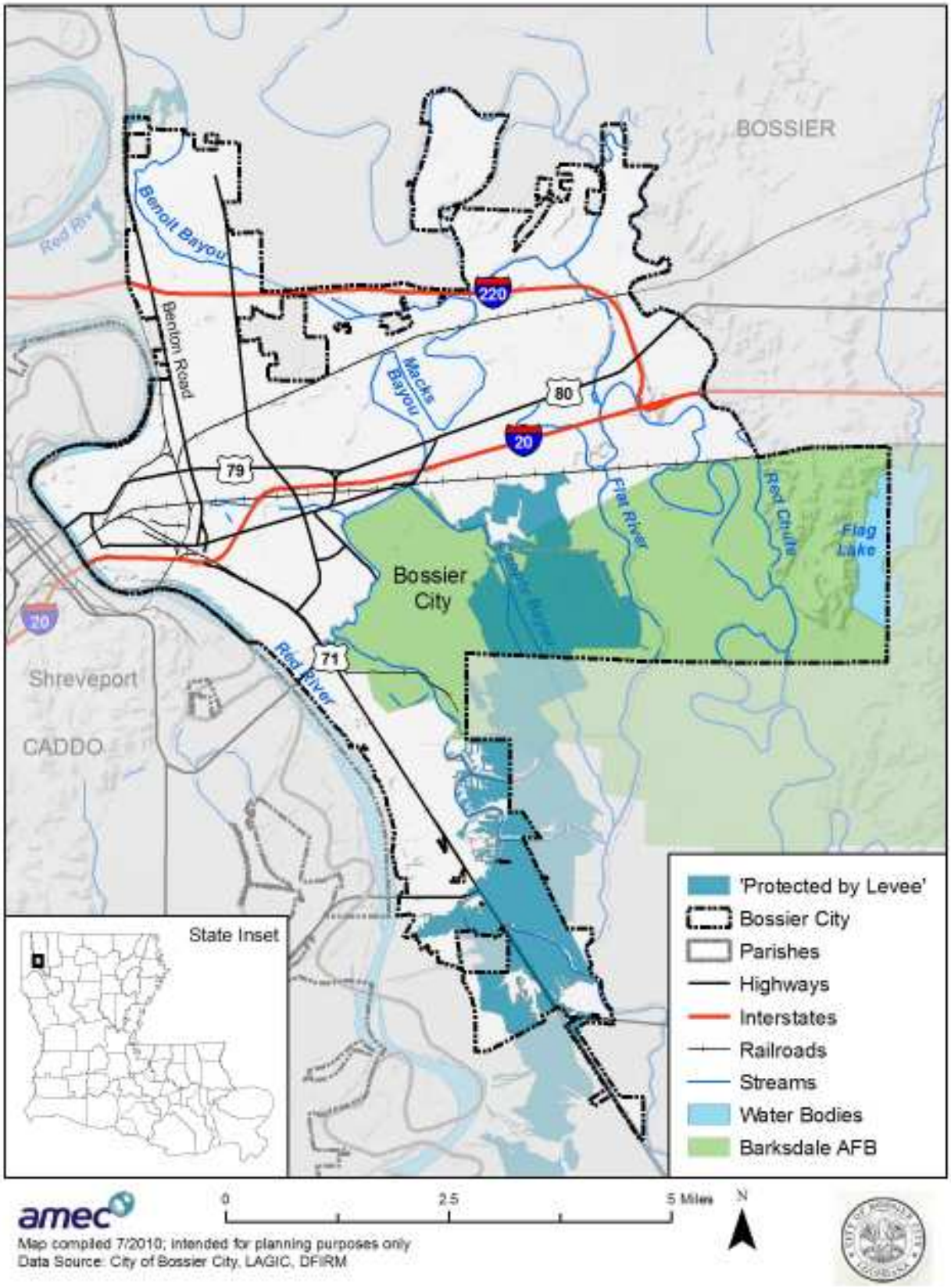


Table 4.23. Critical Facilities in the 'X Protected by Levee' Flood Zone

Tier	Type	Name	Address
1	School	Curtis Elementary School	5600 Barksdale Blvd.
2	Church	Riverside Baptist Church	1714 Jimmie Davis Hwy
2	Church	Heritage Baptist Church	5580 Barksdale Blvd.
2	Public Building	Aulds South Bossier City Branch Library	

Vulnerability to 100/500 -year Flood

Likelihood of Future Occurrence: **Occasional**
Vulnerability: **High**

Flooding has occurred in the past: within the 1 percent annual chance floodplain and in other localized areas. In addition to damage to area infrastructure, other problems associated with flooding include erosion, sedimentation, degradation of water quality, loss of environmental resources, and certain health hazards.

Methodology

The City of Bossier City's DFIRM indicates the extent of the 1 percent annual chance and 0.2 percent annual chance flood events. GIS was used to identify and quantify the possible impacts of flooding within the City of Bossier City planning area. The following methodology was followed in creating these flood vulnerability maps and determining values at risk to the 1 percent annual chance and the 0.2 percent annual chance flood events.

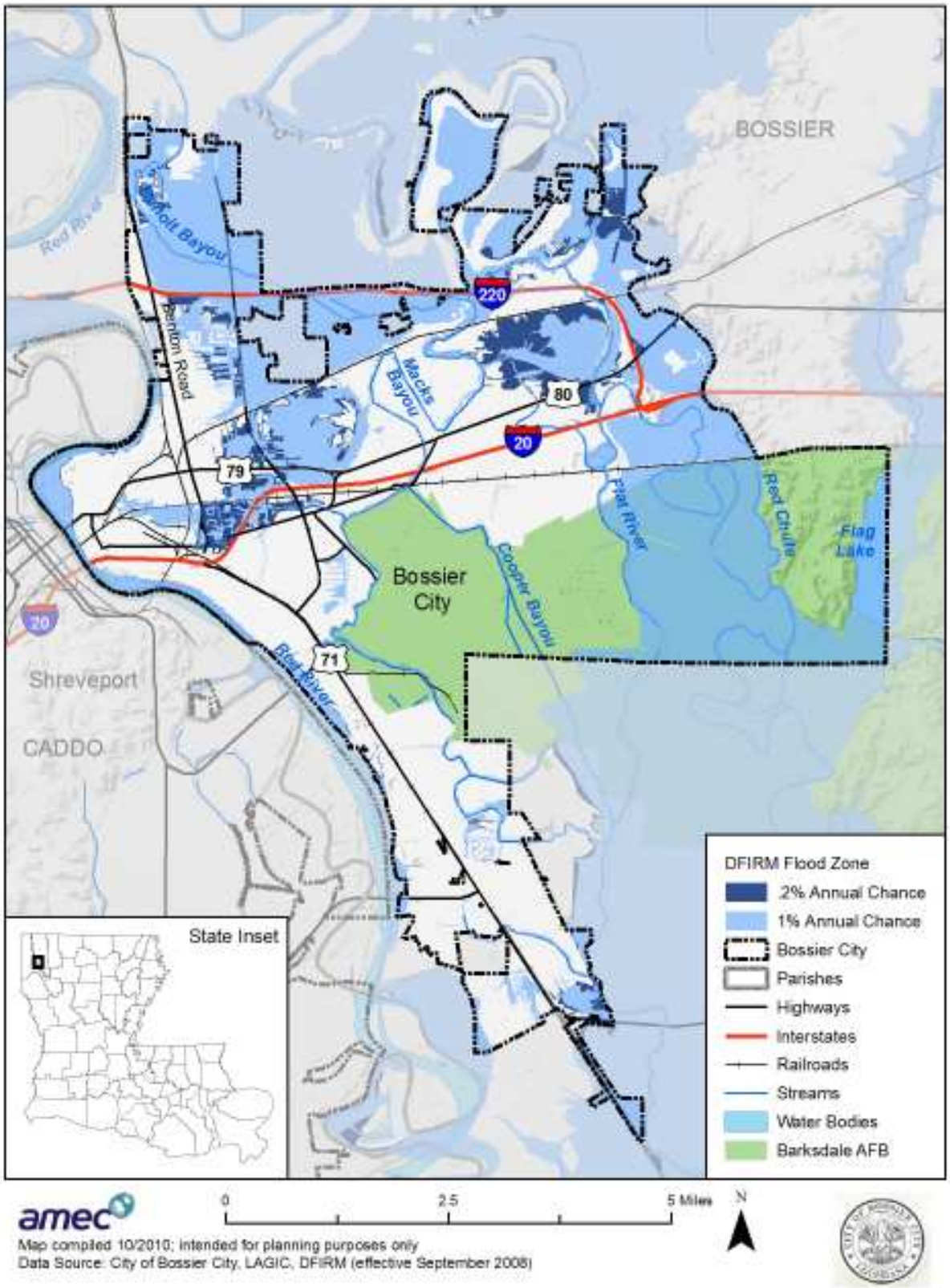
The 2008 FEMA DFIRMs, provided by the City, were used as the floodplain layer. This data set is the most comprehensive, electronic representation of the 1 percent and the 0.2 percent annual chance flood events for the entire planning area. Figure 4.37 shows the 1 percent and the 0.2 percent annual chance flood zones used for this analysis. The HAZUS-MH MR4 census block – level buildings data was used as the basis for the inventory of development in Bossier City. Using GIS software, the floodplain was overlaid on the City's buildings data. A proportional division was performed to account for census blocks that were split by floodplain boundaries, to better model values in the floodplain. For example, a census block that was split by a floodplain (40 percent in the floodplain, 60 percent out) had its building count and valuation multiplied by .40. Information about building replacement value at risk could then be estimated for the Bossier City planning area.

The following assumptions were made to find loss estimates in Table 4.24:

- Building counts and values of each census block in the city are assumed to be evenly distributed over that census block
- A total value was calculated for structure plus contents
- An assumed flood damage of 20 percent of the total value was calculated based on FEMA flood depth-damage curves assuming a two-foot flood depth

Following this methodology, flood maps were created that illustrate where flooding is most likely to happen in the City of Bossier City (see Figure 4.37).

Figure 4.37. The City of Bossier City's 1% Annual Chance and .2% Annual Chance Flood Boundaries



Values at Risk

While there are several limitations to this model, it does allow for potential loss estimation. It should be noted that the model may have included structures in the floodplains that are elevated at or above the level of the base-flood elevation, which will likely mitigate flood damage.

Table 4.24. The City of Bossier City's Count, Building Value and Loss Estimates in the 100-year Floodplain

	Building Count	Building Value	Contents Value	Total Value	Loss Estimate
Residential	4,268	$851,653,000	$425,977,000	$1,277,630,000	$255,526,000
Commercial	304	$192,057,000	$203,599,000	$395,656,000	$79,131,200
Industrial	64	$28,373,000	$37,837,000	$66,210,000	$13,242,000
Agricultural	14	$1,438,000	$1,438,000	$2,876,000	$575,200
Religious	18	$10,945,000	$10,945,000	$21,890,000	$4,378,000
Government	14	$ 9,894,000	$10,457,000	$20,351,000	$4,070,200
Education	9	$4,246,000	$4,432,000	$8,678,000	$1,735,600
	4,689	**$ 1,098,606,000**	**$ 694,685,000**	**$1,793,291,000**	**$ 358,658,200**

Source: The City of Bossier City GIS; FEMA DFIRMs

Table 4.25. The City of Bossier City's Count, Building Value and Loss Estimates in the 500-year Floodplain

	Building Count	Building Value	Contents Value	Total Value	Loss Estimate
Residential	979	$177,024,000	$88,551,000	$265,575,000	$53,115,000
Commercial	72	$59,602,000	$61,133,000	$120,735,000	$24,147,000
Industrial	13	$5,738,000	$7,968,000	$13,706,000	$2,741,200
Agricultural	2	$177,000	$177,000	$354,000	$70,800

Religious	4	$2,813,000	$2,813,000	$5,626,000	$1,125,200
Government	5	$4,097,000	$4,294,000	$8,391,000	$1,678,200
Education	2	$1,292,000	$1,402,000	$2,694,000	$538,800
	1,078	**$250,743,000**	**$166,338,000**	**$417,081,000**	**$83,416,200**

According to this analysis, the Bossier City planning area has 4,689 buildings valued at roughly $1 billion in the 100-year floodplain. Applying the 20 percent damage factor as previously described, there is a 1 percent chance in any given year of a flood causing roughly $359 million in damage in the City of Bossier City planning area. Bossier City has 1,078 buildings valued at over $250 million in the 500-year floodplain. There is .2 percent chance in any given year of a flood causing roughly $83 million in damage to buildings and their contents.

Insurance Coverage, Claims Paid, and Repetitive Losses

The City of Bossier City participates in the Regular Phase of the NFIP. They have an updated FIS and DFIRM since September 2008.

Bossier City has 2,907 Flood Insurance policies in effect amounting to $579,039,200. They have had 199 paid claims totaling $2,723,017 and 15 substantial damage claims since 1978.

Bossier City is a Community Rating System (CRS) Class 8 community with 1,199 points. The City is currently saving $146,992 annually on the cost of flood insurance which amounts to $51 on average for each policy holder.

According to the 2009 data from the state on NFIP communities, there are 16 repetitive loss (RL) buildings in the City of Bossier City with 48 paid losses totaling $708,606.

Populations at Risk

Of greatest concern in the event of a flood, is the potential for loss of life. Using 2000 population data aggregated by census block data from HAZUS-MH and GIS, an estimate was made of populations in the 1 percent annual chance and 0.2 percent annual chance flood zones. Similar to the buildings analysis above, a proportional division was performed to better reflect population counts in the floodplain and to account for census blocks that were split by flood boundaries. Results are provided in Table 4.26.

Table 4.26. The City of Bossier City's Population by Flood Event

	100-Year Flood	500-Year Flood	Total
Bossier City	13,443	3,007	16,450

Source: HAZUS-MH MR4 (Census 2000); The City of Bossier City GIS; FEMA DFIRM

Critical Facilities at Risk

Critical facilities are those community components that are most needed to withstand the impacts of disaster as previously described. Table 4.16 and Table 4.17 provide an inventory of critical facilities in the Bossier City planning area. An analysis was performed using GIS software to determine those critical facilities that are located in Bossier City's floodplain. The DFIRM flood layer previously discussed was used to identify the 1 percent annual chance and 0.2 percent annual chance flood zones. Figure 4.38 illustrates the locations of critical facilities relative to the 1 percent annual chance and 0.2 annual chance flood zones in the City; Table 4.27 and Table 4.28 list those facilities by flood zone. The impact to the community could be great if these critical facilities were damaged or destroyed during a flood event.

Figure 4.38. The City of Bossier City's Critical Facilities in the 1% Annual Chance and .2% Annual Chance Flood

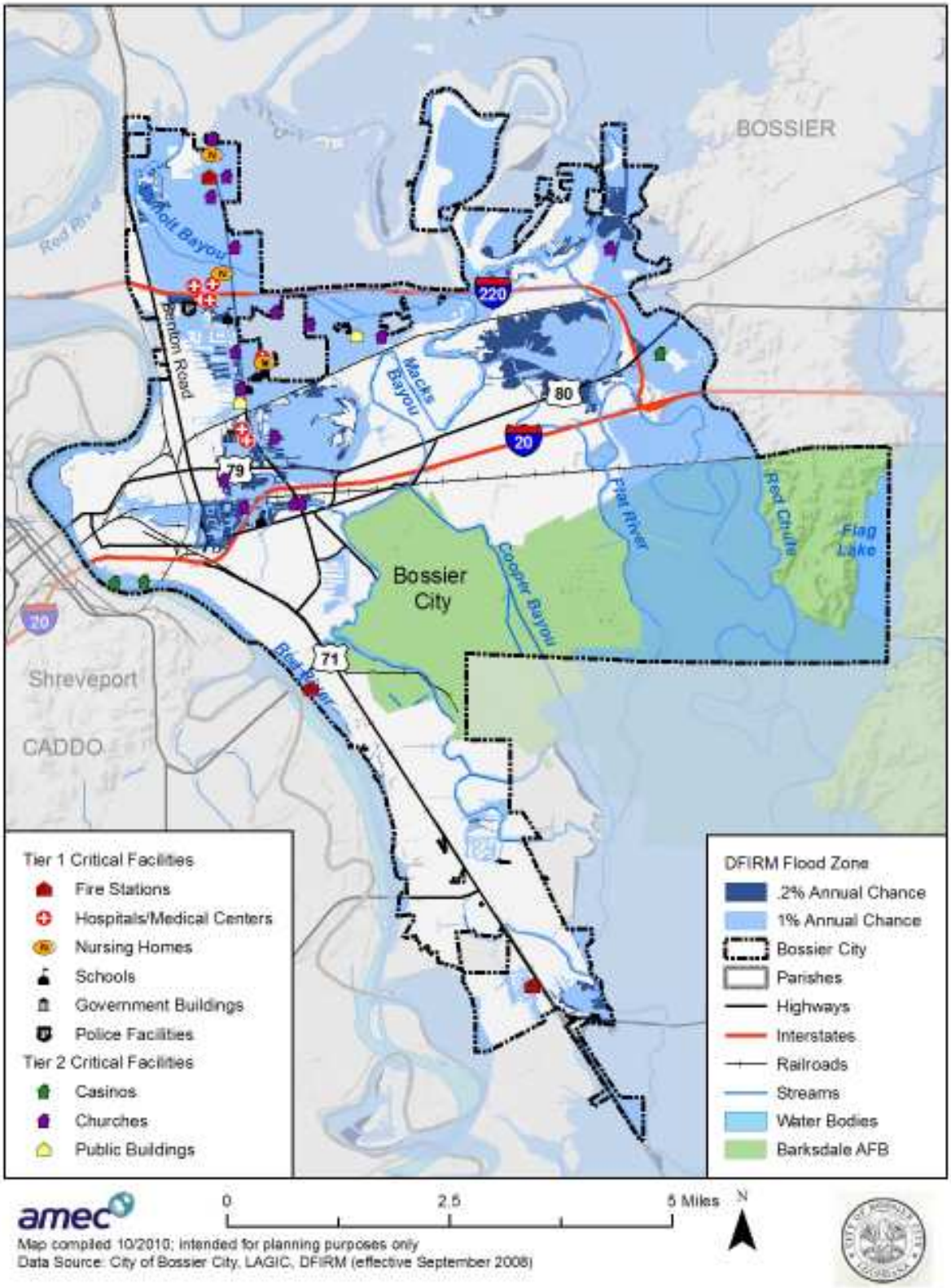


Table 4.27. Critical Facilities in the 100-year Floodplain

Tier	Facility Type	Facility Name	Address
Tier 1	Fire Stations	Fire Station 8	2001 River Bend DR
	Fire Stations	Fire Station 9	2621 Brownlee RD
	Fire Stations	Fire Department 'Rescue Boat Facility'	3133 Arthur Ray Teague Parkway
	Hospitals / Medical Centers	Willis-Knighton Health Center	2400 Hospital DR
	Hospitals / Medical Centers	Red River Behavioral Center	2800 Melrose AVE
	Hospitals / Medical Centers	Promise Specialty Hospital	2525 Viking DR
	Hospitals / Medical Centers	Outpatient Physical Therapy	2450 Hospital DR
	Hospitals / Medical Centers	Med-Express	2539 Viking DR
	Hospitals / Medical Centers	Christus Schumpert Hospital	2105 Airline DR
	Nursing Homes	Morning Star Retirement Community	2540 Beene BLVD
	Nursing Homes	Guest House Of Bossier	2901 Douglas DR
	Nursing Homes	Garden Court Nursing Center	4405 Airline DR
	Schools	Red River Marine Institute	2890 Douglas DR
	Schools	Greenacres Middle School	2220 Airline DR
	Schools	BPCC South Complex	2900 Douglas DR
Tier 2	Casinos	Isle of Capri Casino	711 Isle of Capri BLVD
	Casinos	Harrah's Louisiana Downs	8000 E Texas ST
	Casinos	Boomtown Casino	300 Riverside DR
	Churches	Stockwell Missionary Baptist Church	2201 Stockwell RD
	Churches	ST. Jude's Catholic Church	3800 Viking DR
	Churches	Immanuel Lutheran Church	2565 Airline DR
	Churches	First United Pentecostal Church	2833 Viking DR
	Churches	Family Worship Center	4204 Airline DR
	Churches	Evergreen Ministries	4400 Viking DR
	Churches	Bossier City First Church Of God	4601 Airline DR
	Churches	Asbury United Methodist Church	3200 Airline DR
	Churches	Airline Baptist Church	4007 Airline DR
	Public Buildings	U.S. Post Office, Airline Contract Station	2801 Northside DR
	Public Buildings	Bossier Press Tribune	4250 Viking DR

Table 4.28. Critical Facilities in the 500-year Floodplain

Tier	Facility Type	Facility Name	Address
Tier 1	Schools	Rusheon Middle School	2401 Old Minden RD

	Government Buildings	Caddo-Bossier OHSEP	1511 Doctors DR
	Police Facilities	Bossier Parish Sheriff Sub Station	2510 Viking DR
	Hospitals / Medical Centers	Bossier Orthopedic Specialist	2005 Airline DR
	Schools	Airline High School	2801 Airline DR
Tier 2	Churches	ST. George's Episcopal Church	1959 Airline DR
	Churches	Pre-School First Baptist Church Of Bossier City	2801 Beckett ST
	Churches	Hope Assembly Of God	3012 Shed RD
	Churches	John Knox Presbyterian Church	1944 Airline DR
	Churches	Central Baptist Church	2225 Airline DR
	Churches	Christ Community Church	1013 Gould DR

Vulnerability to Flash Flood

Likelihood of Future Occurrence: **Likely**
Vulnerability: **High**

Historically, the City of Bossier City planning area has been at risk to flooding primarily during the winter and spring months when river systems swell with heavy rainfall. Normally, storm floodwaters are kept within defined limits by a variety of storm drainage and flood control measures. But occasionally, extended heavy rains result in floodwaters that exceed normal high-water boundaries and cause damage.

Levee overtopping issues create flash flooding as well. Bossier City's Red Chute Bayou Levee frequently overtops, and causes flooding at Stonebridge, Stockwell Place Elementary, Carriage Oaks, and Richmond Cove.

Vulnerability to Riverine Flood

Likelihood of Future Occurrence: **Likely**
Vulnerability: **High**

Extended heavy rains result in floodwaters that exceed normal high-water boundaries and cause damage. Flooding has occurred both within the 1 percent annual chance flood zone and in other areas in the Bossier City planning area. Riverine flooding is generally a result of prolonged rainfall, or rainfall that is combined with already saturated soils from previous rain events. This type of flood occurs in river systems whose tributaries may drain large geographic areas and include one or more independent river basins. Bossier City often experiences flooding, for example, in association with flooding in Oklahoma and Arkansas. The Red River, Flat River and multiple Bayous in the planning area can create riverine flooding issues.

Vulnerability to Heavy Rain/Thunderstorm/Lightning/Wind

Likelihood of Future Occurrence: **Highly Likely**
Vulnerability: **Medium**

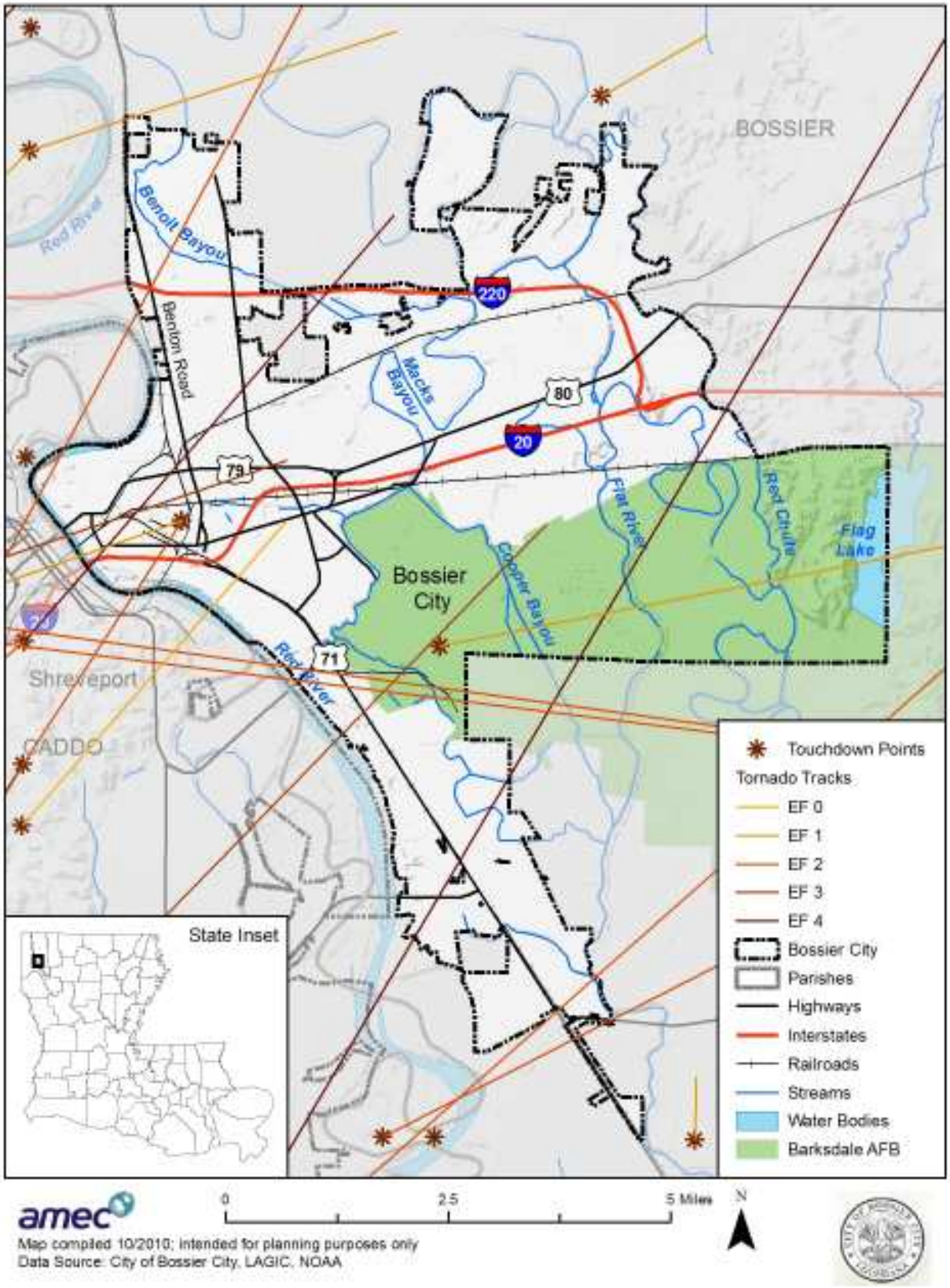
Severe weather is an annual occurrence in the Bossier City planning area. There have been several damage and disaster declarations related to severe weather, specifically to heavy rain, thunderstorms, wind and lightning. The greatest damage associated with severe weather, however, are the secondary hazards, such as floods and fire.

Vulnerability to Tornado

Likelihood of Future Occurrence: **Likely**
Vulnerability: **Medium**

All of the Bossier City planning area is at risk to tornadoes. Figure X shows the tornado paths that NOAA has recorded in the years 1950-2009. Tornado tracks by Enhanced Fujita scale, and tornado touchdowns, are shown inn Figure Figure 4.39. Table 4.10 lists the ratings of the Enhanced Fujita Tornado Damage Scale. Most significant damage from tornadoes will be to mobile homes and other unstable structures.

Figure 4.39. City of Bossier City Tornado Tracks and Touchdowns



Vulnerability to Tropical Storm/Hurricane

Likelihood of Future Occurrence: **Likely**
Vulnerability: **Medium**

The Bossier City planning area experiences tropical storms and hurricanes that have made landfall on the Gulf Coast and have traveled to northern Louisiana. The hurricane season lasts from June through November, when sea and surface temperatures peak. The majority of hurricane activity occurs during August and September.

Social and economic impacts to Bossier City may be also felt by hurricanes in coastal Louisiana. When a severe hurricane in the Gulf of Mexico makes landfall, large numbers of population may need to be displaced off the coast. That population moves to inland cities like Bossier City. The influx of population may have negative implications, including heightened crime rate, and may also have positive implications, such as a boost to the economy.

Vulnerability to Winter Storm/Extreme Cold

Likelihood of Future Occurrence: **Likely**
Vulnerability: **Medium**

All of the Bossier City planning area is susceptible to winter storm and extreme cold conditions. Severe ice is often associated with winter storms. An icy roadway on a bridge or in a busy intersection, for example, threatens the safety of the residents. Ice accumulation causes power outages and has significant impact on communities, especially critical facilities and public utilities.

4.4 The City of Bossier City's Mitigation Capabilities

Thus far, the planning process has identified the hazards posing a threat to Bossier City and described, in general, the vulnerability of the City to these risks. The next step is to assess what loss prevention mechanisms are already in place. This part of the planning process is the mitigation capability assessment. Combining the risk assessment with the mitigation capability assessment results in the City's "net vulnerability" to disasters and more accurately focuses the goals, objectives, and proposed actions of this plan.

The HMPC used a two-step approach to conduct this assessment for the City. First, an inventory of common mitigation activities was made through the use of a matrix. The purpose of this effort was to identify policies and programs that were either in place, needed improvement, or could be undertaken, if deemed appropriate. Second, the HMPC reviewed existing policies, regulations,

plans, and programs to determine if they contributed to reducing hazard-related losses or if they inadvertently contributed to increasing such losses.

This section presents the Bossier City's mitigation capabilities: programs and policies currently in use to reduce hazard impacts or that could be used to implement hazard mitigation activities. It also identifies select state and federal departments/agencies that can supplement the City's mitigation capabilities. This assessment is divided into three sections: regulatory mitigation capabilities, administrative and technical mitigation capabilities, and fiscal mitigation capabilities.

4.4.1 Bossier City's Regulatory Mitigation Capabilities

Table 4.29 lists regulatory mitigation capabilities, including planning and land management tools, typically used by local jurisdictions to implement hazard mitigation activities and indicates those that are in place in Bossier City. Excerpts from applicable policies, regulations, and plans and program descriptions follow to provide more detail on existing mitigation capabilities.

Table 4.29. Bossier City's Regulatory Mitigation Capabilities

Regulatory Tool (ordinances, codes, plans)	Yes/No	Comments
General plan	Yes	2002 Master Plan (Update 2010)
Zoning ordinance	Yes	Appendix A, Arcticle 4 of municipal code
Subdivision ordinance	Yes	Chapter 102 of municipal code
Growth management ordinance	Yes	Appendix A, Arcticle 1, Section 1.1 of municipal code
Floodplain ordinance	Yes	Appendix A, Arcticle 11, Section 11.4 of municipal code
Other special purpose ordinance (e.g., stormwater, steep slope, wildfire)	No	
Building code	Yes	Version 2009 – Chapter 18, Arcticle II, Section 18-31 of municipal code
Fire department ISO rating	Yes	Rating: 1
Erosion or sediment control program	Yes	Chapter 114, Arcticle IV, Section 114-301 of municipal code
Stormwater management program	Yes	Chapter 114, Arcticle 3, Section 114-91 of municipal code
Site Plan Review Requirements	Yes	Part of the planning process.
Capital improvements plan	Yes	
Economic development plan	Yes	Part I, Chapter 13 of municipal code
Local emergency operations plan	Yes	
Other special plans	No	
Flood insurance study or other engineering study for streams	Yes	Completed 9/26/2008
Elevation certificates	Yes	Chapter 54, Arcticle II, Sec 54-55

Regulatory Tool (ordinances, codes, plans)	Yes/No	Comments
Other		

Source: HMPC Data Collection Guide

As indicated in the table above, Bossier City has several plans and programs that guide the City's development in hazard-prone areas. Starting with the Bossier Comprehensive Land Use and Development Master Plan, which is the most comprehensive of the City's plans when it comes to mitigation, some of these are described in more detail below.

Bossier Comprehensive Land Use and Development Master Plan

The Master Plan serves as a guide for policy decisions relating to the physical growth and economic development of Bossier City and the MPC Planning Area, which generally extends five miles beyond the corporate limits into Bossier Parish. In addition to providing a vision, goals and objectives to work toward the Year 2020, the Plan assesses the opportunities and challenges facing the region, identifies important policies and strategies, and establishes priorities for an aggressive implementation program that emphasizes specific actions and practical results.

The Plan addresses the physical aspects of planning such as:

- land use and development;
- natural resources, recreation and open space;
- transportation facilities and improvements;
- utility infrastructure;
- housing and neighborhoods;
- image and design; and
- community facilities.

In addition, it addresses long-term policies that will guide shorter-term decisions regarding development review and approval, budgeting and fiscal management, and capital improvements programming. The Bossier Plan also sets the stage for more focused planning efforts, providing long-term perspective and highlighting how actions in one area, such as annexation, can have implications in other areas, such as land use, infrastructure, public facilities, or parks and recreation planning.

The Bossier Plan is organized into thirteen (13) individual plan elements, which address the existing conditions, issues, goals, objectives, and action plans for various facets of the community. These elements include:

- **Chapter One: Introduction** – Outlines the purposes of comprehensive planning and background on the plan development process and associated citizen involvement activities.
- **Chapter Two: Community Profile** – Documents the existing socioeconomic conditions and characteristics of the City and Parish as well as the projected growth of the area. It includes

data relating to historical, current and forecasted population and employment and local socioeconomic and demographic characteristics and trends.

- **Chapter Three: Vision and Goals** – Expresses the shared vision of what the citizens want Bossier to be now and in the future. The vision statement is intended to provide a clear and concise summary of citizens' expectations for future development, economic opportunity, mobility, public facilities and services, recreational enjoyment, natural beauty, and other aspects of community life.
- **Chapter Four: Market Assessment** – Highlights pertinent market and economic conditions, key product characteristics, program options, the mix of uses that are feasible and those that will enhance the character of Bossier, and factors related to basic development economics.
- **Chapter Five: Land Use** - Illustrates the generalized pattern of future land use, including various types and densities of development.
- **Chapter Six: Natural Resources, Recreation and Open Space** - Provides detailed guidance for the future development of Bossier's parks and recreation system and for complementary land acquisition and conservation strategies.
- **Chapter Seven: Transportation** - Delineates the functional classes of existing and proposed major thoroughfares and identifies the thoroughfare system improvement needs.
- **Chapter Eight**: Utilities and Infrastructure - Recommends changes in policies and procedures; opportunities for cost sharing; location and characteristics of existing facilities plus preliminary recommendations (for budget and route planning) for items to be included in a short-term Capital Improvement Program (CIP).
- **Chapter Nine: Housing** - Summarizes issues and findings related to housing availability and affordability. Identifies specific ways the City and Parish can promote needed housing development and redevelopment and ensure viable and sustainable neighborhood environments.
- ♦ **Chapter Ten**: **Community Image and Design** - Describes the values and documented preferences driving image decisions, graphically illustrates recommended design elements, and identifies implementation strategies for acquisition and installation.
- **Chapter Eleven: Facilities and Education** – Summarizes public facility information and describes and graphically illustrates potential improvements, general locations, and implementation recommendations.
- **Chapter Twelve: Development Policies, Strategies and Incentives** – Documents issues and concerns with the urban form and the character and appearance of the Bossier area at its current stage of development, highlights the values and expectations of Bossier residents, and recommends methods for evaluating and improving the compatibility and attractiveness of future development within the context of an effective growth management framework.
- **Chapter Thirteen: Implementation** - Includes specific actions that are linked to the goals and objectives of each of the plan elements; the timeframe for implementation; and the agency/entity responsible for implementation, such as the MPC, City, Parish or other public agencies and/or entities.

Each of these elements contain community goals, policies and plans for implementation, many of which focus on reducing hazard impacts and mitigating the risk and vulnerability of the community to identified natural hazards. The HMPC determined that it was wise to include mitigation related goals and policies from the Plan. Goals and policies are related to hazard mitigation are below.

Goal 5.1:	**Promote efficient, long term growth within the MPC Planning Area and outside of sensitive development areas.**
Objective B	Establish boundaries for areas that are available for intense development activity compared to those areas that require sensitive development as a result of the Air Installation Compatibility Use Zone (AICUZ), floodplains and wetlands.
Action 5.1.1	Restrict development within the AICUZ to low density development in accordance with the Joint Land Use Study recommendations, including the possibility of Conservation Subdivision Techniques that utilize areas outside of the AICUZ for the majority of home development and preserve land impacted by the AICUZ as open space.
Action 5.1.2	Encourage alternative uses for land within the AICUZ such as agricultural activity, natural areas and low intensity recreational opportunities.

Goal 5.3	**Encourage preservation and sensitive utilization of natural areas, particularly floodplains, wetlands, the Red River and its tributaries.**
Objective A	Utilize floodplain and wetlands as natural trail systems and a series of recreation areas that form linkages and focal points within the community.
Objective B	Limit development in areas with significant floodplain and wetlands to development types that are considerate of natural resource conservation.
Objective C	Encourage continued use of floodplains for agricultural purposes and other limited impact uses.
Objective D	Develop programs aimed at acquiring floodplain and wetlands for purposes of preservation of natural resources and the rural character of the MPC Planning Area.
Action 5.3.1	Design a network of trails throughout the MPC Planning Area and incorporate strategic floodplains, such as those along significant tributaries and the Red River.
Action 5.3.2:	Link public, and possibly private, park facilities together utilizing a pedestrian trail system comprised of natural areas.
Action 5.3.3	Encourage the use of conservation subdivision techniques for neighborhood design within Sensitive Development Areas that will allow for preservation of significant open space while clustering housing units on optimal sites.
Action 5.3.4	Promote establishment of conservation easements on open spaces within conservation subdivisions and other developments that set aside sensitive areas for preservation.
Action 5.3.5	Consider incorporating agricultural areas into conservation subdivisions and permitting agricultural activity to continue on protected open spaces.
Action 5.3.6	Allow large lot subdivision development to occur in the Sensitive Development Area with restrictions on placement of homes, lot size and reduced number of permitted homes compared to conservation subdivisions.
Action 5.3.7	Establish a program to acquire easements or development rights on Sensitive Development Areas and establish a trust to monitor the program.

Goal 6:1:	Promote the conservation of natural resources through parks and recreation land acquisition, open space preservation, and environmentally sensitive planning.
Objective A	Encourage the conservation of environmentally sensitive areas, i.e. streambeds and floodplains, wetlands, wildlife habitats, historic and cultural sites, and areas with topographic conditions or severe soil limitations, and encourage conservation through development incentives, regulations and policies adopted mutually by the City and Parish..
Action 6.1.1	Identify and acquire environmentally sensitive areas and conservation sites to preserve as public open space or recreation areas.
Action 6.1.2	Develop a “land-bank” program in which owners of properties in the flood plain are encouraged to deed their land to the “bank” to ensure long-term conservation
Action 6.1.3	Acquire conservation easements along the Red River, Willow Chute Bayou, Red Chute Bayou, Flat River and other bayou tributaries (Mack’s Bayou, Cooper Bayou, Allison Bayou, Alligator Bayou, Fifi Bayou, Connell Bayou, Racetrack Bayou, St. Charles Bayou) and other sensitive lands to protect valuable resources from encroaching development.
Action 6.1.5	Identify the boundaries of the regulatory floodways and consider acquisition through fee simple or conservation easement methods prior to development, if possible.
Action 6.1.6	Utilize the City-Parish Flood Hazard Mitigation Plan to identify areas of repetitive structure flooding where mitigation activities may result in publicly owned open space.
Action 6.1.7	Create development incentives to encourage preservation and dedication of public parks, open space or conservation easements within subdivisions.
Action 6.1.8	Amend the City and Parish Subdivision Regulations to encourage the use of conservation subdivision techniques, which allow flexibility in lot size, setbacks and other area standards to increase open space, preservation of natural areas, and set-asides for wetlands and other sensitive habitat areas..
Action 6.1.9	Protect the waterfront landscape from encroaching, harmful development while preserving the integrity of the natural environment with natural shorelines and sensitive parks and recreation development and conservation.
Action 6.1.10	Preserve the environmental quality of the Red River and its bayou tributaries as well as area lakes and water bodies by protecting valuable open space and habitats, improving drainage and water quality, and providing sensitive eco-recreational facilities

Goal 6.3	Encourage the preservation of open space to reflect the unique resources of Bossier’s natural environment and to enhance the community’s livability, aesthetic quality, and natural beauty.
Objective A	Create an attractive living and “green” living environment by preserving open space within neighborhoods, along roadways and natural corridors and key character areas throughout the City and Parish planning area.
Action 6.3.1	Establish development incentives to encourage dedication of open space easements adjacent to collector and arterial street rights-of-way, along bayous and other watercourses, and within major developments.
Action 6.3.2	Consider the use of a density bonus program that rewards increased density for greater open space, increased setbacks, preservation of natural areas, provision of natural amenities and set-asides for wetlands and other sensitive habitats.
Action 6.3.4	Increase public open space in flood prone areas through acquisition, relocation and demolition of flood damaged and repetitive loss structures.

Goal 6.7	**Develop an on- and off-street network of pedestrian and bicycle ways throughout the MPC planning area.**
Objective A	To improve access to and throughout the park system, provide an interconnected system of paths, trails, lanes, and routes that are multipurpose, accessible, convenient, and connect to residential neighborhoods, parks, schools, workplaces, major open spaces, and other destinations.
Action 6.7.5	Establish policies and regulations regarding the use and development of floodways and drainage ways, abandoned railroad corridors, vacated alleys, and other rights-of-way and easements.

Goal 7.3	**Promote pedestrian and bicycle pathways as a viable alternative to automobile traffic, parcticularly when tied to a public transportation system.**
Objective A	Pursue development of a communitywide bicycle and trail network that links neighborhoods with other destinations, including, schools, parks, the riverfront, entertainment areas and commercial opportunities.
Action 7.3.4	Acquire conservation easements within the floodplain and along Willow Bayou, Flat River, Fifi Bayou, and the Red River as greenbelt corridors.

Goal 8.2	**Develop a comprehensive flood and stormwater management program to eliminate or mitigate floodplain and localized flooding, stormwater quality issues, and bank erosion within the master plan study area.**
Objective A	Develop a comprehensive floodplain management program through the use of existing flood identification and mitigation studies, new FEMA Flood Insurance Rate Maps, and local governmental and professional expertise.
Objective B	Develop a comprehensive program to analyze, select, prioritize, and implement solutions to flooding and other related drainage problems identified in the South Bossier River Basin Study developed by the USDA NRCS in April, 1998, the Benoit Bayou Floodplain Management Study and other miscellaneous studies performed on smaller development areas.
Objective C	Provide for more consistent development of new residential, commercial and industrial areas through the development of drainage hydrologic and hydraulic design criteria manuals, best management practices manuals with standard details, and standardization of City and Parish requirements.
Objective D	Improve storm water quality standards and meet EPA mandated requirements for Phase II Storm Water NPDES Permits for small municipalities.
Action 8.2.1	Review, revise as necessary and implement the programs in the Draft Flood Hazard Mitigation Master Plan developed by AEGIS Innovation Solutions in conjunction with Bossier City and other local governmental authorities.
Action 8.2.2	Review flooding and related problems in the South Bossier River Basin Study, select desired problem solutions, prioritize, develop funding sources and implement the solutions.
Action 8.2.3:	Review the Benoit Bayou Flood Plain Management Study, develop projects to address identified flooding problems, develop funding sources and implement the solutions to address the problems in this key development area. Benoit Circle Drainage Report developed by FBL Associates can be used for a specific project for Northland Estates Subdivision.
Action 8.2.4	Implement the drainage system improvements identified in the River Bend Drainage Analysis report developed by Owen and White in June, 2001, to alleviate localized flooding problems in the River Bend subdivision.
Action 8.2.5	Have the Bossier City Engineer's office and appropriate Barksdale AFB personnel develop a working relationship concerning mutually beneficial drainage and floodplain conservation and improvement projects.

Goal 8.2	**Develop a comprehensive flood and stormwater management program to eliminate or mitigate floodplain and localized flooding, stormwater quality issues, and bank erosion within the master plan study area.**
Action 8.2.6	Coordinate drainage hydrologic and hydraulic design and analysis criteria between Bossier City's and Bossier Parish's Engineering offices and develop design criteria manuals for use by engineers and developers for new development and substantial redevelopment areas. Manuals could also include situations where retention or detention ponds would be required.
Action 8.2.7	Develop recommended best management practices and details for residential, commercial and industrial areas. All implemented practices should receive approval of Bossier City or Parish Engineers before installation is allowed.
Action 8.2.8	Public education on wetland mitigation and conservation issues should be developed in order to help protect and preserve existing wetlands. A regional wetland banking program might be considered to help development of areas where wetland preservation cannot be accomplished because of an important public need like flood reduction.
Action 8.2.9	Review, amend as required, and adopt the new FEMA Flood Insurance Rate Maps for the Master Plan study area in order to have the most accurate and up to- date flood level information to assist new development and flood mitigation programs.

Goal 9.8	**Preserve flood prone areas and other natural resources to the extent practicable through use of alternative development techniques, and design residential areas to minimize flooding problems and create amenities.**
Objective A	Protect the relationship between Bossier and its many waterways and utilize it as a marketing amenity for development.
Objective B	Discourage development in flood prone areas, to the extent practical, for purposes of safety and property value.
Objective C	Incorporate alternative design techniques into residential areas where flood prone areas can be protected and marketed.
Action 9.8.1	Establish a land trust that can be charged with acquiring and managing sensitive lands throughout Bossier City and Bossier Parish with parcticular emphasis on rural and flood prone areas.
Action 9.8.2	Encourage acquisition of development rights within the regulatory floodway and floodplain or the use of a nonprofit trust to preserve and enhance these sensitive areas of Bossier.
Action 9.8.3	Create an option to utilize cluster residential development as a means of reducing lot size, increasing open space and preserving flood prone areas.
Action 9.8.4	Establish an areawide map that indicates primary conservation areas to be protected during subdivision design.
Action 9.8.5	Determine criteria for secondary conservation areas, conservation easements and concept plan approval.
Action 9.8.6	Revise ordinances as needed to allow for uncommon lot design in appropriate circumstances, including “flag” lots.

Bossier City Ordinances

The following ordinances adopted by Bossier City are among the most important tools for implementing the Master Plan and/or are critical to the mitigation of hazards identified in this plan.

Disaster Organization (Part I, Chapter 18, Section 18.10)

The declared purposes of this chapter are to provide for the preparation and carrying out of plans for the protection of persons and property within the City in the event of an emergency; the direction of the emergency organization; and the coordination of the emergency functions of the County with all other public agencies, corporations, organizations, and affected private persons. The Operations Division

Water and Sewer Management (Appendix A, Arcticle 12)

The purpose of this arcticle is to establish the standards for construction of utility services, parking and loading areas, and on-site lighting for individual occupancies, subdivisions and all other land development projects. This includes sanitary sewers, storm drainage, and water systems.

Building Code (Chapter 18, Arcticle II)

This chapter adopts the most recent edition of that certain building code known as the International Building Code, not including Chapter 1, Chapter 11, Chapter 27, and Chapter 29 thereof, save and except such portions as are deleted, modified or amended in the municipal code, and the same are hereby adopted and incorporated as fully as if set out at length in the municipal code.

Flood Hazard Areas (Chapter 54)

The Legislature of the State of Louisiana has, in L.R.S. 38:84, delegated the responsibility of local governmental units to adopt regulation designed to minimize flood losses. It is the purpose of this chapter to promote the public health, safety, and general welfare and to minimize public and private losses due to flood conditions in specific areas by provisions designed to:

- 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 general public;
- Minimize prolonged business interruptions;
- Minimize damage to public facilities and utilities such as water and gas mains; electric, telephone, and sewer lines; and streets and bridges located in areas of special flood hazard;
- Help maintain a stable tax base by providing for the sound use and development of areas of special flood hazard so as to minimize future blighted areas caused by flood damage;
- Ensure that potential buyers are notified that property is in an area of special flood hazard; and
- Ensure that those who occupy the areas of special flood hazard assume responsibility for their actions.

This chapter includes methods and provisions to:

- Restrict or prohibit uses which are dangerous to health, safety, and property due to water or erosion hazards, or which result in damaging increases in erosion or flood heights or velocities;
- Require that uses vulnerable to floods, including facilities which serve such uses, be protected against flood damage at the time of initial construction;
- Control the alteration of natural floodplains, stream channels, and natural protective barriers, which help accommodate or channel floodwaters;
- Control filling, grading, dredging, and other development that may increase flood damage; and
- Prevent or regulate the construction of flood barriers that will unnaturally divert floodwaters or that may increase flood hazards in other areas.

Requirements of this chapter apply to all new development, substantial improvements, minor improvements, and conversions of existing nonresidential structures to residential uses within flood hazard areas. Notably, it requires that a development permit be obtained before start of construction or beginning of development within any area of special flood hazard. It appoints the Bossier City Engineer to administer and implement the chapter by granting or denying development permit applications in accordance with its provisions.

This chapter addresses the following for construction in areas of special flood hazard:

- Standards of construction
- Standards for storage of materials and equipment
- Standards for utilities
- Standards for subdivisions
- Standards for manufactured homes and manufactured home parks and subdivision
- Provisions for floodway development

Subdivisions (Chapter 102)

Bossier City's subdivision ordinance is deemed necessary to protect the public health, safety, and general welfare. It addresses orderly growth and development of the City; beneficial use of land in the public interest; and conservation, stabilization, and protection of property values and assures adequate provision for necessary utilities, public roads, and other public conveniences in subdivided areas. The subdivision ordinance regulates the design and improvement of land divisions and the dedication of public improvements needed in connection with land divisions.

The City of Bossier City Zoning Ordinance (Appendix A, Arcticle 4)

The purpose of this arcticle is to establish and describe a series of general and overlay zoning districts in which the use of land, separation and height of structures, intensity of development, sign limitations, parking requirements and other development factors will be regulated in accordance with the Bossier City-Parish Comprehensive Plan.

Overlay Districts

Arthur Ray Teague Parkway Overlay District (ARTP-OD). The purpose of the Arthur Ray Teague parkway overlay district is to preserve and encourage development of an attractive gateway corridor to the parkway that is sensitive to and helps maintain the vitality of the adjacent residential neighborhood,

Gateway overlay district (GW-OD). The gateway overlay district is created to enhance the visual character of gateways into Bossier City that link the Interstate 20 interchanges to major focal points of the community. It is intended to ensure that land development adjacent to gateways occurs in a manner that is compatible with the use of the transportation corridor while minimizing traffic hazards and congestion.

East Texas overlay district (ET-OD). The east Texas overlay district is created as a unique development area, compatible with the Bossier Parish Community College Campus. This district is intended to complement the neighborhood, promote a sense of community, encourage tourism, create an extension of the racetrack complex, and provide a family-friendly environment.

Erosion Control Ordinance (Chapter 114, Arcticle IV)

The purpose of this arcticle is to preserve the natural resources, to protect the quality of the waters of the state, to protect public and private property, and to protect and promote the health, safety, and general welfare of the citizens of Bossier City by minimizing the amount of sediment, dust and other pollutants carried by runoff or discharged from land disturbing construction activity to the maximum extent practicable as required by federal and state law. This arcticle establishes methods for controlling soil, sediments, and other pollutants from leaving construction sites from development/redevelopment through the use of best management practices (BMPs) for erosion and sediment control.

Bossier City: Other Regulatory Mitigation Capabilities, Plans and Studies

City of Bossier City, Louisiana Flood Hazard Mitigation Project Plan

The Flood Hazard Mitigation Plan was compiled by Aegis in 2001, and consists of a flood hazard assessment, a vulnerability analysis and a mitigation plan for the Bossier City planning area. Similar to the structure of this mitigation plan, the Bossier City Flood Hazard Mitigation Plan provides a hazard identification and profile, a vulnerability assessment, and a recommended set of goals and actions to help reduce risk to the community.

Capital Improvement Plan

The Bossier City Capital Improvement Plan will be adopted in Spring 2011.

5-year Budget Plan

The Bossier City Budget Plan will be adopted in Spring 2011.

Barksdale Air Force Base Joint Land Use Study (2009)

Barksdale Air Force Base (Barksdale AFB) is within the Shreveport-Bossier City metropolitan area in the northwest corner of Louisiana, 18 miles from the Texas border and within a short drive of Dallas, New Orleans, Houston, and Little Rock. Surrounding communities include the cities of Bossier City (located in Bossier Parish), Shreveport (located in Caddo Parish), Haughton and Benton (located in Bossier Parish).

In 1985, the Department of Defense's Office of Economic Adjustment (OEA) initiated the Joint Land Use Study (JLUS) program to create a parcticipatory, community-based framework for addressing land use issues around military installations. The objectives of the JLUS are two-fold:

1) to encourage cooperative land use planning between military installations and the surrounding communities; and
2) to seek ways to reduce the operational impacts of military installations on adjacent land.

The JLUS report is not a binding document, but rather an advisory report that identifies best practices for ensuring compatible development around the base. The report includes a series of recommended policies and regulations for the Air Force and local governments to consider.

4.4.2 Bossier City's Administrative/Technical Mitigation Capabilities

Table 4.30 identifies the County personnel responsible for activities related to mitigation and loss prevention in Bossier City.

Table 4.30. Bossier City's Administrative and Technical Mitigation Capabilities

Personnel Resources	Yes/No	Department/Position
Planner/engineer with knowledge of land development/land management practices	Yes	Planning & Construction / Supervisor
Engineer/professional trained in construction practices related to buildings and/or infrastructure	Yes	Planning & Construction / Supervisor, Engineering
Planner/engineer/scientist with an understanding of natural hazards	Yes	Planning & Construction / Supervisor
Personnel skilled in GIS	Yes	Engineering

Personnel Resources	Yes/No	Department/Position
Full-time building official	Yes	Permits
Floodplain manager	Yes	Engineer / City Engineer
Emergency manager	Yes	Security / Director
Grant Writer	Yes	Mayor's Office, Research & Staff Development / Supervisor
Other Personnel	Yes	Maintenance / Supervisor, Purchasing / Supervisor, Transportation / Supervisor, Child Nutrition / Supervisor
GIS data—Hazard areas	Yes	Engineering
GIS data—Critical facilities	Yes	Engineering
GIS data—Building footprints	Yes	Engineering
GIS data—Land use	Yes	Engineering
GIS data—Assessor's data	No	
Warning Systems/Service (Reverse 911, cable override, outdoor warning signals)	No	
Communication Network	Yes	Technology / Director

Source: HMPC Data Collection Guide

The City of Bossier City Engineering Department

The Engineering Department contributes to mitigation of the flood hazard. Engineering performs floodplain administration including maintaining FEMA Flood Insurance Rate Maps (FIRM); providing flood depth for special flood hazard areas to property owners, developers, and potential buyers; amending the FIRM (modifying flood areas) in accordance with FEMA LOMA/LOMR process. The flood depth serves as a base for establishing a Finish Floor Elevation (FFE) for new construction.

The City's Engineering Department is responsible for working with engineers, architects, developers, and contractors by providing engineering designs and inspecting all infrastructure to be dedicated to the City. It is comprised of the Geographic Information System (GIS), Flood Plain, Permits and Inspections, Property Standards, and Traffic Engineering Divisions. Divisions related to hazard mitigation are discussed below.

GIS

The power of a GIS comes from the ability to relate different information in a spatial context and to reach a conclusion about this relationship. Simply put, a GIS combines layers of information about a place to give you a better understanding of that place. The system contains over 30 layers encompassing Bossier City and some of the surrounding area. Each layer consists of specific geographic features such as buildings, pavements, water lines, etc. One of the main benefits of GIS is improved management of your organization and resources. A GIS can link data sets together by common locational data, such as addresses, which helps departments and agencies

share their data. By creating a shared database, one department can benefit from the work of another—data can be collected once and used many times.

Permits and Inspection Division

The Bossier City Permits and Inspections Division is responsible for issuing all city building, electrical, plumbing, and mechanical permits and licenses. Also structures outside the city limits on Bossier City water or sewer are permitted thru this office and the Bossier Parish Tax Assessor. The department is also responsible for performing inspections on residential and commercial projects.

The Permits and Inspection office has adopted the following codes:

- Bossier City Ordinance Book Chapter 18
- 2006 International Building Code
- 2006 International Existing Building Code
- 2006 International Residential Code
- 2006 Life Safety Code 101
- National Fire Protection Association
- ANSI Standards
- 2008 NEC Electrical Code
- 2000 Louisiana Plumbing Code
- 2006 International Mechanical Code
- 2006 International Fuel Gas Code

Property Standards Division

The Bossier City Property Standards/Code Enforcement Division is responsible for enforcing basic maintenance standards on private properties. Property Standards were established to protect the health, safety, and welfare of the citizens of Bossier City as adopted by the Bossier City Code of Ordinances Chapter 46, International Maintenance Code, and LA RS 33:4761-4767.

Bossier City Public Utilities Department

The Public Utilities Department is responsible for the overall direction, leadership and coordination of the Department's activities to ensure that the most efficient and effective services are provided within the policies established by the City of Bossier and the Department of Public Utilities. The mission of the Public Utilities Department is to provide staff support for the following divisions: Environmental Affairs, Utilities Warehouse, Lift Station Maintenance, Wastewater Treatment, Water Treatment, and Water & Sewer Maintenance: to ensure all ordinances, codes and policies are enforced; to take personnel action as required; to direct the preparation of and submit proposed operating and capital budgets for approval; to initiate and manage contracts; and prepare City Council legislation.

Community Development

The Department of Community Development helps the city to implement its comprehensive planning program. Through its various adopted plans, the city has identified large general goals to guide the orderly development and maintenance of the city. The Department of Community Development, through the consolidated strategy and action plan, sets more specific goals within the larger context and provides for the funding and action needed to achieve those goals. The funding is available for projects that will help achieve national objectives as determined by Congress for the use of Community Development Block Grant funds. The department is primarily funded by a Community Development Block Grant and receives some city funds.

A large portion of the funding for this department received goes to replace substandard streets, drainage, street lighting, sewer and water lines, and park and recreation facilities in areas that have low to moderate income populations. A list of some programs includes:

- Emergency Housing Rehabilitation
- Emergency Shelter Grant
- Micro-Loans for Business Development
- Public Service Grants
- Single Family Housing Rehabilitation

Planning Commission

Operating with a six person staff, the MPC Office processes over 500 Certificates of Occupancy, approves over 1,000 building permits and reviews over 250 MPC and BOA applications. In addition, the MPC Staff is responsible for ensuring that zoning enforcement efforts are fair and consistent. The MPC Office also reviews building permits for compliance to the Unified Development Code. In addition, Certificates of Occupancy (C-O) are routed to permits and inspections and issued by the MPC Office. A C-O must be issued before new businesses can obtain an Occupational License from the City of Bossier Tax Department. The MPC enforces the zoning ordinance, and was the lead agency in the creation of the Master Plan in 2002.

Fire Department

The Bossier City Fire Department serves and protects the city with nine fire stations and 202 employees. Not only does the BCFD provide the traditional Fire & EMS services, but also provides: Hazardous Materials Operations, high-angle and confined space rescue, water rescue, Bomb Squad, Fire Prevention, SWAT, public education programs, fire investigations and annual fire inspections. The BCFD also has a training academy, a communications division and a fire maintenance division.

In the year 2000, fire protection in the City of Bossier City received the highest Public Protection Classification (PPC) rating awarded by the Property Insurance Association of Louisiana (PIAL). The Bossier City Fire Department was able to achieve its Class 1 rating thanks to numerous

upgrades to the department, which included the construction of the new Fire Station 9, the addition of 23 new firefighters and the addition and relocation of existing specialized fire apparatus and equipment.

The Insurance Services Office (ISO) classifies communities from 1 (Best) to 10 (Worst) based on three categories:

- Water distribution
- Fire department equipment and manpower
- Fire communications

The PPC rating has a direct bearing on the cost of property insurance for every home and building in a community.

Communications

The mission of the Fire and EMS Communications Division is to provide the citizens and visitors of the City of Bossier with prompt, accurate dispatching of firefighting, rescue and medical equipment and personnel in order to minimize the impact of fire, disaster, hazardous conditions, illness and injury through information, quality service, and proper utilization of resources. The Communications Center of the Bossier City Fire Department is a stand-alone, 24-hour emergency communications center. The Communications Center is responsible for matching the public's request for service with the resources of the Fire Department and assuring prompt response to fire and medical emergencies. In 2008, Fire Communications Officers processed 9,343 actual emergency response calls in addition to the hundreds of routine, non-emergency calls. Over 99% of the calls were answered within 15 seconds and dispatched within 60 seconds. This quick response helped the department maintain a Class 1 insurance rating.

Emergency Medical Service Division (EMS)

EMS currently has 4 ALS Units which respond 24 hours a day to serve the City of Bossier City. The EMTs and Paramedics of the Bossier City Fire Dept. are some of the most highly trained in the country. They maintain certification in Basic Life Support, Advanced Life Support, Infectious Disease identification and prevention and Pediatric Advanced Life Support. Many of the personnel are Hazardous Materials Technicians and Rescue Divers. EMS follows the American Heart Association guidelines for Cardiac Resuscitation and update personnel as new guidelines are published. Medical Direction is provided by Dr. Michael Williams. Dr. Williams is involved in all aspects of medical care provided by the Bossier City Fire Department Division of EMS. In 2006, EMS responded to 7,300 calls for service which resulted in 5,300 emergency transports to area hospitals. Average response time to any location in Bossier City is less than five minutes.

Operations/Training

The Bossier City Fire Department's Fire Training Division was formed in 1984. A mileage tax allowed the Fire Department to build classrooms, a training tower, offices, and purchase equipment for this location. Since then, the Fire Department has added an additional concrete slab, a flash-over prop, a large storage building, a wood frame house, and a multi-story burn building to the facility.

The purpose of the Bossier City Fire Academy is to train firefighters, emergency medical technicians, and paramedics for professional response to the public needs. To meet these needs our Fire Training Division staff is certified to teach and evaluate in all areas of instruction for the Louisiana State University's Fire and Emergency Training Institute, American Heart Association, Louisiana Bureau of EMS, Bossier parish School Board, and Bossier Parish Community College.

Many citizens outreach programs are conducted through the Training Division such as:Citizen Emergency Response Teams in conjunction with the Department of Homeland Security, Basic CPR, Advanced Cardiac Life Support, Pediatric Advanced Life Support, and Emergency Medical Technician refreshers in combination with Bossier Parish Community college. 2007 has begun a new venture with American Heart Association in the hosting of an area wide mass CPR event open to all ages.

Fire Prevention Division

The Fire Prevention Bureau was formally created on July 1, 1973. Since the formal creation of the Fire Prevention Bureau in 1973, the division currently has six employees, which are the Chief of Fire Prevention, the Assistant Chief of Fire Prevention, and three Fire Inspectors and a Fire Records Clerk. Fire prevention is responsible for many different areas as listed below.

- Public education programs
- Courtesy home fire inspections
- Annual fire inspections
- Certificate of occupancy inspections for new businesses that open inside the city limits.
- Plan reviews
- New construction and final inspections for new construction projects that are built are conducted to ensure compliance with current fire and life safety codes.
- Fire investigations to determine cause of fires
- Bomb Squad
- Fire watch details
- Complaint investigations concerning public fire safety
- Burn permit & site inspections
- Smoke detector installations/battery replacements
- Provide information to the public and answer questions dealing with fire prevention and the fire service.

- On call duties before and after normal working hours as required for fire investigations, public fire education programs, and complaints.
- Fire safety talks with children and parents. (Usually a short fire safety video is included.)

Hazardous Materials & Special Operations Division

The Special Operations Division is responsible for many of the issues that help make up the diverse response capabilities that the Bossier City Fire Department provides for the public. This division encompasses hazardous materials spill response, high angle and confined space rescue, public safety diving, swift water rescue, and disaster response. Personnel have received very specialized training from approved agencies using the National Fire Protection Association and Occupational Safety and Health Administration as guidelines. The Special Operations Rescue Team (SORT) has been under development over the last several years and is a result of capability and needs-based assessments performed within the division.

Police Department

The Bossier City Police Department is charged with the enforcement of local, state, and federal laws, and with providing around-the-clock protection of the lives and property of the public. The Police Department functions both as an instrument of public service and as a tool for the distribution of information, guidance and direction.

It is the mission of the Police Department to facilitate and administer the laws of governing bodies, the orders of the courts, and to direct all energies and resources toward maintaining the health, welfare and safety of citizens.

Bossier City Local Boards, Commissions, and Committees

There are a number of local boards, commissions, and committees in Bossier City. Those that have responsibilities related to hazard mitigation are listed below.

- Bossier City Office of Emergency Preparedness

- Bossier City Levee Board

Special Districts

There are numerous special districts that provide a variety of public services in Bossier City. Special districts can provide one or more types of public services, facilities, or infrastructure within a prescribed boundary, and they play an important role in growth management because the availability of their services can encourage or discourage new development. Special districts can tax the properties within their boundaries to pay for the services they provide. Monthly fees

may also be assessed. Some of the special districts that provide mitigation-related services in Bossier City are presented below.

- Bossier Levee District

State and Federal Programs

A number of state and federal programs exist to provide technical and financial assistance to local communities for hazard mitigation. Some of the primary agencies/departments that are closely involved with local governments in the administration of these programs include:

- Governor's Office of Homeland Security and Emergency Preparedness

4.4.3 Bossier City's Fiscal Mitigation Capabilities

Table 4.31 identifies financial tools or resources that the City could potentially use to help fund mitigation activities.

Table 4.31. Bossier City's Fiscal Mitigation Capabilities

Financial Resources	Accessible/Eligible to Use (Yes/No)	Comments
Community Development Block Grants	Yes	
Capital improvements project funding	Yes	
Authority to levy taxes for specific purposes	Yes	
Fees for water, sewer, gas, or electric services	No	
Impact fees for new development	No	
Incur debt through general obligation bonds	Yes	
Incur debt through special tax bonds	Yes	
Incur debt through private activities	No	
Withhold spending in hazard prone areas	Yes	Not always politically expedient

Source: HMPC Data Collection Guide

4.4.4 Other Mitigation Activities

The City has many completed, planned and ongoing projects and programs focused on minimizing future losses associated with identified hazards. Many of these projects are sponsored and implemented by one or more City departments and/or other state and local

agencies and organizations. These projects and programs include those listed below in this section.

Community Emergency Response Team (CERT)

In coordination with the Bossier-Caddo Office of Homeland Security and Emergency Preparedness, bi-annual courses are offered to local citizens at the Training Center educating them in the areas of emergency efforts during times of high demand incidents. The CERT program educates people about disaster preparedness for hazards that may impact their area and trains them in basic disaster response skills such as fire safety, basic search and rescue, disaster medical operations, and fire safety. Using the training learned in the classroom and during exercises, CERT members can assist others in their neighborhoods or workplaces following an event when professional responders are not immediately available to help. CERT members are also encouraged to support emergency response agencies by taking a more active role in emergency preparedness projects within their community.

Bossier Levee District Flat River Bank Stabilization

The Bossier Levee District Flat River Bank Stabilization Project is located along the east bank of Flat River and runs from Shed Road to approximately 2,000 feet north of Coy Road near Stockwell Subdivision. This project was developed to repair slopes (see Figure 4.40 and Figure 4.41) along the Flat River which had begun to erode and slide, threatening homes located along the top bank of the river.

Figure 4.40. Flat River Bank Stabilization Project

The project is being constructed in five (5) phases as funding becomes available. Phases 1, II & III have already been completed.

Phase I consisted of a 600 foot section along Flat River located between Shed Road and Coy Road. It was an emergency repair constructed in 2005 by the Bossier Levee District. Phase II of the project was also located between Shed Road and Coy Road. The construction repaired approximately 1,000 feet of the channel slope and was completed in 2006. Phase III of the project is located on the north side of Shed Road in the vicinity of Stockwell Elementary School. This phase spans an area approximately 1550 feet in length and was constructed in 2008.

Figure 4.41. Bank Stabilization Project on Flat River

Phase IV of the project is located from Coy Road to 1000 feet South of Coy Road and connects to Phase 1; it will also complete the portion of the project located between Shed Road and Coy Road. Phase V of the Flat River Bank Stabilization is located from Coy Road to approximately 2000 feet north of Coy Road. The Bossier Levee District is seeking additional capital funding from the State of Louisiana to complete work on phases IV and V.

Red Chute Diversion Structure

The Red Chute Diversion Structure (see Figure 4.42) is a recently completed flood protection project of the Bossier Levee District. The purpose of the diversion structure is to divert water from Red Chute Bayou over to Flat River during certain high water conditions and under U.S. Army Corps of Engineers (USACE) guidelines. By diverting the water to Flat River, the

potential for the Red Chute Bayou Levee to be overtopped leading to flooding of the areas that are protected by it is greatly reduced.

Figure 4.42. Red Chute Diversion Structure

By policy, the water can only be diverted when it reaches an elevation slightly below flood stage on Red Chute Bayou and when the water elevation on Flat River is low enough to allow for the additional water from Red Chute Bayou without flooding Flat River, with one exception. If it is determined that flood waters will overtop Red Chute Bayou Levees, the gates on the diversion structure will be completely opened in order to minimize flood damage to the Levee. This action is taken based on the fact that when the levee is overtopped, the flood water will go to Flat River whether the gates are open or closed.

Red Chute Bayou - Cane Bend Outfall Pipe

The Bossier Levee District installed a new outfall pipe (see Figure 4.43) on Red Chute Bayou near Cane Bend Subdivision in the fall of 2008 with assistance from the Bossier Parish Police Jury. Outfall pipes allow water to drop into the Bayou without eroding the banks. This outfall pipe replaced a rusted existing pipe which had significantly deteriorated. The outfall pipe drains water from an old cut-off section of Red Chute Bayou which was formed when Red Chute Bayou was realigned many years ago.

Figure 4.43. New Outfall Pipe on Red Chute Bayou