Texas Water Development Board

2023 REGIONAL FLOOD PLAN
REGION 7 – UPPER BRAZOS
April 2023

PREPARED FOR THE **SOUTH PLAINS ASSOCIATION OF GOVERNMENTS**

2023 UPPER BRAZOS REGIONAL FLOOD PLAN

PREPARED FOR:

South Plains Association of Governments

PREPARED BY:

Freese and Nichols, Inc., TBPELS Firm #2144
Halff Associates, Inc., TBPELS Firm #312
Jacob & Martin, Ltd., TBPELS Firm #2448
H2O Partners, Inc.

Heather Keister 1/6/2023

Heather Keister, P.E., CFM
Project Manager
Freese and Nichols, Inc.

Holly Ahumada 1/6/2023

Holly Ahumada, P.E., CFM
Deputy Project Manager
Freese and Nichols, Inc.

Stephanie W. Griffin 1/6/2023

Stephanie Griffin, P.E., CFM, F. ASCE
Task Lead, Task 2
Halff Associates, Inc.

1/6/2023

Kirt Harle, P.E.
Task Lead, Task 1 and 6A
Jacob & Martin, Ltd.

Laura Haverlah

Laura Haverlah, CFM
Task Lead, Task 7
H20 Partners, Inc.

TABLE OF REVISIONS

The following summary of changes details revisions to the Region 7 Final 2023 Flood Plan subsequent to its most recent version in January 2023. These changes consist of non-substantive revisions.

Affected Task	Date	Description
5	April 2023	FME geodatabase cost reconciled to Exhibit C Table 15.
5	April 2023	Task 5 No Negative Impact Determination Table added to Appendix C. Reference to Appendix C table added to Summary of Recommended FMPs report section.
5	April 2023	FMS geodatabase cost reconciled to Exhibit C Table 17.
5	April 2023	Exhibit C Table 17 road closure data reconciled to geodatabase.
5	April 2023	Exhibit C Table 17 length of roads data reconciled to geodatabase.
5	April 2023	Exhibit C Table 17 project areas reconciled to geodatabase.
All - Accessibility	April 2023	Document properties were reviewed and corrected including title, primary language, primary view set to document title, and document tags. Table formatting was revised to eliminate accessibility warnings.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

APPENDICES

APPENDIX A - REQUIRED MAPS

APPENDIX B - REQUIRED TABLES

APPENDIX C - ADDITIONAL DATA

Task 2 Future Conditions Approach Memo March 2, 2022
Task 2 Future Conditions Approach Map
Task 3 Menti Poll Results August 19, 2021
Task 4B Process Memo for Identification and Evaluation of FME FMP FMS
Task 4C Tech Memorandum January 2022
Task 4C Tech Memorandum Supplement March 2022
Task 5 Benefit Cost Ratio Calculations
Task 5 No Negative Impact Determination
Task 5 FME One Page Summary Sheets
Task 5 FMP One Page Summary Sheets
Task 5 FMS One Page Summary Sheets
Task 10 SPAG Stakeholder Introduction Letter
Task 10 Upper Brazos Community Officials Web Survey
Task 10 Upper Brazos Public Comment Web Map Capture
Task 10 Upper Brazos Data Collection Website Capture
Task 10 Upper Brazos Outreach Web Map Capture

APPENDIX D – DRAFT PLAN COMMENTS

1 TWDB Region 07 Upper Brazos Draft Comments
2 TPWD Upper Brazos RFP Comment Letter
3 USACE RFP Comments
4 Draft Plan Comment Response Log

GEODATABASE SUBMITTAL

File #	Item Name	Feature Class Name
1	Entities	Entities
2	Watersheds	Watersheds
3 4 5	Existing Infrastructure	ExFldInfraPol ExFldInfraLn ExFldInfraPt
6	Proposed or Ongoing Flood Mitigation Projects	ExFldProjs
7	Existing Flood Hazard	ExFldHazard
8 9	Flood Mapping Gaps	Ex_Map_Gaps Fut_Map_Gaps
10	Model Coverage	ModelCoverage
11 12 13 14	Existing Exposure	ExFldExpPol ExFldExpLn ExFldExpPt ExFldExpAll
15	Future Flood Hazard	FutFldHazard
16 17 18 19	Future Exposure	FutFldExpPol FutFldExpLn FutFldExpPt FutFldExpAll
20	Existing Floodplain Management Practices	ExFpMP - Table
21	Goals	Goals - Table
22	Streams	Streams
23	Flood Management Evaluations	FME
24	Flood Mitigation Projects	FMP
25	Post Project Hazard	FMP_HazPost
26	Project Details	FMP_Details
27	Flood Management Strategies	FMS

LIST OF DEFINITIONS AND ACROYNMS

Acronym	Name	Meaning
ACE	Annual Chance Exceedance	The estimated mean probability that a flood event will occur in any given year. For example, the 1% ACE has a one percent chance of occurring in any given year. A 1% ACE event is also referred to as a 100-year flood event.
BCA	Benefit Cost Analysis	Method by which the future benefits of a hazard mitigation project are determined and compared to its costs. The end result is a BCR.
BCR	Benefit Cost Ratio	Numerical expression of the "cost-effectiveness" of a project, calculated by a project's total benefits divided by its total costs.
BFE	Base Flood Elevation	Regulatory term meaning the elevation of surface water resulting from a flood that has a 1% chance of equaling or exceeding that level in any given year.
BLE	Base Level Engineering	High-level process using best available data and automated techniques to produce approximate, regulatory-quality flood hazard extents.
CDC	Centers for Disease Control and Prevention	Federal agency focused on protecting public health including emergency preparedness.
-	Critical Facilities	A critical facility provides services and functions essential to a community, especially during and after a disaster. Typical critical facilities include hospitals, fire stations, police stations, storage of critical records, and similar facilities.
CRS	Community Rating System	FEMA program to provide incentives for communities that have gone beyond the minimum floodplain management requirements to develop extra measures to provide protection from flooding.
-	Dam Safety Program	Program that monitors and regulates both private and public dams in Texas. The program periodically inspects dams that pose a high or significant hazard.
DCM	Drainage Criteria Manual	Establishes the drainage design standards and methods for a community.
EAP	Emergency Action Plan	Identifies potential emergency conditions and specifies pre-planned actions to minimize property damage, potential loss of infrastructure, and potential loss of life.
-	Cursory Fathom Data	Flood risk data generated by a large, state-wide model. Considered the least-accurate of the floodplains available to the RFPG.
FAFDS	First American Flood Data Services	Digitized flood hazard from previously published FIRMs and FISs and is not available on the NFHL. Even if certain areas in this data set include detailed study (such as AE zones), it is likely very old.

Acronym	Name	Meaning
FEMA	Federal Emergency Management Agency	Federal agency responsible for emergency management activities around disasters. Manages several flood related grant programs and is responsible for the NFIP and maintains FIRMs.
FFD	Future Fully Developed	Anticipated developed land use of an area.
FIRM	Flood Insurance Rate Map	Official map of a community on which FEMA has delineated the Special Flood Hazard Areas (SFHAs), the BFEs, and the flood zones applicable to the community.
FIS	Flood Insurance Study	Compilation of flood risk data, information and maps, within a community from NFIP flood studies.
-	Flood Exposure	For the purposes of flood planning, flood exposure analyses will identify who and what might be harmed by flood including each structure located in flood hazard area.
-	Flood Hazard	For the purposes of flood planning, flood hazard analyses will determine the location, extent, magnitude, and frequency of flooding.
-	Flood Readiness and Resilience	Non-structural projects/programs aimed at improving flood preparedness and response to flood events including plan activation, chain of command, emergency functions, evacuation procedures, flood early warning systems, and/or resilience measures to be implemented to reduce flood damage.
-	Flood Risk	For the purposes of regional flood planning, flood risk analyses will comprise a three-step process of flood hazard, flood exposure, and vulnerability analyses
-	Flood Vulnerability	For the purposes of flood planning, vulnerability analyses will identify vulnerabilities of communities and critical facilities located within the region.
FME	Flood Management Evaluation	Proposed flood study of a specific, flood-prone area that is needed in order to assess flood risk and/or determine whether there are potentially feasible FMSs or FMPs.
FMP	Flood Management Project	Proposed project, either structural or non-structural, that has non-zero capital costs or other non-recurring cost and when implemented will reduce flood risk and mitigate flood hazards to life or property.
FMS	Flood Management Strategy	Proposed plan to reduce flood risk or mitigate flood hazards to life or property. FMSs include any proposed action that the RFPG would like to identify, evaluate, and recommend that does not qualify as either a FME or FMP.
-	Freeboard	An additional amount of height above the BFE used as a factor of safety in determining a structures elevation.

Acronym	Name	Meaning
GIS	Geographic Information System	Data connected to a map, integrating location data with all types of descriptive information.
H&H	Hydrologic and Hydraulic	Engineering assessment to determine flooding extents. Hydrology generally describes determining the amount of stormwater and hydraulics generally describes determining flood elevations.
HMAP	Hazard Mitigation Action Plan	Plan to reduce loss of life and property by minimizing the impact of disasters. Communities identify natural disaster risks and vulnerabilities in the area.
HUC	Hydrologic Unit Code	Unique code for hydrologic units (watersheds). Classified into four levels: regions, subregions, accounting units, and cataloging units.
LOS	Level of Service of Asset	Measure of the level of protection a flood infrastructure asset provides in terms of annual exceedance probability.
LWC	Low Water Crossing	Roadway creek crossing that is subject to frequent inundation during storm events or subject to inundation during a 50% ACE (2-year) storm event. During the first planning cycle, the RFPGs have the flexibility to utilize the community's discretion to identify a roadway creek crossing as LWC.
NFHL	National Flood Hazard Layer	Current effective flood hazard data. FEMA provides the flood hazard data to support the NFIP.
NFIP	National Flood Insurance Program	Program managed by FEMA and provides insurance to help reduce the socio-economic impact of floods.
NID	National Inventory of Dams	Website-hosted database maintained by the USACE including location and age of dams.
NOAA	National Oceanic and Atmospheric Administration	Federal agency that monitors and forecasts weather and climate conditions.
RFP	Regional Flood Plan	Document summarizing the planning activities of each regional flood planning group.
RFPG	Regional Flood Planning Group	The generic term for the planning groups that oversee the regional flood plan development in each region in the State of Texas.
SFHA	Special Flood Hazard Area	Regulatory term for an area having special flood, mudflow, or flood-related erosion hazards, and shown on an FHBM or FIRM.
SPAG	South Plains Association of Governments	Voluntary association created by the local governments. The planning region encompasses 15 counties covering 13,737 square miles geographically centered around Lubbock County. SPAG is the planning group sponsor for Region 7.

Acronym	Name	Meaning
SVI	Social Vulnerability Index	Ranks each census tract on social factors that influence a community's ability to prepare for, respond to, and recover from a disaster.
TAC	Texas Administrative Code	Code that outlines the specific criteria for the development of the regional flood plan.
TCEQ	Texas Commission on Environmental Quality	Environmental agency in Texas responsible for maintaining water quality and availability and the Texas Dam Safety Program.
TDEM	Texas Division of Emergency Management	State agency to ensure the state and its local governments respond to and recover from emergencies and disasters and implement plans and programs to help prevent or lessen the impact of emergencies and disasters.
TFMA	Texas Floodplain Management Association	Organization of professionals involved in floodplain management, flood hazard mitigation, the NFIP, flood preparedness, warning, and disaster recovery.
TWDB	Texas Water Development Board	State agency with oversight of regional flood plan development.
TxPCI	Texas Playa Conservation Initiative	Organization founded to address playa resource concerns for the benefit of the Ogallala Aquifer, wildlife, and residents and producers in Texas' playa region.
USACE	United States Army Corps of Engineers	Federal agency and the engineering section of the US Army.
USDA	United States Department of Agriculture	Federal agency with many functions related to agriculture including farm production, natural resources, research, rural development, etc.
WCID	Water Control and Improvement District	Political subdivision empowered to purchase, construct, operate, and maintain everything necessary to provide water, wastewater, and drainage services.
WCTCOG	West Central Texas Council of Governments	Political subdivision serving the 19 counties of Brown, Callahan, Coleman, Comanche, Eastland, Fisher, Haskell, Jones, Kent, Knox, Mitchell, Nolan, Runnels, Scurry, Shackelford, Stephens, Stonewall, Taylor and Throckmorton in a rural area encompassing 18,000 square miles.
WSEL	Water Surface Elevation	Elevation of the water surface during a flood event.

ACKNOWLEDGEMENTS

The Upper Brazos Regional Flood Planning Group would like to acknowledge the following individuals, entities, and organizations that contributed to the development of the 2023 Regional Flood Plan:

Planning Group Members

Michael Keenum, Chair

Judge Dale Spurgin, Vice Chair

Aubrey Spear

Brian Hurtuk

Carol Faulkenberry

Chris Wingert

Erin Stiggins

Jack Foote

Jennifer Bronson Warren

Jennifer Davidson

Jet Hays

Kelly Cook

Ken Rainwater

Kyle Jacobson

Michael McClendon

Rich Oller

Richard Blake Moore

Ryke Moore

Entities and Organizations

Abilene State Park

Archer County

Baylor County

Benjamin County

Buffalo Springs Lake

Callahan County

City of Abernathy

City of Abilene

City of Amherst

City of Benjamin

City of Breckenridge

City of Dimmitt

City of Floydada

City of Hamlin

City of Hart

City of Idalou

City of Levelland

City of Littlefield

City of Lubbock

City of Lueders

City of Merkel

City of Munday

City of New Home

City of Olton

City of Petersburg

City of Plainview

City of Post

City of Putnam

City of Ralls

City of Shallowater

City of Stamford

City of Throckmorton

City of Wilson

City of Wolfforth

Cochran County

Crosby County

Dickens County

Eastland County

Fisher County

Floyd County

Garza County

Hale County

Haskell County

Hockley County

Jones County

Kent County

King County

Knox County

Lamb County

Lubbock County

Lynn County

Mitchell County

Munday CISD

Nolan County

Parmer County

Post ISD

Ransom Canyon

Shackelford County

South Plains Association of Governments

Stephens County

Stonewall County

Taylor County

Texas Parks and Wildlife Department

Throckmorton County

Town of Buffalo Gap

United States Army Corps of Engineers

Whiteface CISD

Young County

THIS PAGE INTENTIONALLY LEFT BLANK

EXECUTIVE SUMMARY

THE REGIONAL FLOOD PLAN IN CONTEXT

Overview of the Establishing Act

In 2019, in the wake of historic flooding in Texas, the State Legislature adopted changes to Texas Water Code §16.061 that established a regional and state flood planning process. The Texas Water Development Board (TWDB) was charged with overseeing the first-ever regional and state flood planning process for Texas and providing funding for investments in flood science and mapping efforts to support plan development.

This investment and massive planning effort represent an important step for Texas, because

- Flood risks, impacts, and mitigation costs have never before been assessed at a statewide level for Texas;
- Flood risks pose a serious threat to lives and livelihoods across the state; and
- Much of the flood risk in Texas is unmapped or is based on out-of-date maps.

Regional Flood Plans (RFP) are required to be based on the best available science, data, models, and flood risk mapping. When complete, the plans will focus both on reducing existing risk to life and property and on enhancing floodplain management to avoid increasing flood risk in the future.

Overview of the Planning Process

Given the diverse geography, culture, and population of the state, the planning effort is being carried out at a regional level in each of the State's fifteen major river basins. The Upper Brazos Regional Flood Planning Area (Region 7) is one of these regions. A summary of milestones is presented in Table ES-1.

TABLE ES-1 REGIONAL FLOOD PLAN DEADLINES

Plan Deliverable	Deadline
Draft Regional Flood Plan	August 1, 2022
Final Regional Flood Plan	January 10, 2023
Amended Regional Flood Plan	July 14, 2023
State Flood Plan	2024

The first RFP must be submitted to the TWDB by January 10, 2023. The TWDB will compile these regional plans into a single statewide flood plan and will present it to the Legislature in 2024. An updated version of the RFP will be due every five years thereafter. Table ES-2 below summarizes the general content of each Regional Flood Plan task and how they relate to the provisions of Title 31 of the Texas Administrative Code (TAC) Chapters 361 and 362 that serve as a foundation for the regional flood planning process.

TABLE ES-2 RFP CHAPTER, ASSOCIATED TAC SECTIONS, & CONTENT

RFP Task	Primary TAC Section	General Content
1	361.30; 361.31; 361.32	Planning Area Description
2A	361.33	Existing Conditions Flood Risk Analyses
2B	361.34	Future Conditions Flood Risk Analyses
3A	361.35	Evaluation and Recommendation on Floodplain Management Practices
3B	361.36	Flood Mitigation and Floodplain Management Goals
4A	361.37	Flood Mitigation Needs Analysis
4B	361.38	Identification of Potential Flood Management Evaluations and Potentially Feasible Flood Management Strategies and Flood Mitigation Projects
5	361.39	Evaluation and Recommendation of Flood Management Evaluations and Flood Management Strategies and Flood Mitigation Projects
6A	361.40	Impacts of Regional Flood Plan
6B	361.41	Contributions to and Impacts on Water Supply Development and the State Water Plan
7	361.42	Flood Response Information and Activities
8	361.43	Administrative, Regulatory, and Legislative Recommendations
9	361.44	Flood Infrastructure Financing Analysis
10	361.21; 361.12(a)(4)	Public Participation and Plan Adoption

Roles and Responsibilities

The TWDB appointed a Regional Flood Planning Group (RFPG) for each region and provided them with funding to prepare their plans. Region 7 RFPG was established by the TWDB in Fall 2020 to manage the flood planning efforts for the basin. The TWDB administers the regional planning process through a contract with the planning group's sponsor, who is selected by the RFPG. The Region 7 sponsor is the South Plains Association of Governments (SPAG). The Legislature also allocated funding to be distributed by the TWDB for the procurement of technical assistance to develop the regional flood plans. Freese and Nichols (FNI) was selected by the RFPG as the technical consultant to prepare the plan for the Upper Brazos River Basin. The technical consultant team also includes Halff Associates, Inc., Jacob & Martin, LLC., and H2O Partners, Inc.

The RFPG's responsibilities include directing the work of their technical consultant, soliciting, and considering public input, identifying specific flood risks, and identifying and recommending flood management evaluations, strategies and projects to reduce risk in their regions. To ensure a diversity of perspectives are included, members represent a wide variety of stakeholders potentially affected by flooding. Members of the Upper Brazos RFPG who contributed to the development of the 2023 Upper Brazos Regional Flood Plan are listed in Table ES-3.

TABLE ES-3 2020-2023 UPPER BRAZOS RFPG MEMBERS

Interest Group	Member Name	Organization/ Entity	Voting Member
Municipalities	Michael Keenum, Chair	City of Lubbock	Yes
Agricultural	Judge Dale Spurgin, Vice Chair	Jones County Judge	Yes
Counties	Jennifer Davidson	Lubbock County	Yes
Electric Generating Utilities	Richard Blake Moore	Lamb County Electric Cooperative	Yes
Environmental Interests	Rich Oller	Oller Engineering, Inc.	Yes
Industries	Erin Stiggins	Dry Land Engineering, LLC	Yes
Public	Ken Rainwater	Texas Tech University	Yes
River Authorities	Michael McClendon	Brazos River Authority	Yes
Small Businesses	Kyle Jacobson	Lubbock Chamber of Commerce	Yes
Water Districts	Chris Wingert	West Central Texas Municipal Water District	Yes
Water Utilities	Aubrey Spear	City of Lubbock	Yes
General Land Office	Jet Hays	General Land Office	No
Region 8 Lower Brazos RFPG Liaison	Michael McClendon	RFPG Liaison	No
Texas Commission on Environmental Quality	Kelly Cook	Texas Commission on Environmental Quality	No
Texas Department of Agriculture	Carol Faulkenberry	Texas Department of Agriculture	No
Texas Division of Emergency Management	Brian Hurtuk	Texas Division of Emergency Management	No
Texas Parks and Wildlife Department	Jennifer Bronson Warren	Texas Parks and Wildlife Department	No
Texas State Soil and Water Conservation Board	Jack Foote	Texas State Soil and Water Conservation Board	No
Texas Water Development Board	Ryke Moore	Texas Water Development Board	No

Task 1 Planning Area Description

The Upper Brazos Regional Flood Planning Area (Region 7), shown in Figure ES-1, comprises all or portions of 36 North Central and West Texas counties and 81 cities and towns. Region 7 is approximately 20,000 square miles in area and includes two distinct subregions with varying geography. These subregions include the flat agricultural areas of the Llano Estacado in the far western part of the Upper Brazos region and the farming and ranching areas of the Rolling Plains in the southeastern part of the region.

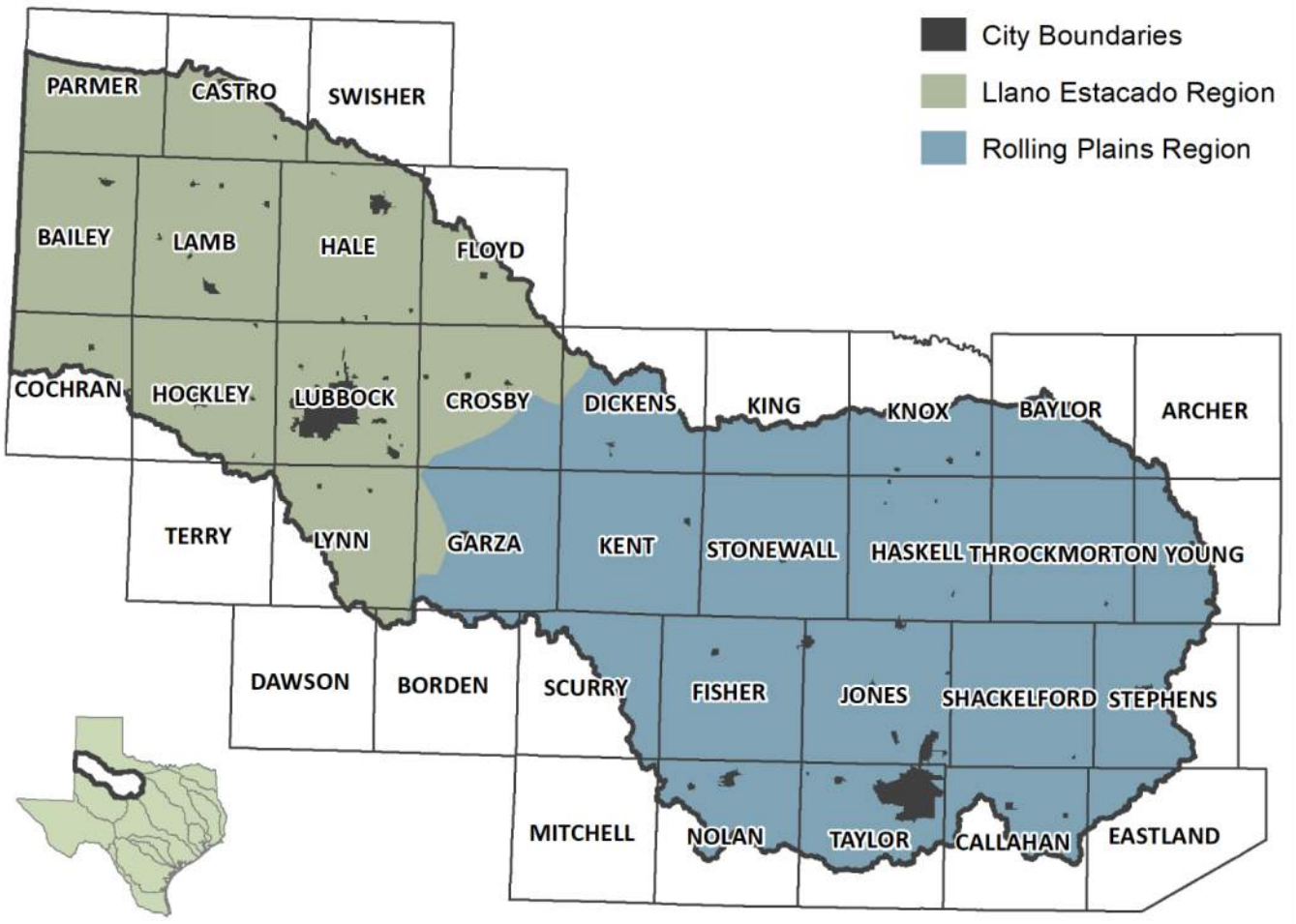


FIGURE ES-1 REGION 7 LOCATION MAP

Major cities with population greater than 10,000 include Abilene, Levelland, Lubbock, Plainview, and Sweetwater. Table ES-4 summarizes the anticipated growth of the major cities over the 50-year planning period as identified by the TWDB State Water Planning population estimates.

TABLE ES-4 POPULATION OF MAJOR CITIES

City	Population Data 2020	Population Data 2070	% Change (2020-2070)
Abilene	117,339	135,500	15.5%
Levelland	14,839	17,700	19.1%
Lubbock	261,706	403,900	54.3%
Plainview	24,624	26,900	9.1%
Sweetwater	12,196	14,600	19.8%

Natural features in Region 7 include rivers, tributaries, lakes, wetlands, springs, and playas, as shown in Figure ES-2. Due to the flat topography, the standard engineering design approach in Region 7 is to convey stormwater in the local streets to natural features like playas therefore, constructed drainage features are generally limited to the urbanized areas of Lubbock and Abilene.

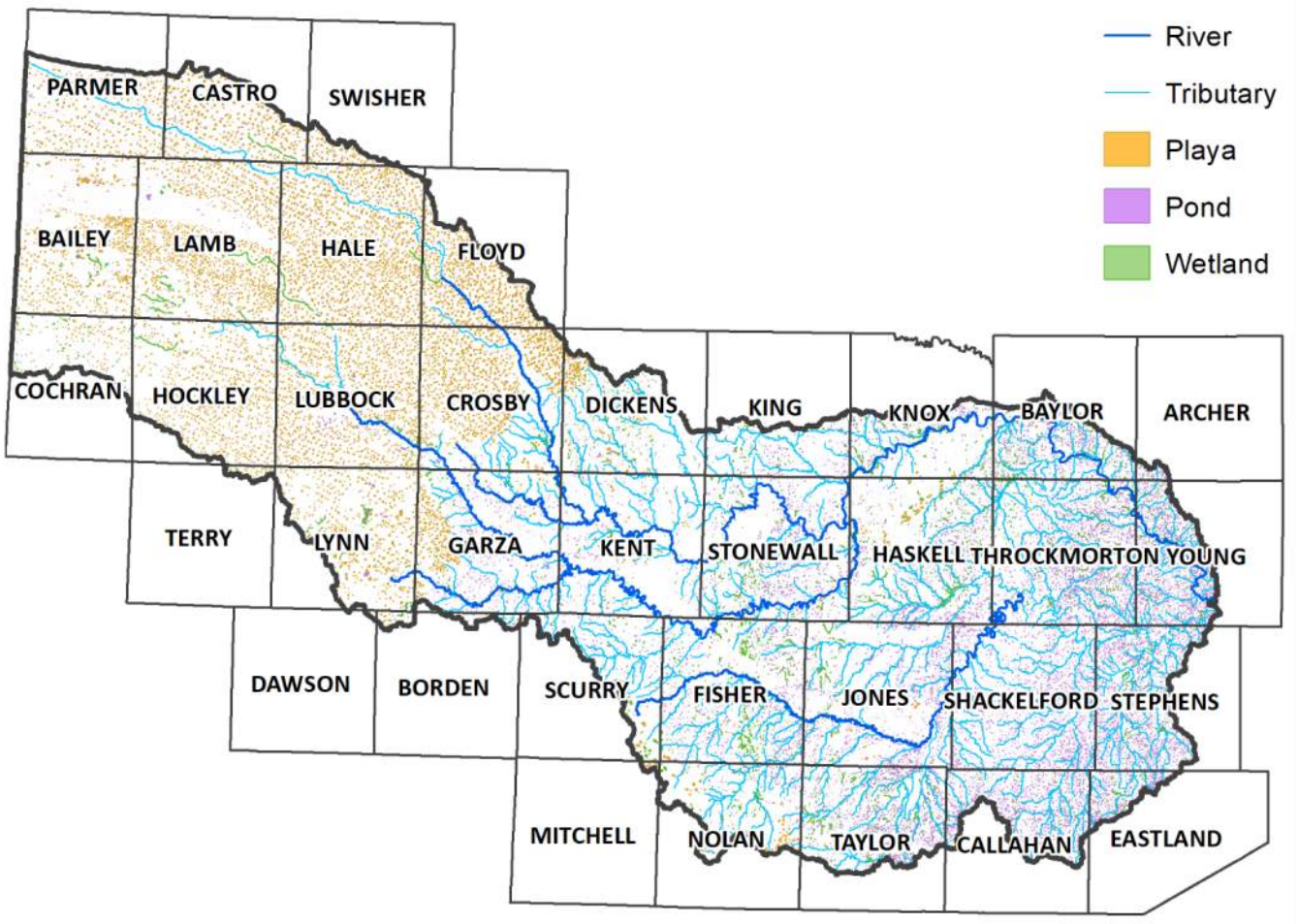


FIGURE ES-2 NATURAL FLOOD INFRASTRUCTURE FEATURES

Task 2 Flood Risk Analyses

Riverine and playa flooding are the two major types of inundation in Region 7. Urban flooding data was also evaluated for inclusion in the existing flood risk analysis, where available. Within Region 7, the available effective FEMA FIRMs are 22 years old on average. Most of the communities and counties in the region do not have modernized, digital, FEMA FIRMs.

Existing Conditions

With a limited amount of regulatory floodplain mapping, additional data sources were required to identify the flood risk extents. Based on the available floodplain mapping, approximately 6% of the total area in the region is within the 1% annual chance storm event floodplain. The 1% annual chance storm event correlates to a 1% annual risk of loss also known as a "100-year" event. TWDB also provided Floodplain Quilt data to each of the regions to be used as a starting point for identifying flood risk areas. The Floodplain Quilt consists of multiple layers of data from various sources available throughout the state to 'quilt' together a single flood hazard dataset. The flood risk data sources for Region 7 are shown in Figure ES-3**.**

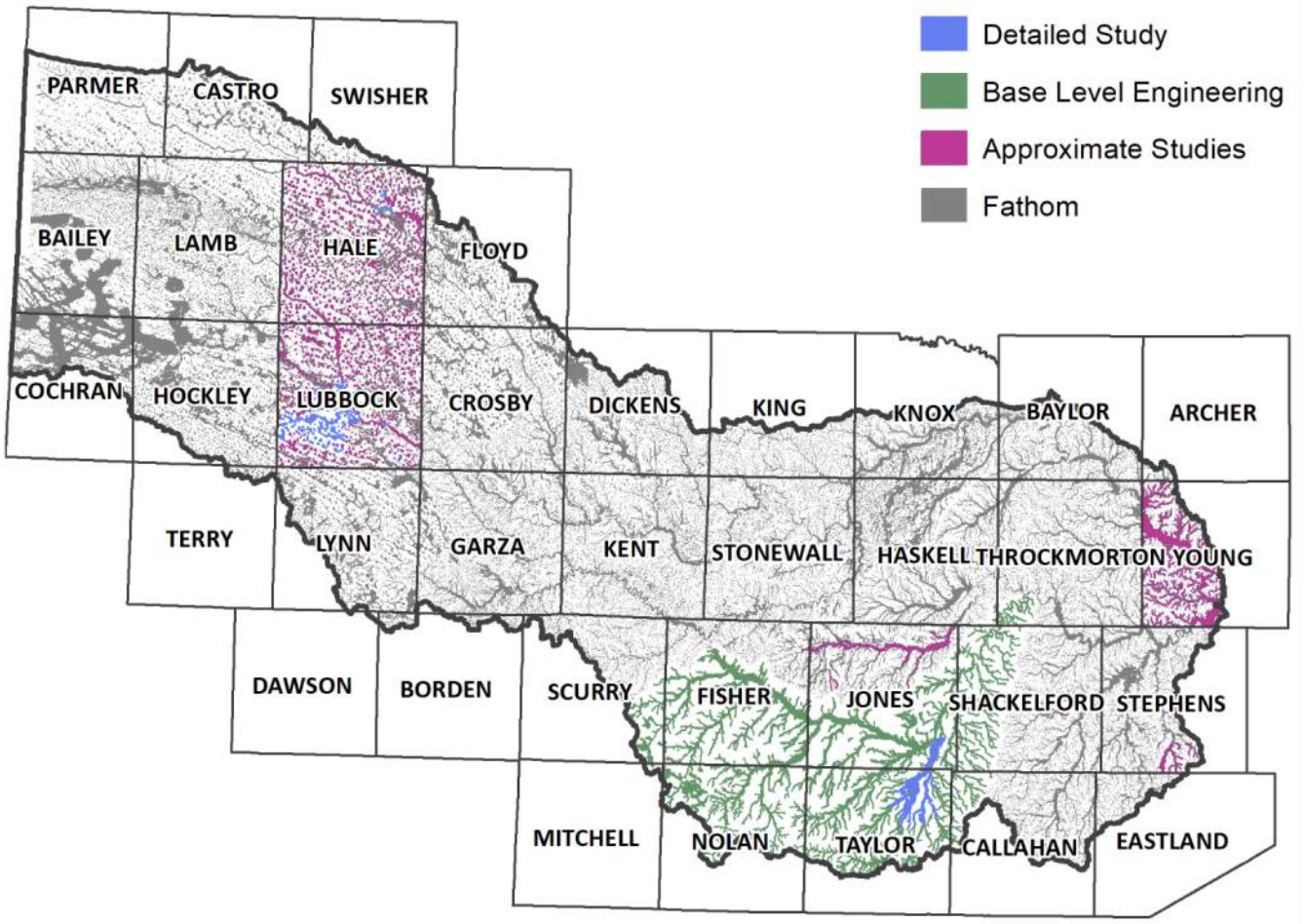


FIGURE ES-3 REGION 7 FLOODPLAIN QUILT

The existing condition flood risk exposure analysis leveraged the compiled existing condition 1% and 0.2% annual chance storm event floodplains in Region 7 to determine existing flooding exposure to development, critical facilities, and agriculture. Table ES-5 shows a basin-wide summary of some key features that are currently within existing flood risk areas.

TABLE ES-5 SUMMARY OF ASSETS IN EXISTING FLOOD RISK

Regional Asset	In 1% ACE Floodplain	In 0.2% ACE Floodplain
Total Area (sq mi)	3,634	5,028
Total Number of Structures	28,532	54,087
Residential Structures	19,838	37,008
Population	60,299	109,284
Roadway Stream Crossings	4,299	4,694
Roadway Segments (mi)	1,811	2,908
Area of Agriculture (sq mi)	126	200
Critical Facilities	81	147

Future Conditions

For the 2020 – 2023 planning cycle, RFPGs were tasked with performing a future condition flood evaluation to determine the potential increased risk of both 1% and 0.2% annual chance storm event flood hazard. The estimated flood risk changes will be used solely for the purpose of estimating the general magnitude of potential future increases in flood risk under the equivalent of a “do-nothing” alternative. The projected future flood risk extents within the regional flood planning context will not, in any way, be used for developing new flood extent maps for any regulatory purposes.

The RFPG selected two unique approaches to the future conditions flood analysis to account for the varied topographic difference within the region. Due to the limited projected population growth and minimal rainfall changes anticipated, the RFPG selected to hold the current existing 1% and 0.2% annual chance storm event flood extents for future conditions for the flat Llano Estacado subregion, “on the caprock”. The main population center on the Caprock, the City of Lubbock, has existing floodplain management practices that account for future conditions.

For the Rolling Plains subregion, a lack of data hindered analyses to determine the effects of land use and future rainfall pattern changes “off of the Caprock”. In order to account for the slight increase in land use and lack of stormwater maintenance, the RFPG determined that the future 1% annual chance storm event potential flood risk areas should be represented by a “range” of possible flooding extents. The minimum extent shall be represented by the existing 1% annual chance storm event and the maximum extent represented by the existing 0.2% annual chance storm event. The future 0.2% annual chance storm event is not to increase past the existing 0.2% annual chance storm event extents.

Task 3 Floodplain Management Practices and Flood Protection Goals

Floodplain Management Practices

A total of 30 out of 36 Counties (83%) and 60 out of 81 Cities/Towns (74%) within the region have some form of floodplain management regulation, shown on Figure ES-4. The overall level of floodplain management practices for the region are low as defined by the TWDB *Technical Guidelines* with 67% of community regulations only meeting minimum Nation Flood Insurance Program (NFIP) standards. With so much of the basin lacking flood risk information in the form of FIRM maps, it follows that the practices associated with minimizing flood risk are not widely used.

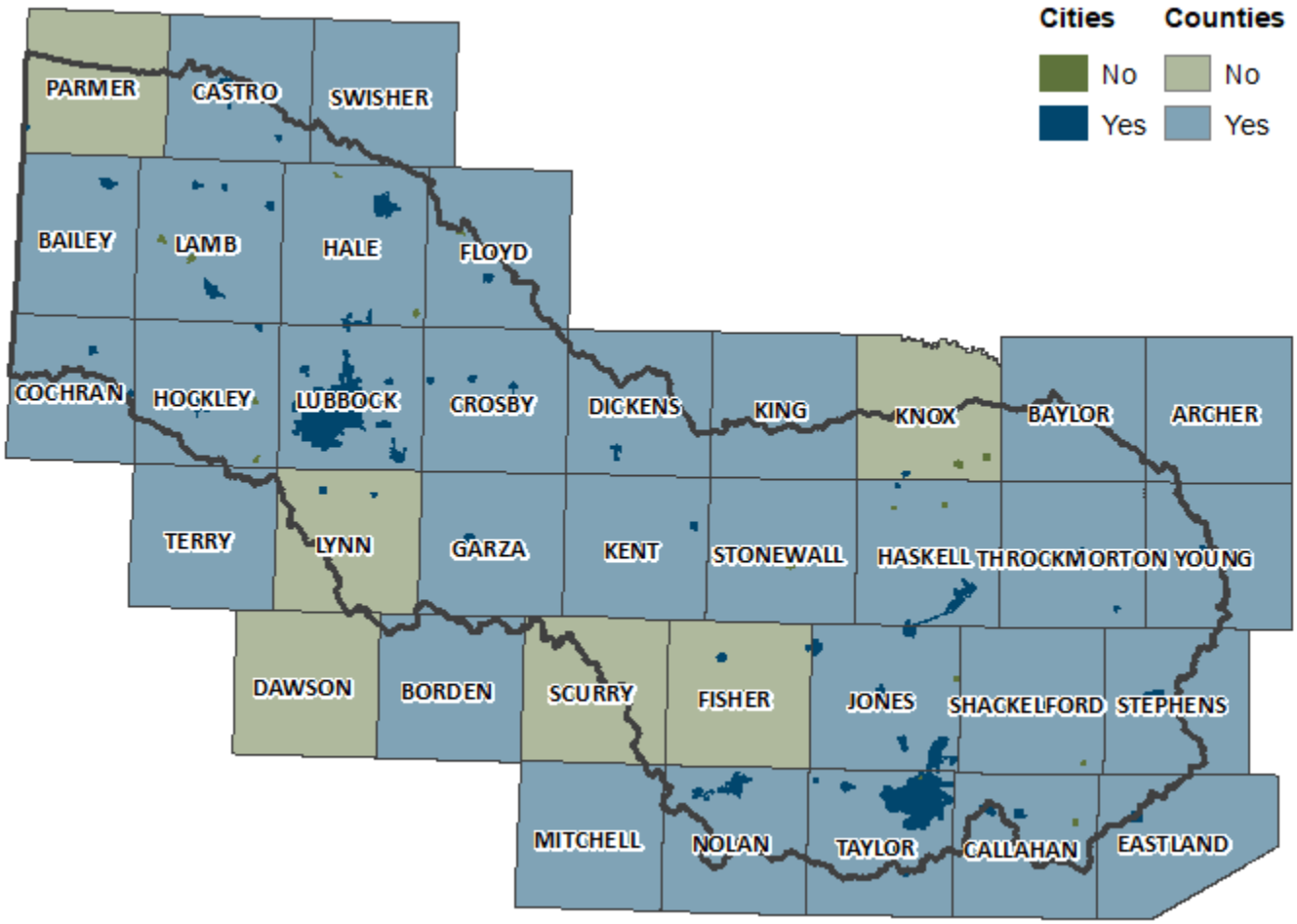


FIGURE ES-4 COMMUNITIES WITH FLOODPLAIN MANAGEMENT REGULATIONS

The Upper Brazos RFPG was required to consider the possibility of recommending or adopting consistent minimum floodplain management standards and land use practices for the entire region. Recommended practices encourage entities with flood control responsibilities to establish minimum floodplain management standards over the next several years to reduce or eliminate potential flooding areas. Table ES-6 presents the final recommended, not adopted, minimum standards as approved by the RFPG for consideration by local entities within the region.

TABLE ES-6 REGION 7 RECOMMENDED FLOOD PROTECTION STANDARDS

Infrastructure	Type / Condition	Recommended Flood Protection Standard
Residential and Commercial Buildings	New Construction or Pre-Existing (Retrofit)	• Finished floor elevations at or above 1% ACE WSEL. • All Playas: Elevate structures 1-ft minimum above 1% ACE WSEL and 1-ft above the nearest crown in street or curb (whichever is higher) near playa floodplains. • Overflow Playas: Elevate structures 2-ft minimum above overflow elevation or 1% ACE WSEL. • Non-overflow Playas: Elevate 1-ft above 0.2% ACE WSEL.
Critical Facilities	New Construction	• Construct facilities outside the SFHA.
	Pre-Existing (Retrofit)	• Elevate or floodproof electrical components
Roadways	New Construction	• All streets designed to convey stormwater runoff shall convey the 1% ACE flow within the right-of-way (ROW) limits and/or specifically dedicated easements. • Major roads constructed at or above the SFHA.
	Pre-Existing (Retrofit)	• Provide ROW conveyance to lower depth in existing streets where 1% ACE flow depths exceed 18-in, limiting access by emergency vehicles. • Provide/construct additional means of access into single-entry neighborhoods where 1% ACE ROW conveyance is not feasible.
Culverts / Bridges	New Construction	• Culverts and bridges should be designed to convey the 1% ACE flow. • Where a max allowable flow depth over the roadway is allowed, warning/signage systems should also be implemented.
	Pre-Existing (Retrofit)	• Improve safety at LWC through structural improvements for 4% ACE event and/or warning/signage systems.
Storm Drainage Systems	New Construction or Pre-Existing (Retrofit)	• Convey the 1% ACE flow within the ROW limits and / or specifically dedicated easements and drainage infrastructure.
Detention / Playas	New Construction or Pre-Existing (Retrofit)	• Implement volumetric mitigation criteria to preserve natural storage function of playas.
Dams	TCEQ Regulatory Dams	• Follow design, construction, and operations & maintenance regulations as defined by 30 TAC §299.
Property Acquisition	N/A	• Consider adopting voluntary acquisition program for repetitive loss properties and other areas at flood risk.

Flood Protection Goals

One of the critical components of the inaugural State Flood Plan process was the development of flood mitigation and floodplain management goals. The overarching goal of all regional flood plans must be "to protect against the loss of life and property" as set forth in the Guidance Principles (31 TAC §362.3). The selected specific goals, Table ES-7, guided the development of the Regional Flood Plan for Region 7.

TABLE ES-7 REGION 7 FLOOD MITIGATION AND FLOODPLAIN MANAGEMENT GOALS

Short Term (10 year)	Long Term (30 year)
Increase the availability of flood hazard data that uses the best available land use and precipitation data to reduce gaps in mapping by 25%.	Increase the availability of flood hazard data that uses the best available land use and precipitation data to reduce gaps in mapping by 75%.
Improve safety at 20% of LWCs through structural improvements and/or warning/signage systems.	Improve safety at 50% of LWCs through structural improvements and/or warning/signage systems.
Establish a baseline of the risks associated with high & significant hazard and NRCS dams, including coordination with the Texas State Soil & Water Board dam maintenance plan.	Participate in projects to bring 50% of deficient dams up to current state and / or federal standards.
Reduce structures in 1% ACE hazard layer by 5%.	Reduce structures in 1% ACE hazard layer by 15%.
Establish a baseline of the flood risk to agriculture, ranching, energy, and forestry and the associated flood-related losses	Encourage best practices to reduce the vulnerability of agriculture, ranching, energy, and forestry to flood-related losses through outreach.
Improve the participation of community stakeholders in the RFP process by 25%.	Improve the participation of community stakeholders in the RFP process by 75%.
N/A	Encourage annual outreach to improve awareness of flood hazards, planning, and projects associated with emergency response.
Locate dedicated funding sources for 25% of cities with populations over 10,000 and 10% of counties. Locate funding sources for communities with populations less than 10,000.	Locate dedicated funding sources for 50% of cities with populations over 10,000 and 30% of counties. Locate funding sources for communities with populations less than 10,000.
Increase the number of entities that have floodplain standards that meet or exceed the NFIP-minimum standards to 90% of cities with populations over 10,000 and 85% of counties.	Increase the number of entities that have floodplain standards that meet or exceed the NFIP-minimum standards to 100% of cities with populations over 10,000 and 100% of counties.
Increase entities that designate the 1% ACE floodplain on future land use plans that serve as the basis for zoning regulations to 90% of cities with populations over 10,000 and 85% of counties.	Increase entities that designate the 1% ACE floodplain on future land use plans that serve as the basis for zoning regulations to 100% of cities with populations over 10,000 and all counties.
N/A	Encourage all communities to avoid new exposure to flood hazards by adopting comprehensive plans and subdivision regulations that direct development away from the floodplain.

Task 4 Assessment and Identification of Flood Mitigation Needs

Flood Mitigation Needs Analysis

The main objectives of the needs analysis were to identify the areas of greatest **known flood risk** and areas where the greatest **flood risk knowledge gaps** exist. The needs analysis considered the factors listed in below and scored watersheds in the region for knowledge gaps and known flood risk.

1. Most prone to flooding that threatens life and property
2. Locations, extent and performance of current floodplain management and land use policies and infrastructure
3. Inadequate inundation mapping
4. Lack of hydrologic and hydraulic (H&H) models
5. Emergency need
6. Existing models and flood risk mitigation plans
7. Previously identified and evaluated flood mitigation projects
8. Historic flooding events
9. Previously implemented flood mitigation projects
10. Additional other factors deemed relevant by RFPG

Identification of Potential Flood Mitigation Actions

The goal of Task 4B was to identify and evaluate a wide range of potential actions to define and mitigate flood risk across the basin. These actions have been broadly categorized into three distinct types, as defined below:

- **Flood Management Evaluation (FME)**: A proposed flood study of a specific, flood prone area that is needed in order to assess flood risk and/or determine whether there are potentially feasible FMSs or FMPs.
- **Flood Mitigation Project (FMP)**: A proposed project, either structural or non-structural, that has non-zero capital costs or other non-recurring costs and, when implemented, will reduce flood risk or mitigate flood hazards to life or property.
- **Flood Management Strategy** (**FMS**): A proposed plan to reduce flood risk or mitigate flood hazards to life or property.

Identification of potential FMEs and potentially feasible FMPs and FMSs began with the execution of the Flood Mitigation Needs Analysis. Based on the results of this analysis, several sources of data were used to develop a list of potential flood risk reduction actions that may address the basin's needs. An overall summary of the identified flood mitigation actions is provided in Table ES-8**.**

TABLE ES-8 POTENTIAL FLOOD MITIGATION ACTION SUMMARY

Action Type	General Description	Number Identified
FME Watershed Planning - Drainage Master Plan	Supports the development and analysis of H&H models to define flood risk or identify flood prone areas OR large-scale studies that are likely to benefit multiple jurisdictions.	53
FME Watershed Planning - Flood Risk Mapping	Promotes the development and/or refinement of detailed flood risk maps to address gaps and inadequate mapping.	30
FME - Engineering Project Planning	Evaluation of a proposed project to determine whether implementation would be feasible OR initial engineering assessment including conceptual design, alternative analysis, and up to 30% engineering design.	67
FME - Other	FMEs associated with studies to support criteria and ordinance updates including property acquisition programs.	76
FMP - Non-Structural: Early Warning System	Installation of sensors at three railroad underpasses	1
FMP - Structural: Channel Improvements	Playa excavation, open channel construction for playa overflow and culvert improvements.	1
FMP - Non-Structural: Property Acquisition	Voluntary buyout of five residential properties adjacent to a playa and provision of green space.	1
FMS - Education and Outreach	Develop an education, outreach, and training program to train staff and to inform the public about the dangers of flooding and how to prevent flood damages to property.	10
FMS - Flood Measurement and Warning Systems	Install gauges, sensors, and precipitation measuring sites to monitor streams and waterways for potential flooding and support emergency response.	5
FMS - Infrastructure Projects	Reinforcement of slopes, spillway expansion, dam repairs and upgrades	11
FMS - Regulatory and Guidance	Application to join NFIP or adoption of equivalent standards.	36
FMS - Other	Consider incentive programs.	1

Task 5 Recommendation of Flood Management Actions

The RFPG evaluated the identified potential flood mitigation actions and, based on the significant needs in the region, recommended those that met TWDB requirements. The RFPG understands that not all recommendations may be performed in the same planning cycle as they are identified. All recommendations considered alignment with RFPG-adopted flood mitigation and floodplain management goals. The RFPG decided that a potential Sponsor did not have to affirm its willingness to sponsor a given action as a prerequisite for inclusion in the plan. As a result, all potential actions were

considered for inclusion unless an entity had specifically stated that a particular action was not of interest to that entity and no other appropriate potential sponsor was identified.

FMEs were recommended according to TWDB *Technical Guidelines* in which those actions are most likely to result in the identification of potentially feasible FMPs and FMSs. Recommended FMEs are intended to account for the 1% annual chance flood event and support one or more flood mitigation or floodplain management goals. Due to the limited reliable floodplain models and mapping available in Region 7, there is a significant need for evaluations. A total of 226 FMEs representing a combined cost of approximately $83M were recommended. These evaluations are needed to establish effective floodplain management practices and to identify future FMPs. The entire footprint of Region 7 is represented by one or more of the recommended FMEs, summarized in Table ES-9.

TABLE ES-9 SUMMARY OF RECOMMENDED FMES

FME Type	Recommended	Total Cost
Watershed Planning – Drainage Master Plan	53	$19M
Watershed Planning – Flood Risk Mapping	30	$26M
Engineering Project Planning	67	$30M
Other	76	$8M
Region 7 FMEs	**226**	**$83M**

For consideration as an FMP, a project must be defined in a sufficient level of detail to meet the technical requirements of the regional flood planning project *Scope of Work* and the associated *Technical Guidelines* developed by the TWDB. All potentially feasible FMPs that had the necessary data and detailed H&H modeling results available to populate these technical requirements were considered for recommendation by the RFPG, summarized in Table ES-10.

TABLE ES-10 SUMMARY OF RECOMMENDED FMPS

FMP	Description	Estimated Cost	Reduced Flood Risk	BCR
City of Abilene Downtown Railroad Underpasses Flood Warning	Installation of sensors at 3 railroad underpasses to monitor water levels	$636,000	N/A	N/A
City of Lubbock Santa Fe Drive Improvements	Playa excavation and open channel construction for playa overflow and culvert improvements	$4,500,000	60 Structures	0.7
Bovina Buyout Program	Voluntary buy out of 5 properties, turn to green space adjacent to playa.	$550,000	5 Structures	1.9
Region 7 FMPs	**Total**	**$5,686,000**	**65**	

A variety of FMS types were identified and evaluated for Region 7, summarized in Table ES-11. Generally, the FMSs recommend city-wide and county-wide strategies and initiatives that represent a combined total cost of approximately $13M. Some projects did not meet FMP requirements and therefore were listed individually as FMEs or collectively as city-wide or county-wide FMSs to capture

the anticipated construction costs. These FMSs support several of the regional floodplain management or flood mitigation goals established in Task 3.

TABLE ES-11 SUMMARY OF RECOMMENDED FMSS

FMS Type	Recommended	Total Cost
Education and Outreach	10	$750,000
Flood Measurement and Warning Systems	5	$800,000
Infrastructure Projects	11	$9,883,000
Regulatory and Guidance	36	$1,725,000
Other	1	$25,000
Region 7 FMSs	**63**	**$13.2M**

Task 6 Impact and Contribution of the Regional Flood Plan

The goal of Task 6A was to summarize the overall impacts of the Regional Flood Plan. This includes potential impacts to areas at risk of flooding, structures and populations in the floodplain, number of low water crossings impacted, impacts to future flood risk, impact to water supply (details provided in Task 6B), and overall impact on the environment, agriculture, recreational resources, water quality, erosion, sedimentation, and navigation. The benefits from the recommended FMPs to structures and population are summarized in Table ES-12.

TABLE ES-12 SUMMARY OF IMPACTS FROM FMPS FOR THE 1% ACE

Hazard	Existing Conditions At Risk	Remaining After FMP Implementation	Number with Exposure Reduction from FMPs
Exposed Structures	88	40	65
Exposed Population	338	239	159

Impacts to water supply were also evaluated as part of Task 6B. The TWDB established 16 regional water planning areas and appointed members who represent key public interests to the regional water planning groups. This grassroots approach allows planning groups to evaluate region-specific risks, uncertainties, and potential water management strategies. Regional water planning groups overlapping Region 7 include Regions B, F, G, and O, as shown in Figure ES-5. None of the recommended flood management actions have an impact on water supply.

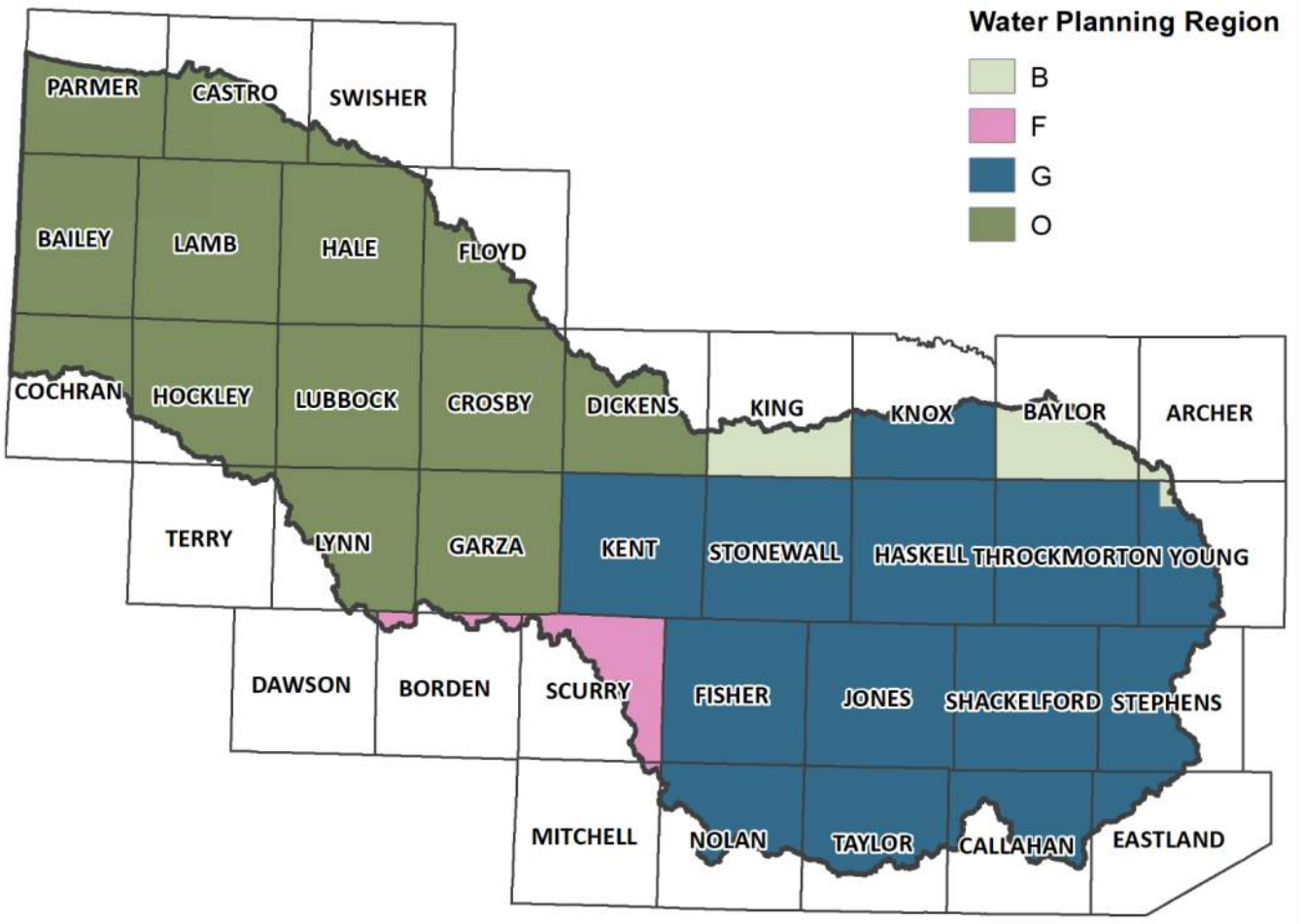


FIGURE ES-5 REGION 7 ASSOCIATED REGIONAL WATER PLANNING GROUPS

Task 7 Flood Response Information and Activities

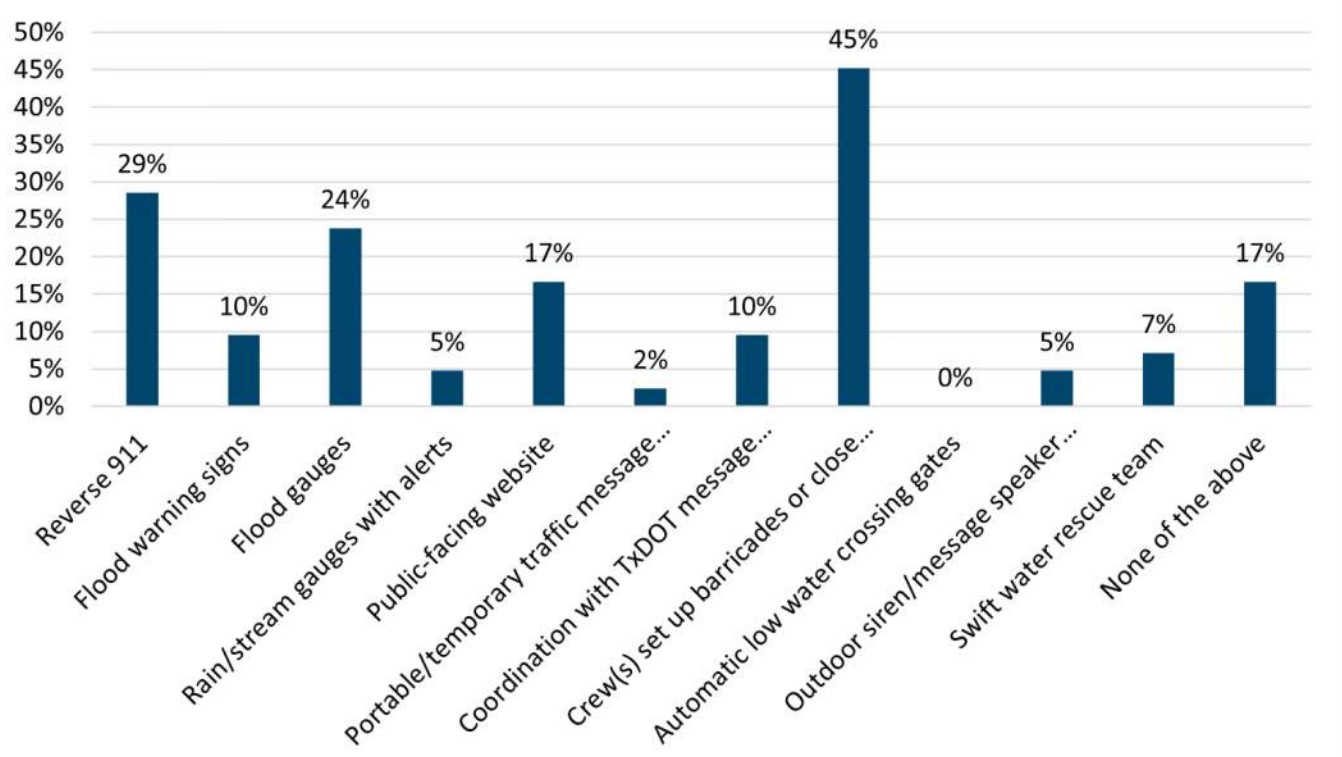
The most common types of flooding in the Upper Brazos region are river and pluvial floods. River flooding tends to be more widespread, encompassing huge swaths of land while pluvial floods tend to be more locally dangerous, impacting mobility and emergency access. Stormwater in the Upper Brazos region is typically conveyed through streets and the natural drainage features which makes the region susceptible to flash flooding. The Upper Brazos region is prone to different types of flooding depending on the part of the region. When such flood events occur, it is imperative that plans are in place to combat the effects of the flooding. There are four phases to emergency management, mitigation, preparedness, response, and recovery.

Actions and Preparations

A total of nine HMAPs were collected from Region 7. These plans were reviewed, and the following mitigation actions were identified by communities in the Upper Brazos region

- Buyout/Acquisition/Elevation projects
- Drainage Control & Maintenance
- Education & Awareness for Citizens
- Equipment Procurement for Response
- Erosion Control Measures
- Flood Insurance Education
- Flood Study/Assessment
- Infrastructure Improvement
- Installation/Procurement of Generators
- Natural Planning Improvement
- Outreach and Community Engagement
- Technology Improvement
- Urban Planning and Maintenance

In May 2021, a web-based survey was sent out to each regulatory entity in the region to gather additional information. The survey indicated that several of the types of floodplain management activities were in place including reactive maintenance following complaints or damages after a storm, utilizing Emergency Alert Systems, and ordinance enforcement. Figure ES-6 shows the flood response activities in practice in Region 7.



Source: Region 7 Data Collection Tool and Interactive web map as of September 2021

FIGURE ES-6 FLOOD RESPONSE ACTIVITY FROM WEB SURVEY

Region 7's ability to prepare, respond, recover, and mitigate disaster events is determined by several factors. With a clear understanding of the plans that determine a community's capabilities, a recognition of the entities with whom coordination is key, and knowledge of the actions sustained to promote resiliency, the region can be better equipped to implement sound measures for flood mitigation and preparedness.

Task 8 Administrative, Regulatory, and Legislative Recommendations

According to 31 Texas Administrative Code 362.3, the RFPG shall include legislative recommendations that are considered necessary and desirable to facilitate flood management planning and implementation to protect life and property. The RFPG discussed administrative, regulatory, and legislative issues during the Flood Planning effort. The RFPG considered regional input provided through a region-wide survey shortly after the Region 7 planning efforts began. Recommendations are summarized below.

Administrative Recommendations

1) TWDB should develop model standards, ordinances, and processes.
   a) Model ordinances for general law cities (e.g., building codes, subdivision regulations)
   b) Model floodplain management standards for varied levels of floodplain management practices to encourage increased levels. (e.g. low/medium/high)
   c) Model processes for participation in the FEMA National Flood Insurance and Community Rating System program. Develop state incentives for local governments to participate in each program.
   d) Model the process and clarify the investment required to take BLE data to 1) regulatory BLE information on a FIRM panel and 2) detailed study on a FIRM panel.
2) TWDB should provide support to local floodplain administrators.
   a) Provide ongoing training targeted to non-technical floodplain administrators.
   b) Assist smaller jurisdictions in preparing funding applications or make the application process easier.
   c) Use the project list in the State Flood Plan to help connect local communities to federal grant programs that are administered by state agencies (TWDB/TDEM), providing a “one stop” application process.
   d) Provide training to state agencies, local governments, engineers, planners in the use of natural floodplain preservation/conservation.
   e) Incentivize voluntary buy out programs, turning previously flooded properties/neighborhoods into green space and parkland as an alternative to large-scale construction projects.
3) TWDB should utilize a variety of flood mitigation criteria to evaluate projects for funding including alternatives to traditional methods.
   a) Do not score or award funding for projects that benefit agricultural activities based on a traditional benefit-cost ratio; provide guidance on TWDB-preferred methodology to account for benefits to agricultural areas and activities and include consideration of agricultural benefits when ranking projects in the State Flood Plan. Methodology should consider temporary nature and ancillary benefits provided by occasional agricultural land flooding.
   b) Do not score or award funding for projects that benefit energy activities based on a traditional benefit-cost ratio; provide guidance on TWDB-preferred methodology to account for benefits to energy activities and include consideration of energy benefits when ranking projects in the State Flood Plan.

   c) Expand consideration and priority for FMEs that establish initial FEMA effective floodplains.
   d) Expand consideration for projects that do not provide 100-year level of service but can demonstrate substantial benefit during higher frequency events.
   e) Consider alternate requirements to eliminate barriers that prevent jurisdictions from working together to provide regional flood mitigation solutions. For example, if primary sponsor meets all administrative requirements but additional jurisdictions do not, allow the regional solution to remain in contention for state funding.
4) TWDB should increase efforts to educate the public about flood-related issues.
   a) Develop a statewide database and tracking system to document flood-related fatalities that is publicly available. This could be an addition to the Flood Plan Data Hub to capture existing data from TxDOT, NOAA, or others.
   b) Partner with TFMA to promote public education and outreach about flood awareness and flood safety and provide outreach materials to communities. Partnership with Texas Association of Counties to include dedicated outreach to County Judges who often act as Floodplain Administrators without a technical flooding background.
   c) Maintain a flood hazard area map on a public web map platform database, potentially integrated with the existing Water Data interactive site.
   d) Develop a model-based future conditions flood hazard data layer using BLE data and provide it for use by RFPGs and the technical consulting teams during the next flood planning cycle.

Regulatory Recommendations

1) The State should review and update pertinent TxDOT criteria.
   a) Review TxDOT design criteria to identify opportunities to improve consideration for flood safety. Align with goals and objections of flood planning criteria. Develop funding mechanism for TxDOT to improve facilities flood safety.
   b) Update TxDOT design criteria to include no adverse impacts requirement for proposed road projects.
2) The State should consider adopting current versions of International Building Code and International Residential Code as State building standards.
3) The State should recommend (not adopt or require) an additional statewide building standard of a minimum floor elevation equal to the base flood elevation (BFE) plus freeboard to account for potential changes in future rainfall depths and flood elevations.
4) The State should encourage FEMA to streamline the CRS application process to make it easier to obtain certification and implement at the local level.
5) The State should explore the use of current legislatively authorized entities to provide continuity and resources for communities related to flooding before creating new entities.

Legislative Recommendations

1) The Texas Legislature should provide recurring biennial appropriations to the Flood Infrastructure Fund for study, strategy, and project implementation.

2) The Texas Legislature should provide State incentives for establishment of dedicated drainage funding at a local level.
3) The Texas Legislature should provide guidance for use of public funds to improve private properties for flood risk reduction (e.g., elevation of structures in floodplains).
4) The Texas Legislature should provide counties with legislative authority to establish drainage utilities and assess drainage fees.
5) The Texas Legislature should provide counties with expanded regulatory authority to manage new development to reduce future flood risk and benefit water supplies.
6) The Texas Legislature should provide clarity on roles and responsibilities within ETJ areas related to floodplain management activities.
7) The Texas Legislature should develop and allocate State funding to assist private dam owners and NRCS dams with the costs associated with repair and maintenance of dams. Priority should be given to NRCS dams with the highest risk to the public at large.
8) The Texas Legislature should allocate a percentage of funds appropriated for this overall program to assist rural or small entities to implement identified actions.

Task 9 Flood Infrastructure Financing Analysis

The RFPG performed a survey of the sponsors for the recommended FMEs, FMSs and FMPs. The RFPG primarily used in-person meetings and email surveys to survey the sponsors. As a last resort, the RFPG mailed surveys or used other means of collecting the required information. The primary aim of this survey effort was to understand the funding needs of local sponsors and obtain feedback regarding the role the state should have in financing the recommended FMEs, FMSs, and FMPs.

The RFPG met with 43 sponsors and emailed the funding survey to 55 additional sponsors. As of June 29, 2022, 39 responded through email or an in-person meeting, for a response rate of 40%. The RFPG assumed that those sponsors who did not respond to the survey would need 100% of the total project costs to be funded by state and/or federal sources. Many smaller and more rural communities do not have any local funding available for flood management activities. Those communities that did report having local funding indicated relatively little local funding available in relation to overall need.

Overall, there is a total cost of **$100 M** needed to implement the recommended FMEs, FMSs, and FMPs in this regional flood plan. From the total cost, it is projected that **$98.6 M in state and federal funding is needed**. This number does not represent the amount of funding needed to mitigate all risks in the region and solve flooding problems in their totality. This number simply represents the funding needs for the specific, identified studies, strategies, and projects in this cycle of regional flood planning. It is estimated an additional $97M would be needed to construct additional projects that are not yet included as FMPs. Future cycles of regional flood planning will continue to identify more projects and studies needed to further flood mitigation efforts in Region 7.

Task 10 Adoption of Plan and Public Participation

As required by 31 TAC §361, the RFPGs conducted all business in meetings posted and held in accordance with the Texas Open Meetings Act, Texas Government Code Chapter 551, with a copy of all materials presented or discussed available for public inspection prior to and following public meetings. Additional notice requirements referenced in 31 TAC §361.21 were followed when applicable.

The Upper Brazos RFPG held monthly meetings to obtain updates from the Technical Consultant Team, provide input on processes and methodologies, and provide approval for components of the Regional Flood Plan. These meetings were open to the public and were held in a hybrid format with opportunities to attend in person or virtually through Zoom.

The RFPG utilized several targeted outreach methods to engage the public and stakeholders in this inaugural plan development. The RFPG included public access to a data collection survey on their project webpage, www.upperbrazos.org . Figure ES-7 shows the interactive public comment web map available through this survey. An interactive dashboard was also available for the public and stakeholders to review GIS data developed through the planning process.

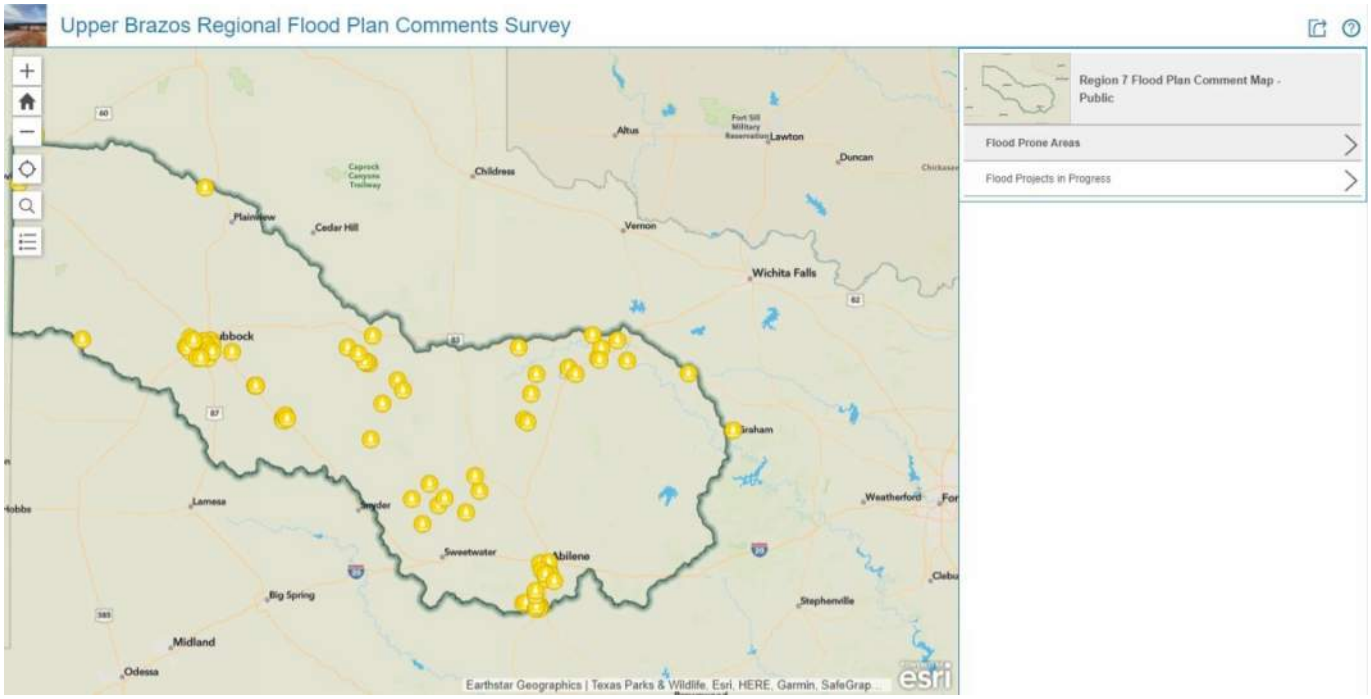


FIGURE ES-7 REGION 7 PUBLIC COMMENT WEB MAP

Additional public outreach has been conducted throughout the planning cycle. In person stakeholder meetings were conducted following the development of preliminary flood hazard data and preliminary flood management actions. The RFPG has also presented on the flood planning process at several community events including SPAG and WCTCOG meetings.

The final plan has been developed and adopted in accordance with 31 TAC §361.50 and §361.60–.61 the flood planning guidance principles 31 TAC §361.20 (31 TAC §362.3). This plan satisfies each of the guidance principles including that the plan will not negatively affect a neighboring area.

Task 1. Planning Area Description

Character of the Upper Brazos Flood Planning Area

The Upper Brazos Regional Flood Planning Area (Region 7), shown in Figure 1-1, comprises all or portions of 36 North Central (Rolling Plains) and West Texas (Llano Estacado) counties and 81 cities and towns. Region 7 is approximately 20,000 square miles in area, or 7.5% of the State's total area. The two largest metropolitan areas in the region include Lubbock and Abilene.

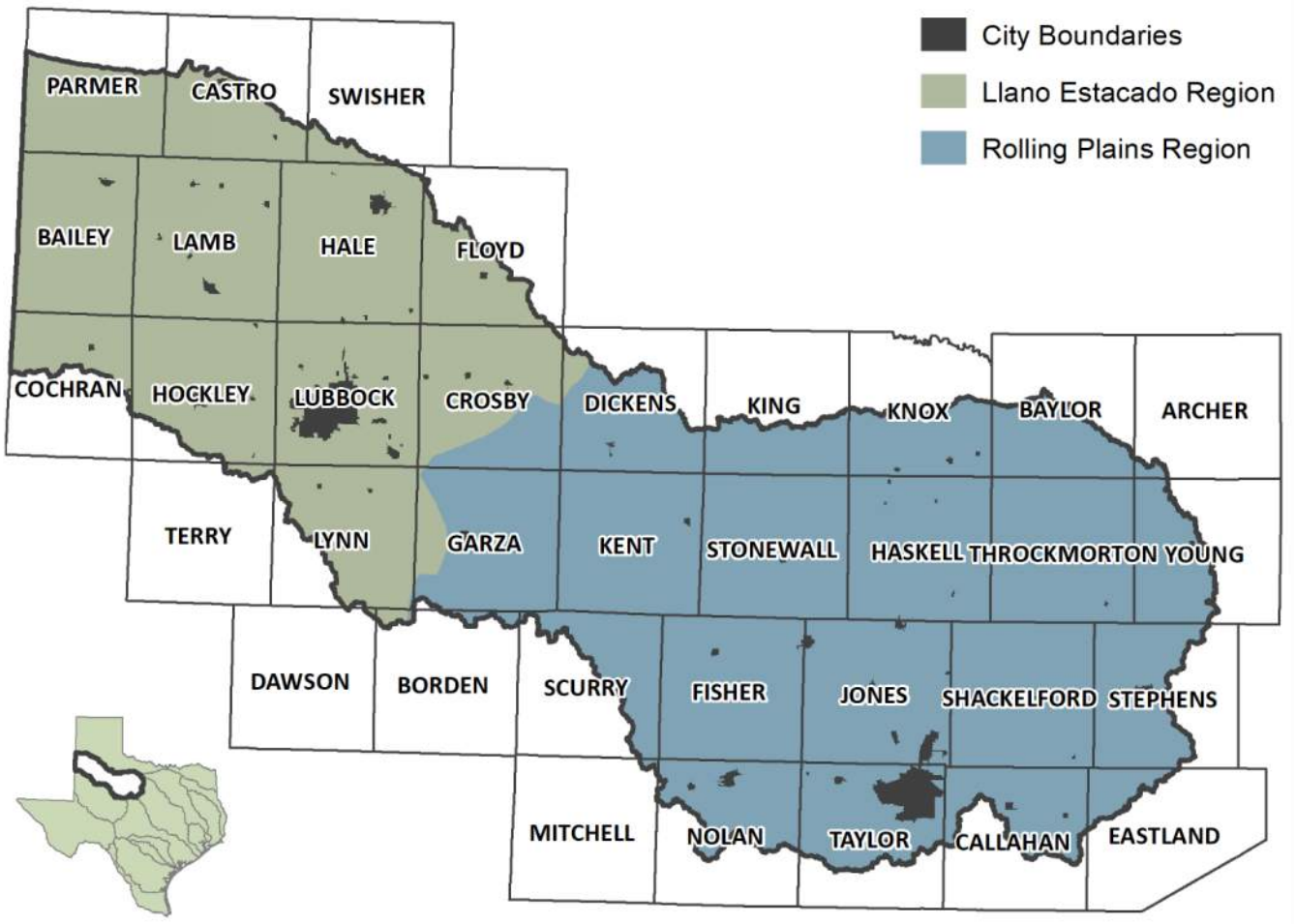


FIGURE 1-1 REGION 7 LOCATION MAP

The City of Lubbock is the largest city in Region 7 with a population greater than 250,000 people. Agribusiness is the major industry in the region, with the City of Lubbock serving as the hub for health care and education in the western portion of the region. The education centers here include Texas Tech University, Lubbock Christian University, Wayland Baptist University, and South Plains College. The City of Abilene, which is the other large metropolitan city in the region, has a population greater than 100,000 people. The City of Abilene, the "Key City," also serves as a hub for health care as well as education in the eastern portion of the region. Education centers here include Abilene Christian

University, Hardin Simmons University, McMurry University, and Cisco College. Abilene is also the home of Dyess Air Force Base, a major military base for the United States.

Region 7 includes two distinct subregions with varying geography, as shown in Figure 1-1. There are the flat agricultural areas of the Llano Estacado in the far western part of the Upper Brazos region and the farming and ranching areas of the Rolling Plains in the southeastern part of the region. Figure 1-2 shows the Caprock Escarpment, the dramatic transition between these two distinct regions.

FIGURE 1-2 CAPROCK ESCARPMENT IN SOUTHEAST LUBBOCK COUNTY

Population and Future Growth

Figure 1-3 provides an illustration of the historical population growth for counties that are fully or partially included in Region 7 for the period of 1900 to 2020[1]. Over the period from 1900 to 1990 the population of Region 7 grew at a rapid rate averaging 1.86% per year. Over the past 30 years from 1990 to 2020, the population of Region 7 grew slowly at an average rate of 0.26% per year. During the same period, the total population of Texas grew at an average rate of 1.9% annually. Population in Region 7 is projected to increase by an average of 0.58% annually, exceeding 900,000 by 2070. In order to remain

[1] Texas Almanac. 2021. Population History of Counties from 1850-2010: https://texasalmanac.com/sites/default/files/images/topics/ctypophistweb2010.pdf

consistent with other statewide planning activities, the population projections included in this plan are based on projections that are published by the TWDB[2] as part of the state water planning process.

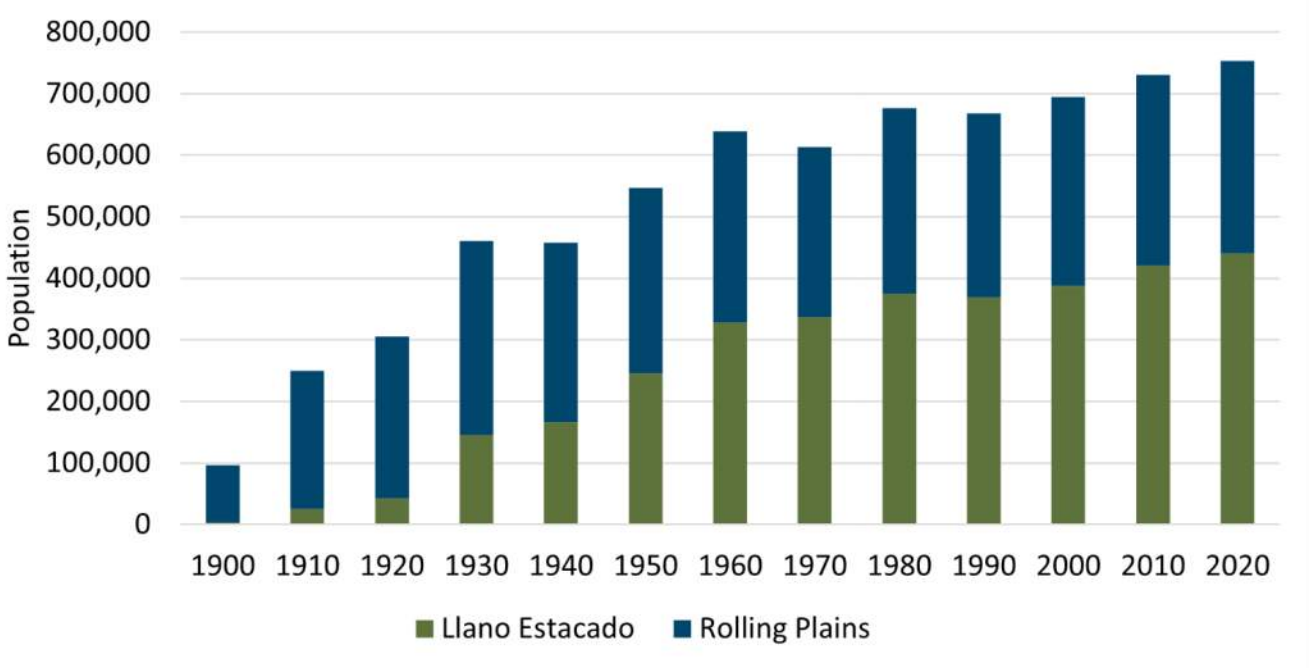


FIGURE 1-3 HISTORICAL POPULATION OF REGION 7

With two distinct subregions in Region 7, as well as a large portion of the basin being comprised of rural and agricultural lands, it is important to look at the population trends for each of these areas. Figure 1-4 illustrates population distribution by county for the year 2020 and the estimated growth distribution over the next 50 years. The Llano Estacado region is projected to grow at a greater rate than the Rolling Plains region, while the major cities and rural areas are projected to grow at similar rates from 2020 to 2070. A total of 4 counties have no anticipated growth, Baylor, Dickens, Throckmorton, and Fisher counties.

[2] TWDB. 2022. Regional Water Plan Population & Water Demand Projections: https://www.twdb.texas.gov/waterplanning/data/projections/2022/popproj.asp

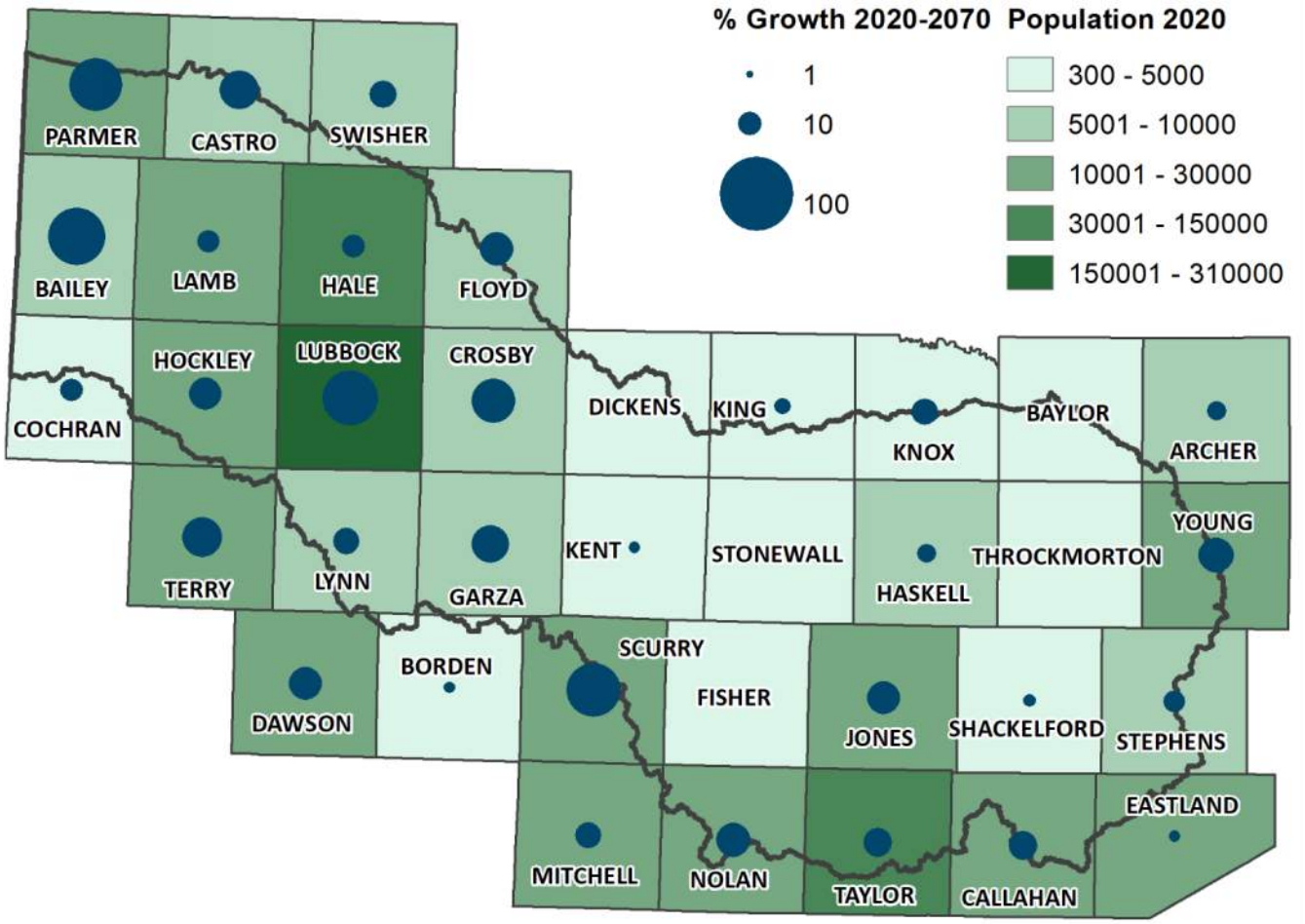


FIGURE 1-4 2020 POPULATION DISTRIBUTION BY COUNTY

Llano Estacado Region

The counties in the Llano Estacado region are Bailey, Castro, Cochran, Dawson, Hale, Hockley, Lamb, Lubbock, Lynn, Parmer, Swisher, and Terry. These counties represent about 62% of Region 7's population as of 2020. Since 1990 this region has grown at an average rate of 0.39% per year. Major cities in this region include Lubbock, Levelland, and Plainview. The Llano Estacado region is projected to grow at an average rate of 0.74% per year for the period of 2020 to 2070 and increase to about 67% of the total population in Region 7 according to TWDB projections.

Rolling Plains Region

The counties in the Rolling Plains region are Archer, Baylor, Borden, Callahan, Crosby, Dickens, Eastland, Fisher, Floyd, Garza, Haskell, Jones, Kent, King, Knox, Mitchell, Nolan, Scurry, Shackelford, Stephens, Stonewall, Taylor, Throckmorton, and Young. These counties represent about 38% of Region 7's population in 2020. Since 1990 this region has grown at an average rate of 0.08% per year. Major cities in this region include Abilene and Sweetwater. The Rolling Plains region is projected to grow at an average rate of 0.28% per year for the period of 2020 to 2070 and decrease to about 33% of the total population in Region 7 according to TWDB projections.

Figure 1-5 illustrates projected population growth in the two subregions from 2020 to 2070.

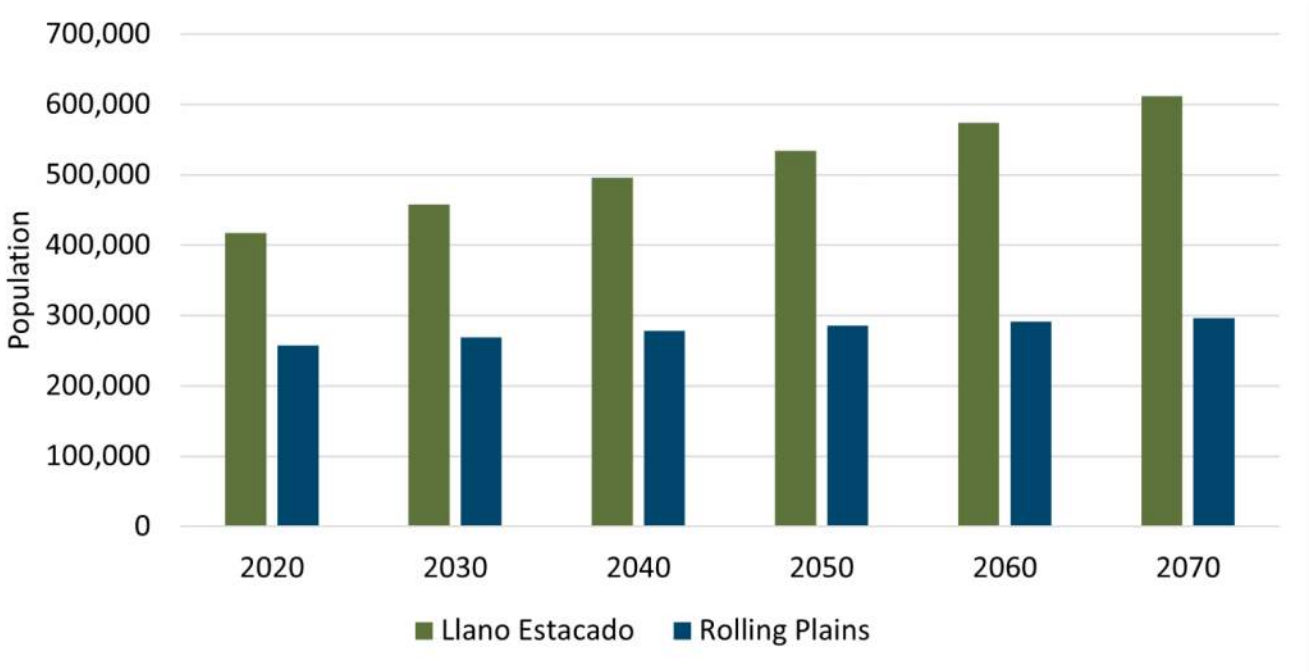


FIGURE 1-5 PROJECTED POPULATION BY SUBREGION

Major Cities

Major cities in Region 7 are cities with populations greater than 10,000 and include Abilene, Levelland, Lubbock, Plainview, and Sweetwater. These cities represent about 65% of Region 7's population in 2020. The major cities in Region 7 are projected to grow at an average rate of 0.58% per year for the period of 2020 to 2070 and represent about 67% of the total population in Region 7 according to TWDB projections, which is a slight increase in the proportion of the total population over the next 50 years. Table 1-1 presents 2020 population and projected populations for 2070 for the major cities in the basin. This table also presents the percent change in population from 2020 to 2070 in each major city.

TABLE 1-1 POPULATION OF MAJOR CITIES

City	County	Population Data 2020*	Population Data 2070*	% Change (2020-2070)
Abilene	Taylor / Jones	117,339	135,500	15.5%
Levelland	Hockley	14,839	17,700	19.1%
Lubbock	Lubbock	261,706	403,900	54.3%
Plainview	Hale	24,624	26,900	9.1%
Sweetwater	Nolan	12,196	14,600	19.8%

*2020 and 2070 populations are based TWDB State Water Planning Population Estimates

Rural and Agricultural Areas

The rural and agricultural areas in Region 7 represent a large portion of the geographic area for the basin. However, the rural and agricultural areas only represent about 35% of Region 7's population in

2020. The rural and agricultural areas in Region 7 are projected to grow at an average rate of 0.63% per year for the period of 2020 to 2070 and represent about 33% of the total population in Region 7 according to TWDB projections, which is a slight decrease in the proportion of the population over the next 50 years.

Figure 1-6 illustrates projected population growth for the major cities and rural areas from 2020 to 2070. Major cities are defined as those having at least 10,000 people in 2020.

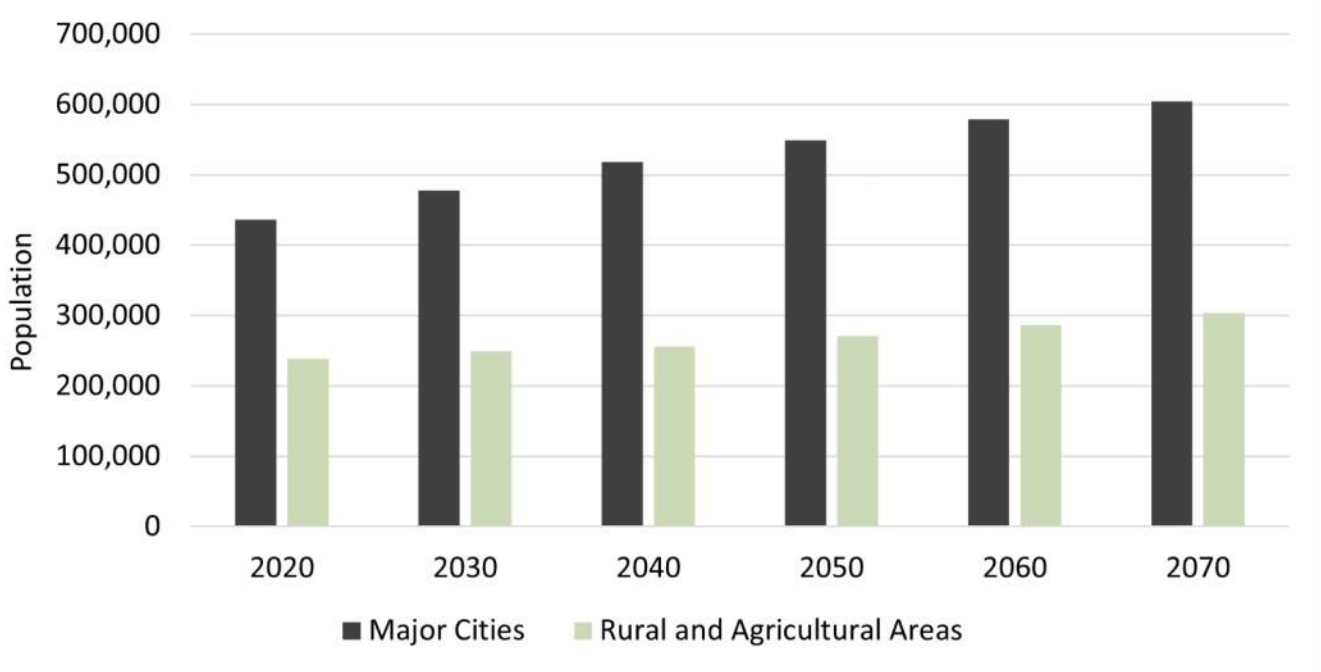


FIGURE 1-6 PROJECTED POPULATION IN MAJOR CITIES AND RURAL AREAS

Economic Activity

Understanding the economy of the region is crucial for developing flood planning strategies. This section describes the economic aspects of the region, such as economic activity and economic sectors. The region's economic base is agriculture, with significant contributions from healthcare, retail and wholesale trade, construction, manufacturing, and oil and gas services.

Agricultural / Ranching

The Upper Brazos basin is an extremely productive agricultural region with a rich farming and ranching heritage. Although fewer individuals are exposed to flood hazards in rural areas, the impact of flooding on agriculture and ranching can be severe. Floods can delay planting and ruin crops, kill livestock, and damage structures and equipment, causing significant economic hardship to the farmers and ranchers.

The agricultural and ranching economic activities in Region 7 are predominantly comprised of cattle and crop production. Figure 1-7 below shows the general agricultural uses across the region.

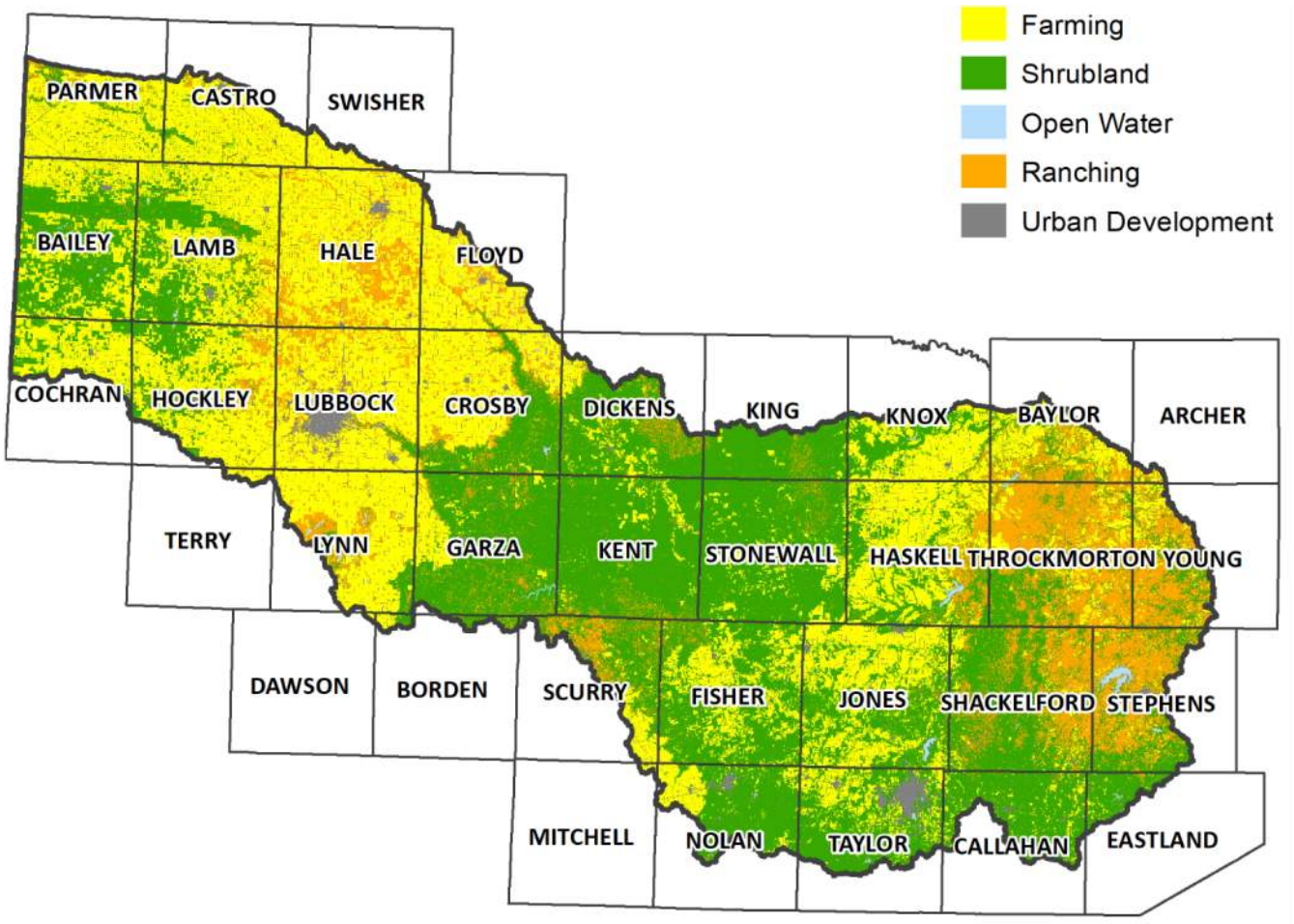


FIGURE 1-7 AGRICULTURAL AND RANCHING REGIONS

Due to the semi-arid climate, limited water, and a relatively short growing season, the region can only support certain crops. The major crops grown are cotton, grain sorghum, wheat, corn, soybeans, wine grapes, peanuts, and hay. Crop production for Region 7 for 2017 is shown in Table 1-2. These crop production numbers are according to the USDA National Agricultural Statistics Service (NASS) 2017 Census of Agriculture[3] which is published every five years. The 2017 census is the most recent data for the state of Texas.

Major types of livestock produced in Region 7 include cattle, swine, sheep, and poultry. The largest classification of livestock is cattle and calves followed by beef cows, milk cows, poultry, sheep, and swine. Livestock numbers for Region 7 for 2017 are shown in Table 1-3. The livestock numbers are according to the USDA National Agricultural Statistics Service (NASS) 2017 Census of Agriculture.

[3] USDA. 2017. National Agricultural Statistics Service 2017 Census of Agriculture: https://www.nass.usda.gov/Publications/AgCensus/2017/Full_Report/Volume_1,_Chapter_2_County_Level/Texas/

TABLE 1-2 CROP PRODUCTION IN 2017

Crop	Region Total	State Total	Region %
Corn (bushels)	32.2 M	286.8 M	11%
Wheat (bushels)	18.0 M	71.4 M	25%
Oats (bushels)	18,000	2,722,000	0.7%
Barley (bushels)	318,000	828,000	38%
Sorghum (bushels)	483,000	920,000	52%
Soybeans (bushels)	66,000	6,782,000	1%
Cotton (bales)	4.2 M	8.9 M	48%
Hay and Haylage (tons)	658,000	9,127,000	7%
Peanuts (pounds)	221.8 M	670.7 M	33%

TABLE 1-3 LIVESTOCK NUMBERS IN 2017

Livestock	Region Total	State Total	Region %
Cattle & Calves	2.3 M	12.6 M	18%
Beef Cows	334,000	4.6 M	7%
Milk Cows	184,000	532,000	35%
Swine (Hogs & Pigs)	8,700	1.0 M	0.8%
Sheep & Lambs	26,000	729,000	4%
Poultry	27,000	21.0 M	0.1%

Oil & Gas

The oil and gas production activity in Region 7 is concentrated in the southern and central counties. Scurry, Borden, and Hockley counties are the leading oil and gas producers in the region, however only Hockley County is fully located in Region 7. Other counties with significant oil and gas production include Cochran, Terry, Dawson, Garza, Kent, Mitchell, and Fisher. Oil and gas production in Region 7 for 2020 is shown in Table 1-4. The oil and gas production numbers were taken from the Railroad Commission of Texas Oil & Gas Data Query[4].

TABLE 1-4 OIL AND GAS PRODUCTION IN 2020

Oil / Gas	Region Total
Oil (bbl)	37.1 M
Casing Head Gas (mcf)	47.8 M
Gas Well Gas (mcf)	5.0 M
Condensate (bbl)	50,000

[4] Railroad Commission of Texas. 2020. Oil & Gas Data Query: http://webapps2.rrc.texas.gov/EWA/ewaMain.do

Commercial Economic Activity

The US Census Bureau publishes data on the business patterns of every county in the United States. The different economic industries are divided in accordance with the North American Industry Classification System (NAICS), which classifies all business establishments to facilitate the publication of statistical data related to the United States economy. The economic census established three economic factors for evaluating economic status: establishments, employment, and salary. These three factors will be evaluated to determine the economic risk of flooding events in Region 7. The data included in this plan was taken from the 2018 County Business Patterns from the US Census Bureau[5].

There are a total of 17,314 establishments in the counties included in Region 7. As shown in Figure 1-8, the industries with the largest number of establishments in the region are retail trade, other services (not including public administration), healthcare and social assistance, accommodation and food services, construction, professional, scientific and technical services, and finance and insurance.

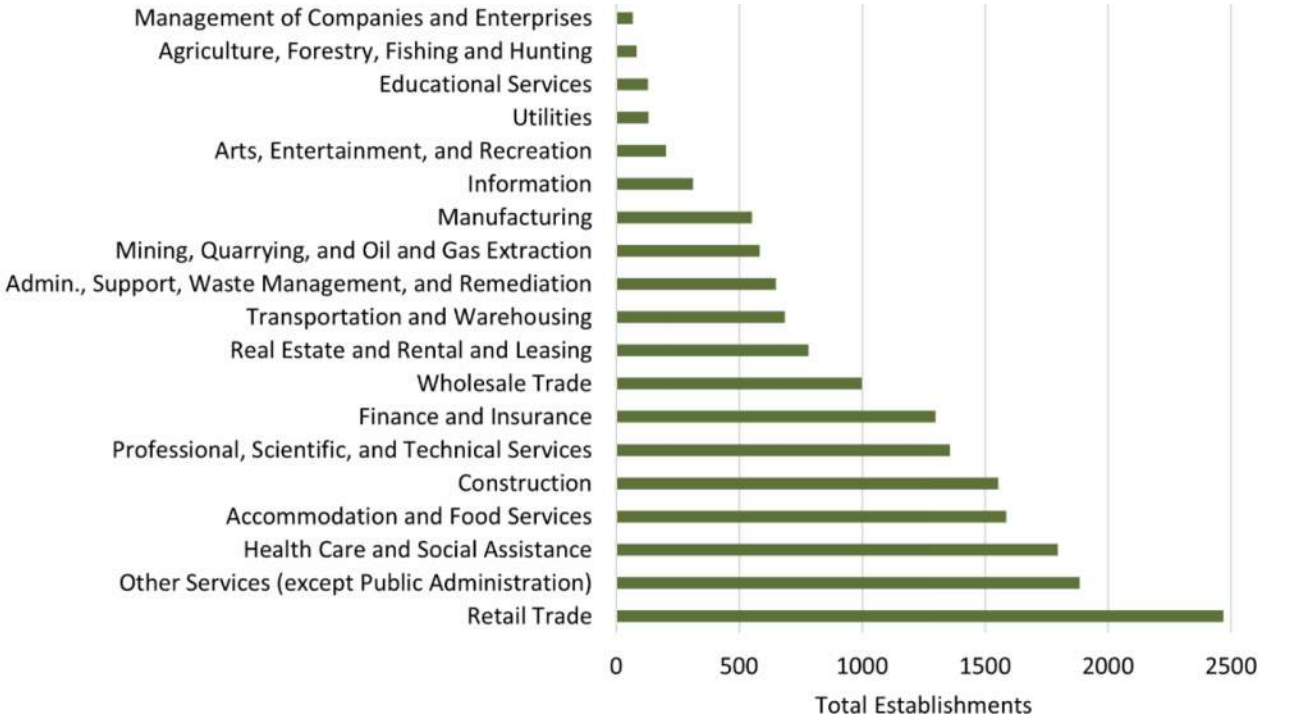


FIGURE 1-8 ESTABLISHMENTS BY INDUSTRY

There are 239,937 people employed in the counties that are wholly or partially included in Region 7. As shown in Figure 1-9, the industries that employed the largest amount of people in Region 7 are healthcare and social assistance, retail trade, accommodation and food services, manufacturing, construction, other services (not including public administration), wholesale trade, finance and insurance, and transportation and warehousing.

[5] US Census Bureau. 2018. 2018 County Business Patterns. Data Tables by Establishment Industry: https://www.census.gov/data/tables/2018/econ/susb/2018-susb-annual.html

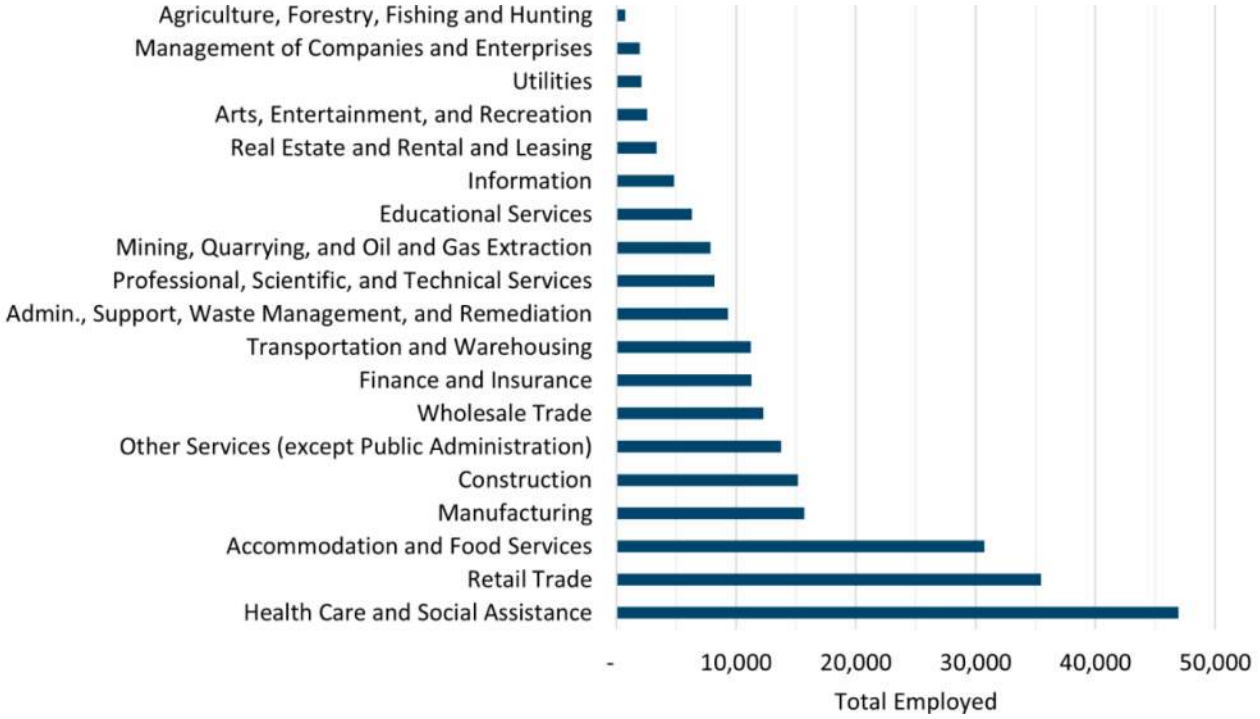


FIGURE 1-9 EMPLOYMENT BY INDUSTRY

The total annual salary in the counties that are wholly or partially included in Region 7 for 2018 was $9,551,302,000. As shown in Figure 1-10, the industries that had the largest total annual salaries in Region 7 are healthcare and social assistance, retail trade, construction, manufacturing, wholesale trade, and finance and insurance.

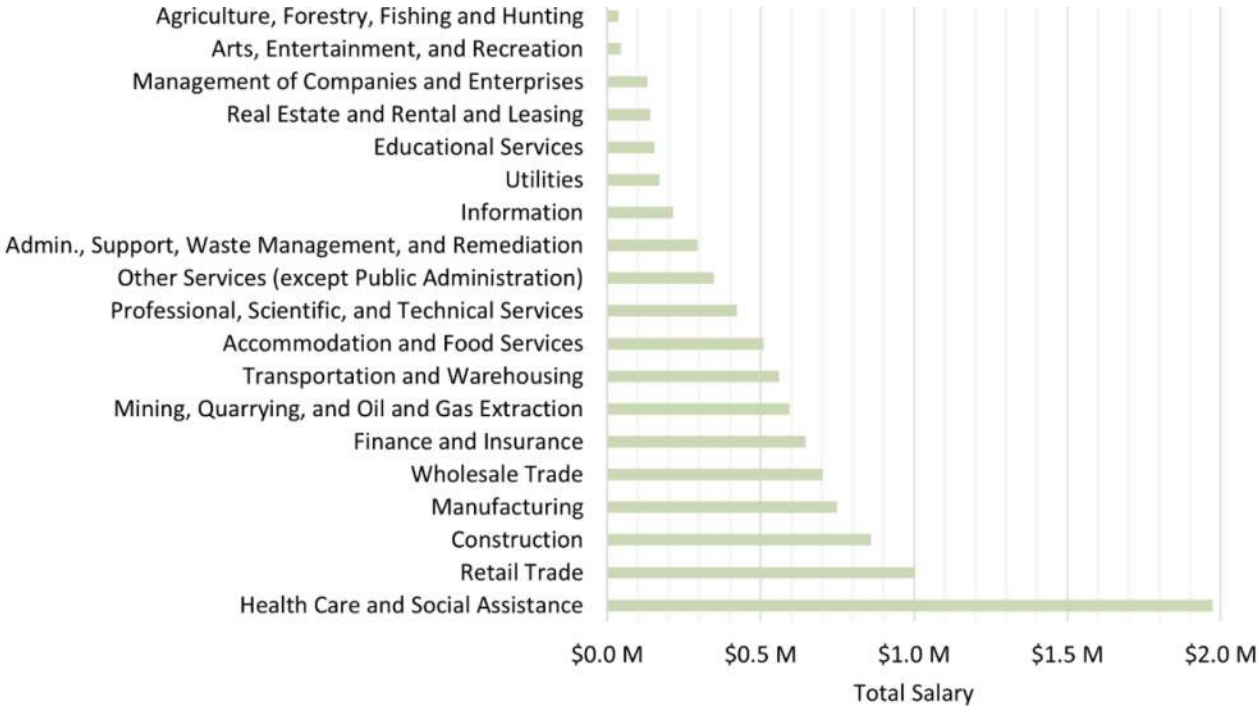


FIGURE 1-10 SALARY BY INDUSTRY

Economic Status of Population

Median household incomes can be affected by many factors, including education levels, opportunity of employment, and location. The median household income provides a good comparison for income levels across the basin. Within Region 7, the median income is $53,577. This value is less than the Texas median of $63,524 and the U.S. median of $64,730. Figure 1-11 below shows the median household income of the region by census tract.

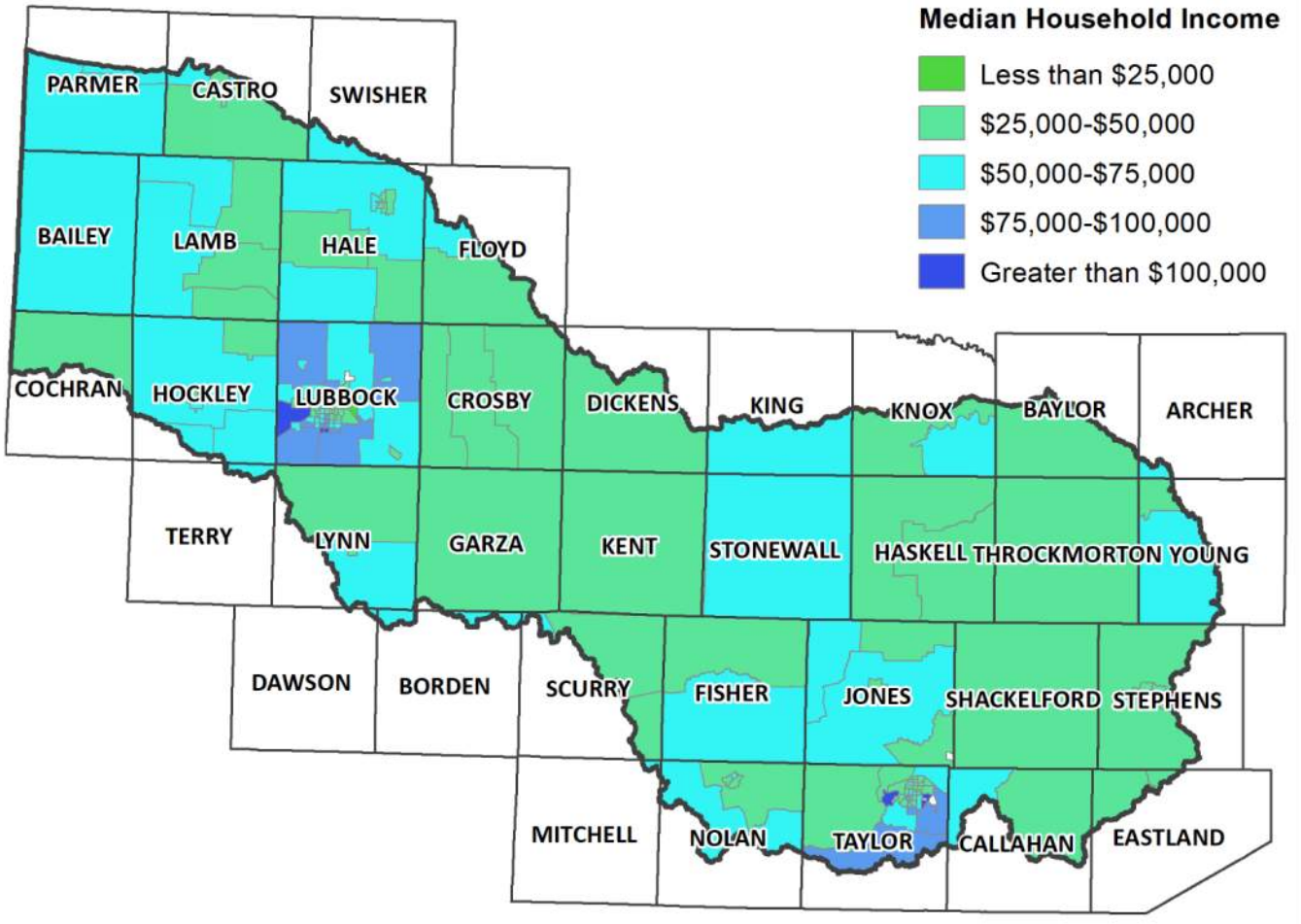


FIGURE 1-11 MEDIAN HOUSEHOLD INCOME BY CENSUS TRACT

Social Vulnerability Analysis

When anticipating the likely extent of damages to a community from catastrophic floods, this assessment first considers “exposure” based on geographic location of people and property. Another important dimension to consider is each community’s relative “vulnerability” to floods when they do occur. Disasters affect different people or groups in different ways, which range from their ability to evacuate an area in harm’s way, to the likelihood of damage to their homes and properties, to their capacity to marshal the financial resources needed to recover and rebuild after a storm.

These factors are evaluated to determine an area's Social Vulnerability, which measures a person's or group's capacity to anticipate, cope with, resist, and recover from the impacts of a natural hazard, based on their relative vulnerability. The Social Vulnerability Index (SVI) is a standard system for assigning a Social Vulnerability score at a census-tract basis created by the Centers for Disease Control. SVI ranks census tracts on 15 social factors, including unemployment, minority status, and disability, and further groups them into four related themes. A score of 0.75 or greater indicates that a community is highly vulnerable to impacts from a natural disaster. Figure 1-12 below shows the Social Vulnerability Index

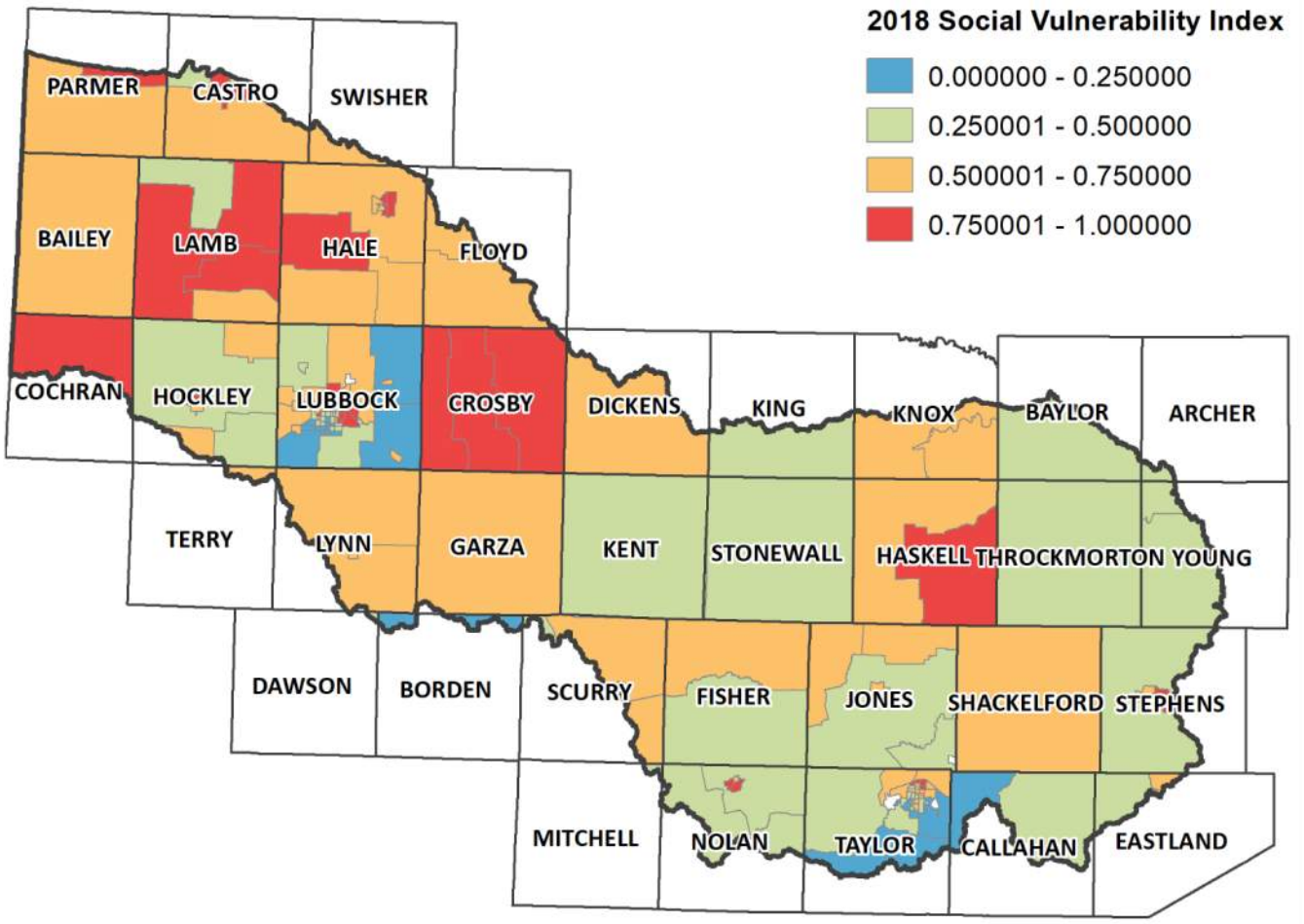


FIGURE 1-12 SOCIAL VULNERABILITY INDEX BY CENSUS TRACT

Political Subdivisions with Flood Related Authority

There are a total of 140 political subdivisions in Region 7 with flood related authority. This section provides a characterization of what entities comprise the political subdivision with flood related authority in Region 7 and a summary of the existing flood plans currently in place within Region 7. The political subdivisions include 36 counties, 81 municipalities, and 24 other entities. The other entities are comprised of water authorities, districts, council of governments, and commissions. Table 1-5 includes a list of all the political subdivisions in Region 7 with flood related authority.

TABLE 1-5 POLITICAL SUBDIVISIONS IN REGION 7 WITH FLOOD RELATED AUTHORITY

Counties					
Archer	Cochran	Floyd	Kent	Mitchell	Stonewall
Bailey	Crosby	Garza	King	Nolan	Swisher
Baylor	Dawson	Hale	Knox	Parmer	Taylor
Borden	Dickens	Haskell	Lamb	Scurry	Terry
Callahan	Eastland	Hockley	Lubbock	Shackelford	Throckmorton
Castro	Fisher	Jones	Lynn	Stephens	Young
Municipalities					
Abernathy	Clyde	Idalou	Muleshoe	Ransom Canyon	Stamford
Abilene	Crosbyton	Impact	Munday	Roby	Sudan
Albany	Dickens	Jayton	New Deal	Rochester	Sweetwater
Amherst	Dimmitt	Knox City	New Home	Ropesville	Tahoka
Anson	Earth	Levelland	Newcastle	Roscoe	Throckmorton
Anton	Edmonson	Littlefield	O'Brien	Rotan	Trent
Aspermont	Farwell	Lockney	Olton	Rule	Tuscola
Baird	Floydada	Lorenzo	Opdyke West	Seymour	Tye
Benjamin	Goree	Lubbock	Petersburg	Shallowater	Weinert
Bovina	Hale Center	Lueders	Plainview	Slaton	Whiteface
Breckenridge	Hamlin	Megargel	Post	Smyer	Wilson
Buffalo Gap	Hart	Merkel	Putnam	Springlake	Wolfforth
Buffalo Springs	Haskell	Moran	Ralls	Spur	Woodson
Cisco	Hawley	Morton			

Other	
Brazos River Authority	Nortex Regional Planning Commission
Canadian River Municipal Water Authority	Panhandle Regional Planning Commission
Dickens County WCID 1	Permian Basin Regional Planning Commission
Fort Griffin Special Utility District	Red River Authority of Texas
Haskell County Water Supply District 1	Rotan Municipal Water Authority
Knox County Drainage District 1	Salt Fork Water Quality District
Knox County WCID 1	South Plains Association of Governments
Lake Alan Henry Water District	Stonewall County WCID 1
Lower Colorado River Authority	Tuscola - Taylor County WCID 1
Lubbock County WCID 1	West Central Texas Council of Governments
Lytle Lake WCID	West Central Texas Municipal Water District
North Central Texas Municipal Water Authority	White River Municipal Water District

Summary of Existing Flood Plans and Regulations

The entities in Region 7 have varying levels of flood planning and regulation activities. Through surveys of the entities, 73% identified as having some floodplain management regulations. According to FEMA's list of National Flood Insurance Program (NFIP) participating communities, 80% of the region's entities participate in regular or emergency capacity. Figure 1-13 identifies communities participating in the NFIP. Of the entities in Region 7 that have flood related authority only Abilene and Lubbock have adopted and enforce local flood planning regulations and design criteria.

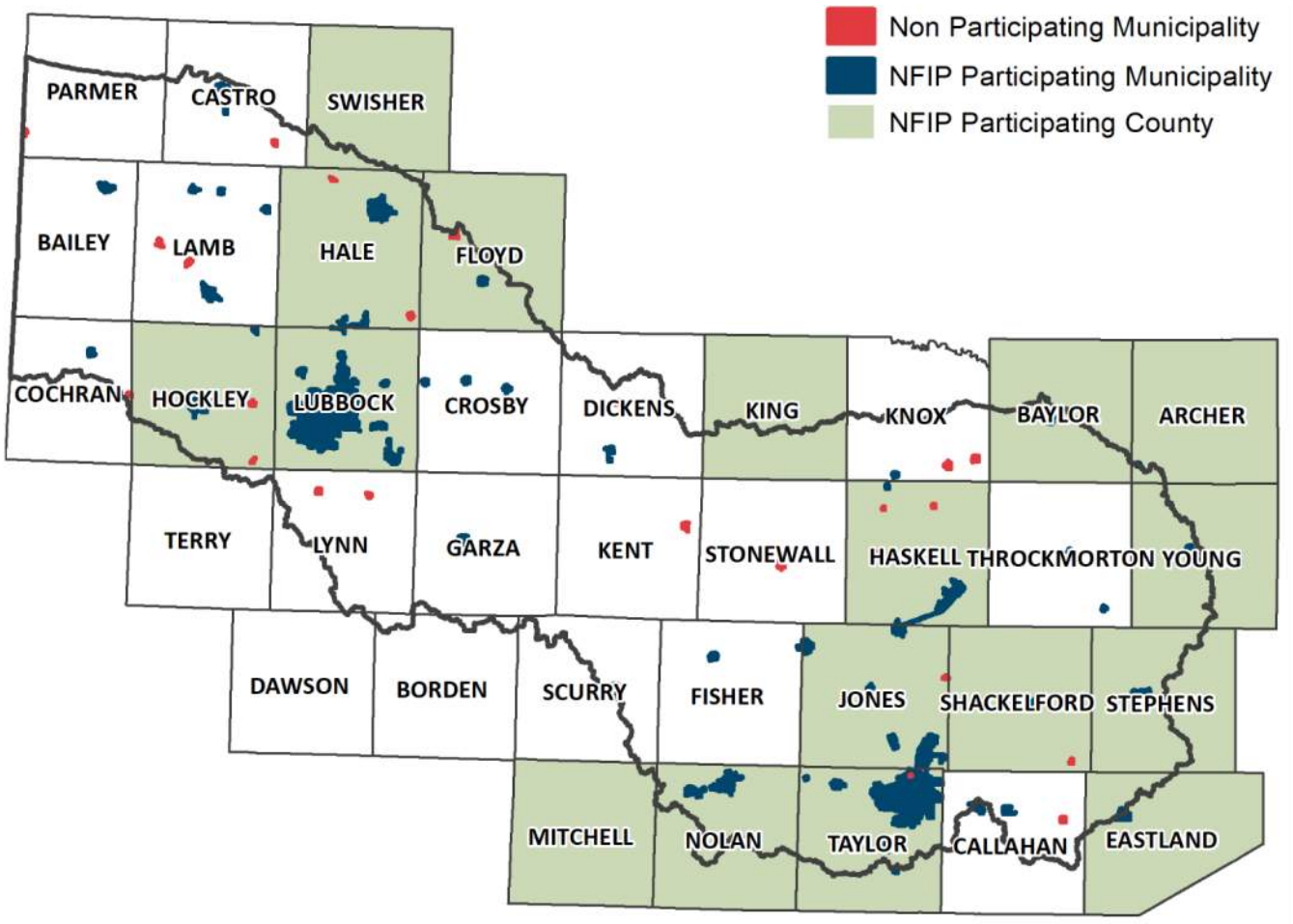


FIGURE 1-13 NFIP PARTICIPATION

Flood Prone Areas & Flood Risks to Life and Property

One of the goals of the regional flood planning process in Texas is to better understand and manage flood risk. Better management of flood risk will provide for better means to mitigate loss of life and property from flooding. This section establishes a baseline of what is known with respect to the area's exposure to flood hazards, as well as the vulnerability of the communities within Region 7. This is a critical step in reducing the vulnerability of the region's people and places to future flooding.

Identification of Flood Prone Areas

The NFIP mapping for Region 7 is limited. With a limited amount of regulatory floodplain mapping, additional data sources are required to identify the flood risk extents. Based on the available floodplain mapping, approximately 6% of the total area in the region is within the 1 percent annual chance event (ACE) flood plains. The 1% annual chance storm event correlates to a 1% annual risk of loss. TWDB has also provided Floodplain Quilt data to each of the basins to be used for better identifying flood risk extents. The Floodplain Quilt consists of multiple layers of data from various sources available throughout the state to 'quilt' together a single flood hazard dataset. The Quilt is only the starting point of flood hazard data for Region 7. RFPGs will need to review, reprioritize and update quilt data as appropriate by location and incorporate additional information as it becomes available. The Floodplain Quilt for Region 7 is shown in Figure 1-14**.** The RFPG collected additional information on flood-prone areas from the communities and the public. Additional information on this process and resultant flood risk areas are discussed in Task 2.

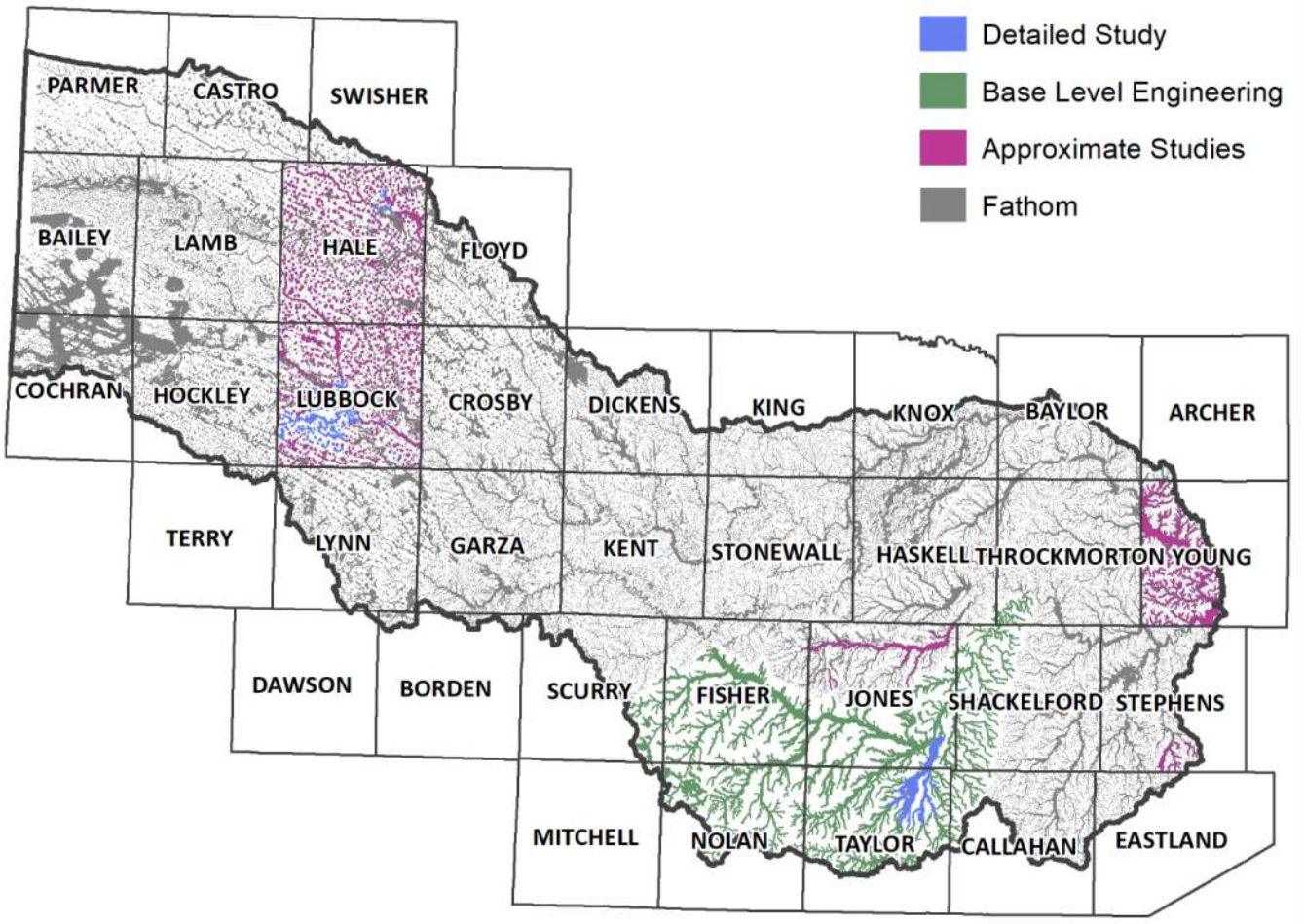


FIGURE 1-14 REGION 7 FLOODPLAIN QUILT

Rates of NFIP Participation & Flood Related Planning Activities

Of the counties, municipalities, and other entities in Region 7 identified as having flood-related authority, only half participate in the National Flood Insurance Program (NFIP). Figure 1-13 shows the participating entities within Region 7. Within Region 7, 47% of counties and 64% of cities participate in the NFIP. Low participation rates in the NFIP limit the abilities of some of the communities to recover economically in the event of a major flood event.

Agricultural and Natural Resources Most Impacted by Flooding

With a large portion of Region 7 being rural and agricultural, flash flooding and prolonged rain events can have a significant impact on livestock and crop production. While timely rains can be very beneficial for crop production during growing seasons, flash flooding can delay and sometimes prevent farmers from harvesting crops when needed. Similarly, livestock production can be largely affected by flash flooding. With crop production and livestock being major economic factors in the region, flash flooding and prolonged rain events can have huge impacts on the economy of the Upper Brazos region that then ripple to the rest of the state. Oil & gas production is also a large economic factor in Region 7 and for the entire state of Texas. Flash flooding and flood events can have an impact on the production and supply of oil & gas for the region and the state.

Key Historical Flood Events

With much of Region 7 in West Texas and further away from the coast, Region 7 has seen fewer flooding events compared to other basins that are in areas prone to hurricanes and other severe storms that have resulted in disaster declarations. However, the Upper Brazos basin has experienced significant flooding due to flash flooding and prolonged rain events. According to the FEMA disaster declaration[6] database, there have been 12 disaster declarations in Region 7 directly related to flooding since 1980. A list of disaster declarations resulting from flooding and the counties affected in Region 7 over the period from 1980 to 2021 is shown in Table 1-6.

[6] FEMA. 2021. All Disasters Declarations: https://www.fema.gov/disaster/declarations

TABLE 1-6 FEMA DISASTER DECLARATIONS FOR FLOODING

Disaster Declaration	Declaration Date	Declaration Description	Affected Counties in Region 7
DR-828-TX	May 19, 1989	Severe Storms, Tornadoes, Flooding	Archer, Baylor, Hale, Knox, Lubbock, Taylor, Young
DR-863-TX	May 2, 1990	Flooding, Severe Storm, Tornado	Archer, Callahan, Eastland, Jones, Shackelford, Taylor, Throckmorton, Young
DR-930-TX	December 26, 1991	Severe Storms, Thunderstorms	Callahan, Eastland, Jones
DR-1179-TX	July 7, 1997	Severe Storms and Flooding	Eastland
DR-1425-TX	July 2, 2002	Severe Storms and Flooding	Callahan, Eastland
DR-1696-TX	May 1, 2007	Severe Storms and Tornadoes	Swisher
DR-1709-TX	June 29, 2007	Severe Storms, Tornadoes, and Flooding	Archer, Baylor, Callahan, Eastland, Haskell, Jones, Shackelford, Stephens, Taylor, Throckmorton
DR-1730-TX	October 2, 2007	Tropical Storm Erin	Jones, Taylor
DR-4223-TX	May 29, 2015	Severe Storms, Tornadoes, Straight-line Winds and Flooding	Archer, Baylor, Callahan, Dickens, Eastland, Garza, Jones, Lubbock, Lynn, Throckmorton, Young
DR-4269-TX	April 25, 2016	Severe Storms and Flooding	Callahan, Jones
DR-4272-TX	June 11, 2016	Severe Storms and Flooding	Callahan, Eastland, Fisher, Stephens, Throckmorton
DR-4416-TX	February 25, 2019	Severe Storms and Flooding	Archer, Baylor, Callahan, Haskell, Jones, Knox, Nolan, Throckmorton

Past Casualties and Property Damage

In a major flood event, there are often losses of life and damages to property. In Region 7, since 2000 there have been a total of 5 deaths and no injuries reported as direct results of a flood events. Within the same period there were multiple reported losses to property. Property damage losses throughout Region 7 amounted to $133,690,800. Table 1-7 provides a summary of events, deaths, injuries and reported property damages for each county in Region 7 from 2000 to 2021. The data were taken from the National Oceanic and Atmospheric Administration (NOAA) National Centers for Environmental Information (NCEI)[7] storm events database.

[7] NOAA. 2021. National Centers for Environmental Information. Storm Events Database: https://www.ncdc.noaa.gov/stormevents/choosedates.jsp?statefips=48%2CTEXAS

TABLE 1-7 TOTAL EVENTS, CASUALTIES, AND PROPERTY DAMAGE (2000-2021)

County	Total Events	Deaths Direct	Injuries Direct	Reported Property Damage
Archer	16	0	0	$15,000
Bailey	18	0	0	$25,000
Baylor	9	0	0	$0
Borden	12	0	0	$15,400
Callahan	19	0	0	$2,019,000
Castro	16	0	0	$40,000
Cochran	4	0	0	$110,000
Crosby	13	0	0	$131,000
Dawson	34	0	0	$20,386,000
Dickens	7	0	0	$0
Eastland	18	0	0	$1,396,000
Fisher	23	0	0	$36,000
Floyd	15	0	0	$225,000
Garza	17	0	0	$1,915,000
Hale	23	0	0	$1,281,000
Haskell	19	0	0	$3,400,000
Hockley	32	0	0	$445,000
Jones	25	2	0	$32,250,000
Kent	4	0	0	$0
King	1	0	0	$0
Knox	11	0	0	$100,000
Lamb	13	0	0	$83,000
Lubbock	46	0	0	$27,098,000
Lynn	28	0	0	$2,872,000
Mitchell	38	0	0	$66,600
Nolan	17	0	0	$1,100,000
Parmer	7	0	0	$0
Scurry	38	0	0	$142,300
Shackelford	8	1	0	$3,011,000
Stephens	16	1	0	$235,000
Stonewall	4	0	0	$0
Swisher	12	0	0	$500,000
Taylor	47	1	0	$33,002,000
Terry	14	0	0	$650,000
Throckmorton	11	0	0	$860,000
Young	30	0	0	$281,500
Total		**5**	**0**	**$133,690,800**

Past Losses for Farming & Ranching

Crop production is an important economic factor in Region 7. The counties in Region 7 account for approximately half of the State's production of cotton and sorghum, one-third of the of the State's production of peanuts and barley, and one-fourth of the State's production of wheat. The reported losses to crops due to flooding in Region 7 since 2000 amounted to $380,867,700. Table 1-8 summarizes the crop damages by county within Region 7 from 2000 to 2021. The data were taken from the NOAA-NCEI storm events database.

TABLE 1-8 TOTAL VALUE OF REPORTED CROP DAMAGE (2000-2021)

County	Total Events	Reported Crop Damage	County	Total Events	Reported Crop Damage
Archer	16	$0	**Kent**	4	$0
Bailey	18	$250,000	**King**	1	$0
Baylor	9	$0	**Knox**	11	$0
Borden	12	$0	**Lamb**	13	$850,000
Callahan	19	$0	**Lubbock**	46	$116,525,000
Castro	16	$350,000	**Lynn**	28	$256,450,000
Cochran	4	$500,000	**Mitchell**	38	$0
Crosby	13	$2,000,000	**Nolan**	17	$0
Dawson	34	$250,000	**Parmer**	7	$0
Dickens	7	$1,000,000	**Scurry**	38	$70,000
Eastland	18	$31,000	**Shackelford**	8	$0
Fisher	23	$0	**Stephens**	16	$0
Floyd	15	$1,000,000	**Stonewall**	4	$0
Garza	17	$50,700	**Swisher**	12	$350,000
Hale	23	$650,000	**Taylor**	47	$0
Haskell	19	$0	**Terry**	14	$250,000
Hockley	32	$291,000	**Throckmorton**	11	$0
Jones	25	$0	**Young**	30	$0
Total					**$380,867,700**

Location of Critical Assets

Critical assets are an important consideration for flood risk evaluation. The numbers of critical assets broken down by classification for Region 7 are shown in Table 1-9. The classifications of critical assets include facilities such as hospitals, fire stations, police stations, storage of critical records, water and wastewater treatment plants, and similar facilities. Figure 1-15 shows a density map of the number of critical facilities across the region.

TABLE 1-9 SUMMARY OF CRITICAL FACILITIES AT RISK

Critical Facility	Totals
Medical	30
Emergency Services (EMS, Fire, Police)	30
Schools (K-12)	30
Infrastructure	39
Other	18

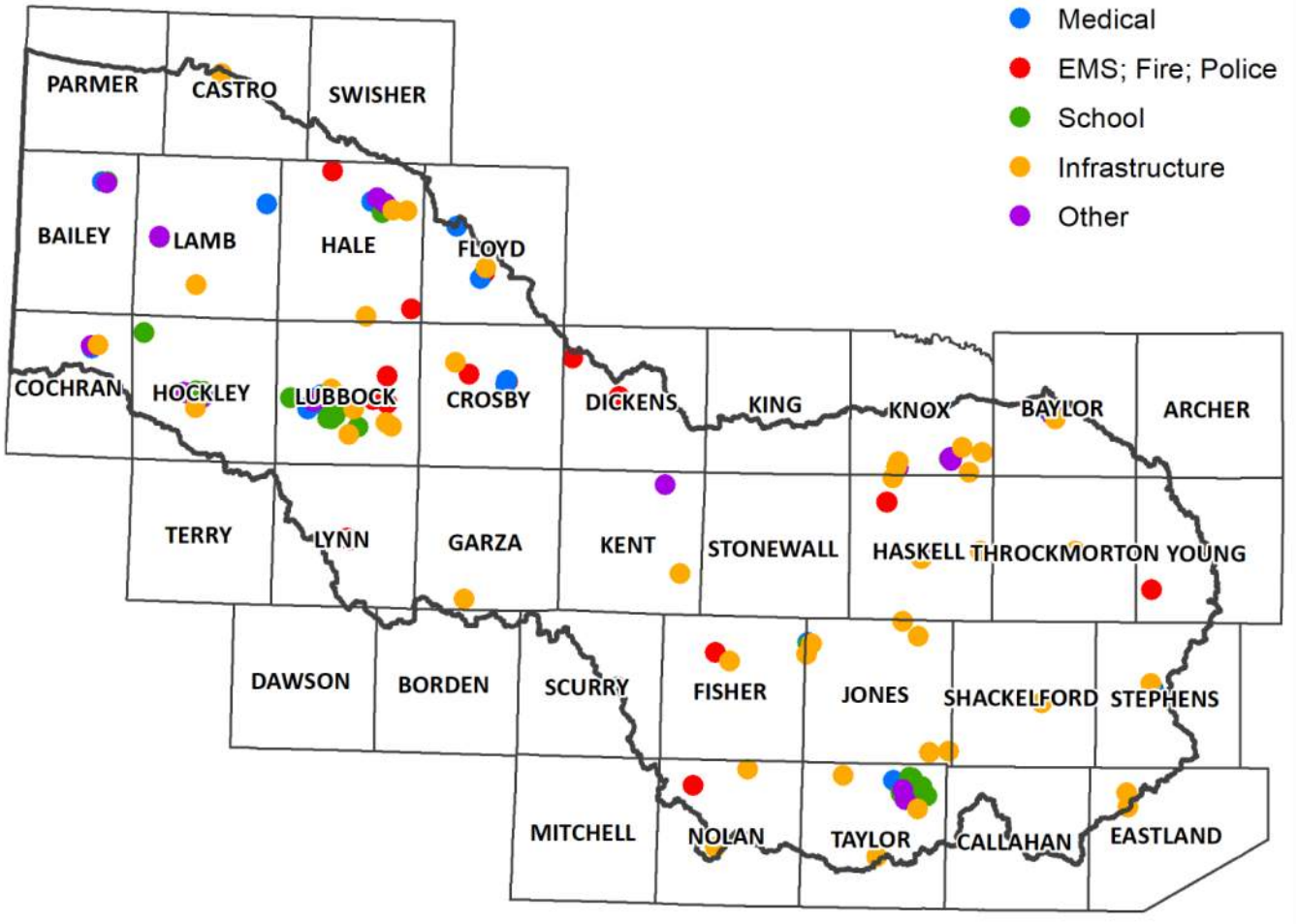


FIGURE 1-15 CRITICAL FACILITIES AT RISK

Assessment of Flood Infrastructure

Region 7 is uniquely divided into two subregions with distinct topography for each subregion. The distinct topographies correlate to unique flood infrastructure for each of the two subregions. The upper region of the basin that includes the counties of the Llano Estacado is dominated by playa systems, while the lower region of the basin that includes the counties in the Rolling Plains is comprised primarily of rivers, streams, and lakes. Each of the regions' distinct flood infrastructure features play an integral role in managing flood risk for Region 7. This section provides an overview of both the natural and

constructed flood infrastructure in Region 7. The natural and constructed features found in the Upper Brazos basin include the following:

- Rivers and tributaries,
- Wetlands,
- Playas,
- Dams,
- Detention and retention ponds,
- Storm drains systems,
- Roadway Crossings, and
- Agriculture Features

TWDB provided several data sources to assist with the identification of flood management infrastructure in the TWDB's Flood Data Hub. There were also several questions posed in a data collection survey to the communities and public that were used to complement the information provided by existing data sources to create a more complete picture of how communities in the region protect themselves from flood risk. The flood infrastructure presented in this report considered all major public infrastructure collected in the data collection phase. The definition of "major" and "minor" infrastructure was left up to each regional flood planning group to define. The flood infrastructure features in Region 7 and the criteria that were used to define minor flood infrastructure are shown in Table 1-10.

TABLE 1-10 REGION 7 MINOR FLOOD INFRASTRUCTURE CRITERIA

Flood Infrastructure Feature	Criteria for "Minor" Infrastructure
Rivers and Tributaries	All unnamed features
Wetlands	Stock ponds and riverine wetlands
Playas	All playas with available storage less than 10 acre-ft
Dams	Privately owned and non-regulated dams
Detention and Retention Ponds	Ponds that are not regional detention and retention ponds
Storm Drains	Storm drains with diameter less than 24 inches
Culverts	Llano Estacado subregion - diameter less than 48 inches Rolling Plains Subregion - less than bridge class culvert
Farm, Ranch, and Ag Related	Dams, levees, stock ponds, and weir diversion channels

A comprehensive inventory of existing flood infrastructure is provided in the TWBD-required format as Appendix B Required Table 1. This inventory serves as the basis for several tables, charts, and summary figures provided in this section. Due to the scale of this assessment, the plan includes only major flood infrastructure, for example regional detention facilities but not small stock ponds servicing individual properties. The existing flood infrastructure features are shown on the Appendix A Required Map 1 for each individual county in Region 7.

Natural Features

Natural features in Region 7 include rivers, tributaries, ponds, wetlands, and playas. The natural features for Region 7 are shown in Figure 1-16 and are described further below. Natural features are also shown in detail on Appendix A Required Map 1.

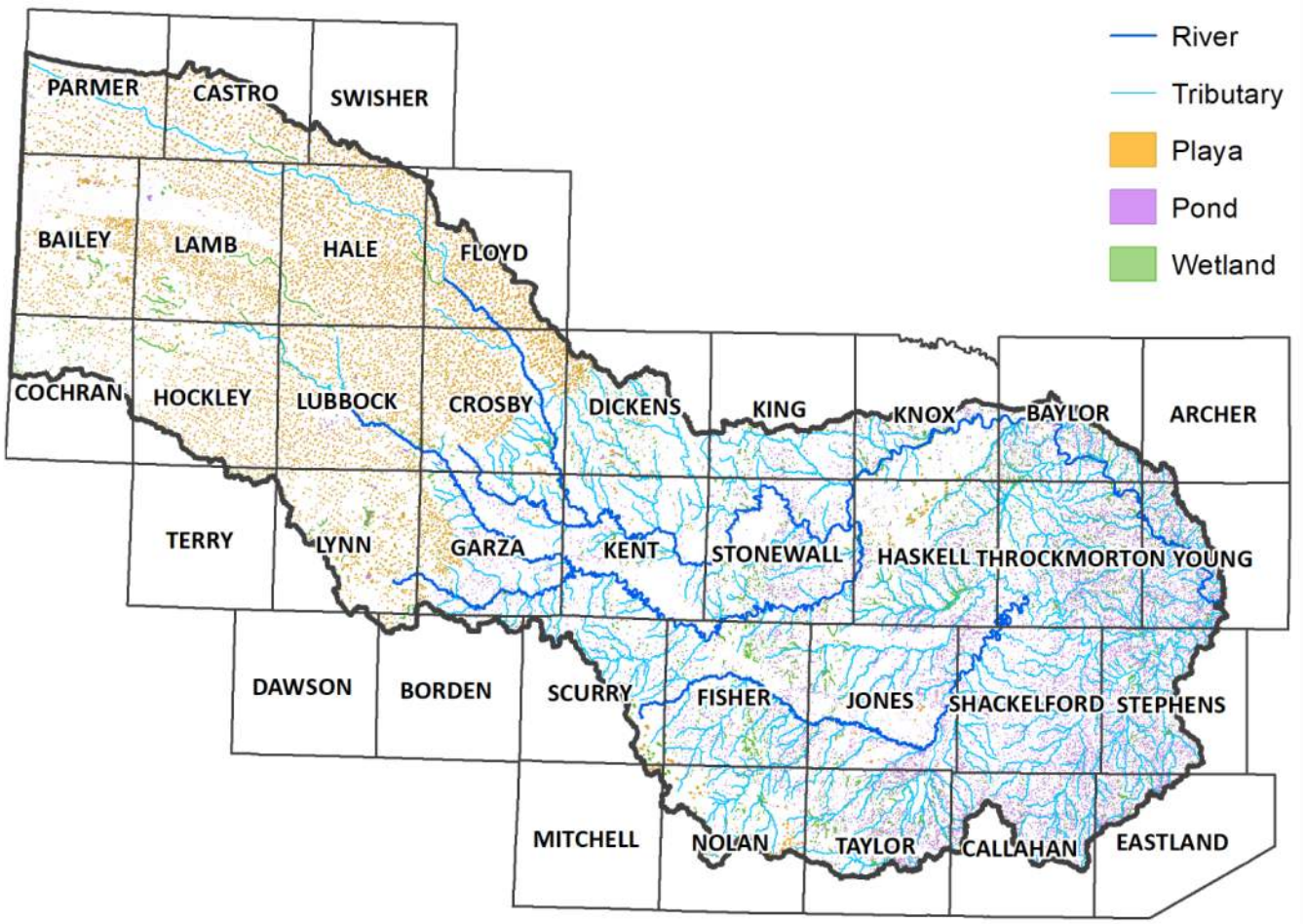


FIGURE 1-16 NATURAL FLOOD INFRASTRUCTURE FEATURES

Natural flood features serve a critical role in ecological health. Region 7 incorporates the critical habitat for the endangered Smalleye Shiner *Notropis bucculo* and Sharpnose Shiner *Notropis oxyrhynchus*. Both fish are broadcast spanners and require unobstructed, wide, flowing river segment lengths greater than 170 miles to support development of their early life stages. Freshwater mussels are another species that are impacted from streambed modifications. TPWD works with agencies and consultants across the state on construction projects impacting bed and banks to reduce impacts to Texas' unique freshwater mussel species. The Brazos Basin also includes two species that are currently under review for federal listing, and one is located within the Region7's boundaries, the Texas Fawnsfoot *Truncilla macrodon*.

Rivers and Tributaries

Many of the streams and tributaries that form the Brazos River have their origins, often from springs, near the Caprock Escarpment in Lubbock, Lynn, Floyd, Crosby, and Garza counties. The Caprock Escarpment is the geographical transition point between the relatively level Southern High Plains of the Llano Estacado and the Rolling Plains. The streams and tributaries flow into the Salt Fork and Double Mountain Fork branches of the Brazos River and eventually combine to form the Brazos River in Stonewall County. There are approximately 500 named rivers, creeks, and channels in Region 7.

Playas

Playas are shallow, circular-shaped ephemeral wetlands that are primarily filled by rainfall, although some playas found in cropland settings may also receive water from irrigation runoff. Playas are arguably the most significant ecological feature in the Texas High Plains, even though they cover only 2% of the region's landscape. There are over 25,000 playas located in Region 7 with most of the playas located on the Caprock in the Llano Estacado subregion of Region 7. The playas are a unique flood infrastructure feature for this region as well as the Upper Red River region, and the playas play an integral role in mitigating flood risk for Region 7.

Playas are generally classified in two categories, Overflow and Non-Overflow, dependent on the overflow characteristics of the playa. A non-overflow playa is often defined as a playa with storage volume sufficient to completely contain the combined runoff from its subbasin's initial condition runoff, its contributing 1% annual chance storm event runoff. The playa may experience overflow discharge during a 0.2% annual chance storm event. An overflow playa is often defined as a playa with storage volume that is NOT sufficient to completely contain the combined runoff from its subbasin's initial condition runoff and contributing 1% annual chance storm event runoff. For overflow playas, the calculated water surface elevation in the playa is greater than the playa's natural overflow elevation. Overflow routes for playas are those conveyance areas that allow discharges from one playa to flow to the next downstream playa. Overflow routes become an import part of the drainage system in this region as they allow runoff to travel downstream and create playa systems.

The City of Lubbock recently completed construction of Phase 3 of a multi-phase stormwater collection system project that strategically collects runoff from playas within the City of Lubbock, restoring capacity to the playas and conveying stormwater flows east to the Yellow House Draw.

Wetlands

The non-playa wetlands in Region 7 are primarily located along the rivers, streams, and tributaries in the region. The wetlands in the region comprise over 3,699 acres and cover the largest amount of area for flood infrastructure in Region 7. However, the wetlands have a minor role in mitigating flood risk and providing flood protection in Region 7. While wetlands do not have a major role providing flood protection, wetlands play an important role in water quality and recharge to aquifers.

Constructed Flood Infrastructure

There are many types of flood infrastructure that can be constructed by municipalities, counties, and other flood authority entities to mitigate the risk and effects of a flood event. The constructed flood infrastructure most found in Region 7 are dams, lakes and reservoirs, storm drain systems and detention and retention ponds. The constructed flood infrastructure features in Region 7 are shown in Figure 1-17 and are described further below.

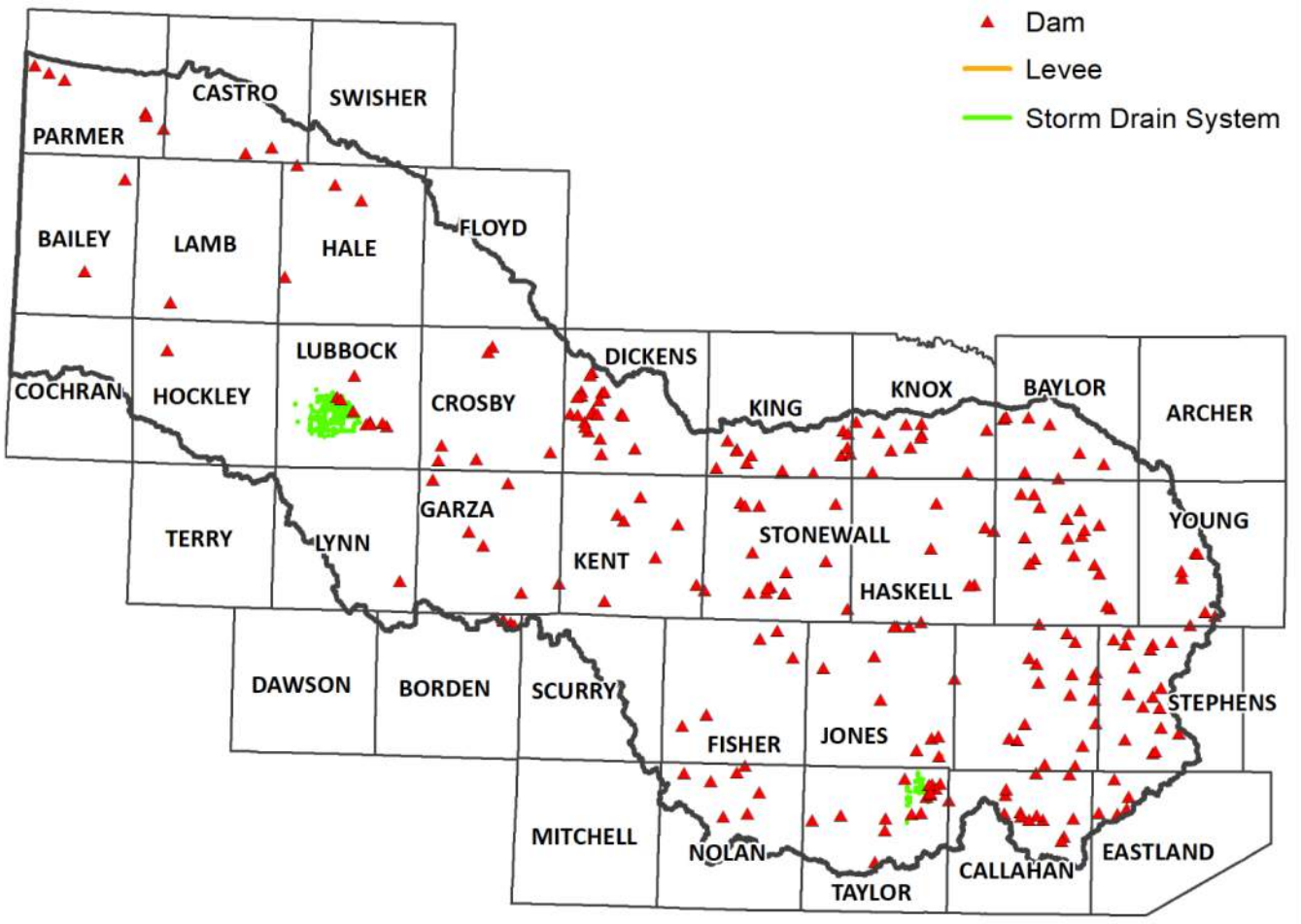


FIGURE 1-17 CONSTRUCTED FLOOD INFRASTRUCTURE FEATURES

Dams

Dams in Texas provide water storage to serve many purposes including recreation, flood risk mitigation, irrigation, water supply, and fire protection, among others. About 30% of the state's dams intended use are for flood risk mitigation and one in seven dams are for irrigation or water supply. There are 240 dams located in Region 7, with 23 classified as flood control dams.

The National Inventory of Dams (NID)[8] is a website-hosted database maintained by the USACE. Information on the webpage includes location and age of dams. Some features contain even more detailed information. The NID shows 240 dams in Region 7. Over 90 of those dams are regulated by the State of Texas. Figure 1-17 shows the dams and other infrastructure features in Region 7 while Table 1-11 shows a quantification of dams in Region 7 by county.

[8] USACE. 2020. Dams of Texas: https://nid.usace.army.mil/#/

TABLE 1-11 QUANTIFICATION OF DAMS IN REGION 7 BY COUNTY

County	Dams within County Limits	Avg Age of Dams (yrs)	County	Dams within County Limits	Avg Age of Dams (yrs)
Archer	-	-	**Kent**	8	67
Bailey	2	58	**King**	12	70
Baylor	8	53	**Knox**	11	61
Borden	4	60	**Lamb**	1	86
Callahan	13	66	**Lubbock**	7	52
Castro	2	59	**Lynn**	1	70
Cochran	-	-	**Mitchell**	-	-
Crosby	6	59	**Nolan**	7	78
Dawson	-	-	**Parmer**	6	50
Dickens	21	55	**Scurry**	-	-
Eastland	5	83	**Shackelford**	18	68
Fisher	5	70	**Stephens**	17	83
Floyd	-	-	**Stonewall**	14	62
Garza	6	68	**Swisher**	-	-
Hale	4	48	**Taylor**	15	79
Haskell	7	80	**Terry**	-	-
Hockley	1	88	**Throckmorton**	18	67
Jones	11	83	**Young**	7	80

Twenty-three of the flood control dams are classified as high hazard dams. Texas Administrative Code §299.14 defines hazard classification criteria for the state of Texas. Dams are classified for hazard based on either potential loss of human life or property damage in the event of malfunction or failure. The classification in §299.14 includes criteria for Low, Significant, and High hazard dams.

1) Low. A dam in the low-hazard potential category has:
   a) no loss of human life expected (no permanent habitable structures in the breach inundation area downstream of the dam); and
   b) minimal economic loss (located primarily in rural areas where failure may damage occasional farm buildings, limited agricultural improvements, and minor highways as defined in §299.2(38) of this title (relating to Definitions)).
2) Significant. A dam in the significant-hazard potential category has:
   a) loss of human life possible (one to six lives or one or two habitable structures in the breach inundation area downstream of the dam); or
   b) appreciable economic loss, located primarily in rural areas where failure may cause:
      i) damage to isolated homes;
      ii) damage to secondary highways as defined in §299.2(58);
      iii) damage to minor railroads; or
      iv) interruption of service or use of public utilities, including the design purpose of the utility.

3) High. A dam in the high-hazard potential category has:
   a) loss of life expected (seven or more lives or three or more habitable structures in the breach inundation area downstream of the dam); or
   b) excessive economic loss, located primarily in or near urban areas where failure would be expected to cause extensive damage to:
      i) public facilities;
      ii) agricultural, industrial, or commercial facilities;
      iii) public utilities, including the design purpose of the utility;
      iv) main highways as defined in §299.2(33); or
      v) railroads used as a major transportation system.

Lakes and Reservoirs

There are ten major lakes and reservoirs located in Region 7. The lakes and reservoirs and the counties where they are located are shown in Table 1-12.

TABLE 1-12 LAKE AND RESERVOIRS IN REGION 7

Reservoir	County	Reservoir	County
Lake Alan Henry	Kent	Kirby Lake	Taylor
White River Reservoir	Crosby	Lake Fort Phantom Hill	Jones
Millers Creek Reservoir	Baylor/Throckmorton	Lake Stamford	Haskell
Lake Sweetwater	Nolan	Lake Cisco	Eastland
Lake Abilene	Taylor	Hubbard Creek Lake	Stephens

Roadway Crossings

The *Technical Guidelines* defines low water crossings as a roadway creek crossing that is subject to frequent inundation during storm events or subject to inundation during a 50% annual chance storm event (2-year) storm event. During the first planning cycle, the RFPGs have the flexibility to utilize the community's discretion to identify a roadway creek crossing as LWC. In Region 7, low water crossing data provided by communities through the RFPG's data collection efforts and by the TWDB (through TxDOT) were used to identify exposed road and railway crossings.

Storm Drain Systems

Storm drains are a common type of flood infrastructure utilized primarily in urbanized areas to collect and convey stormwater flows from populated areas to other manmade or natural flood infrastructure through underground pipes with inlets and outfalls. Due to the relatively flat topography the standard engineering design approach in the Upper Brazos region is to convey stormwater in the local streets to outfall points like playas, as there is frequently insufficient fall or cover to daylight a closed system. With Lubbock and Abilene being the only two large, urbanized cities located within Region 7, these are the only two cities that have constructed and are maintaining major storm drain systems.

Detention and Retention Ponds

Like the storm drain system, detention and retention ponds are common flood infrastructures utilized primarily in urbanized areas to mitigate stormwater flows from flash flooding and prolonged rain events. Detention ponds are designed to collect and release stormwater flows while retention ponds are designed to only collect stormwater flows. Abilene and Lubbock are the only cities in Region 7 that have required development within the city and ETJ to construct detention or retention ponds to mitigate stormwater flows. In some areas of the state, regional detention ponds are considered as a single facility that can accommodate detention from multiple developments. Most of the detention and retention ponds built within the City of Abilene are not regional ponds and do not meet the criteria for major flood infrastructure as established by this Upper Brazos RFPG. In November 2019, the City of Lubbock adopted new drainage design criteria that require stormwater detention for new development.

Condition and Functionality of Existing Infrastructure

TWDB has gathered spatial data to assist the RFPGs in a Flood Planning Data Hub. The Flood Planning Data Hub provided little information about the condition of the region's flood mitigation features. Participants in the data collection effort provided little information that could supplement the information provided by the TWDB initially. However, throughout Texas, flood infrastructure is rapidly aging and in need of repair.

A comprehensive inventory of existing flood infrastructure condition and functionality is provided in the TWBD-required format as Appendix B Required Table 1. The existing flood infrastructure features with known condition and functionality are shown on the Appendix A Required Map 3 for each individual county in Region 7. Where information is available, the following definitions of functional, non-functional, and deficient infrastructure have been used for this plan.

- Functional: The infrastructure is serving its intended design level of service.
- Non-Functional: The infrastructure not providing its intended or design level of service.
- Deficient: The infrastructure or natural feature is in poor structural or non-structural condition and needs replacement, restoration, or rehabilitation.

Dam Safety Assessment

The 2021 American Society of Professional Engineers Infrastructure Report Card[9] gave Texas a D+ for dams. The Infrastructure Report Card has collected estimates related to the costs of rehabbing dams in Texas. In 2019, the Association of State Dam Safety Officials (ASDSO) estimated the cost to rehabilitate all non-federal dams in Texas at around $5 billion. The Texas State Soil and Water Conservation Board (TSSWCB) estimates about $2.1 billion is needed to repair or rehabilitate dams included in the Small Watershed Programs. Of the 7,200 non-federal dams in our state, approximately 25% could result in loss

[9] ASCE. 2021. 2021 Texas Infrastructure Report Card: https://infrastructurereportcard.org/wp-content/uploads/2016/10/2021-Texas-Infrastructure-Report-Card.pdf

of life should they fail. More than 3,200 Texas dams are exempt from dam safety requirements by State legislation, which represents almost half of these dams.

Of the 240 dams identified in Region 7, the condition of 59 dams were collected from Texas Commission on Environmental Quality (TCEQ) inventory of state regulated dams. A total of 41 dams were identified as non-functional (not providing the intended level of service). A total of 18 dams were identified as being deficient (requiring replacement, restoration, or rehabilitation). These dams are listed as in poor condition by TCEQ regulations. Figure 1-18 shows the locations and condition of the dams in Region 7.

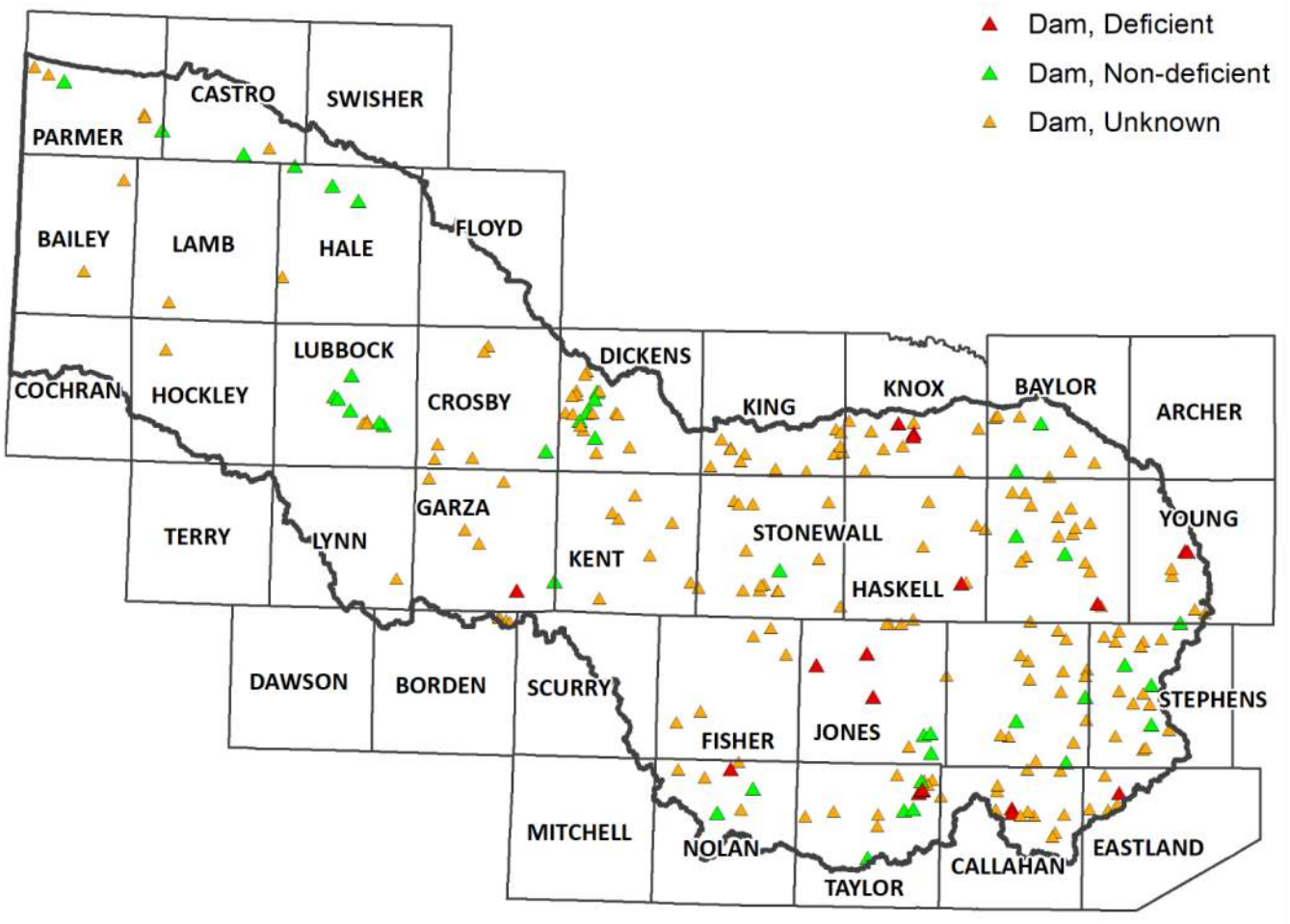


FIGURE 1-18 REGION 7 DAM CONDITION

Reasons for Functionality and Deficiency

A total of 18 dams were identified as being deficient based on their condition assessment by TCEQ. Additional information was requested on known functionality and condition of dams in the data collection survey. In 2015, the TCEQ performed a dam inspection of Abilene Dam at Lake Abilene. The TCEQ inspection report recommended repairs and maintenance of the dam to ensure the protection of human life and infrastructure. TPWD operates Abilene State Park immediately below the Abilene Dam making park visitor safety and infrastructure impacts from floods a top priority for TPWD operations. Through the draft plan comment period, TPWD expressed interest to working with the City of Abilene to

ensure maintenance and dam safety of Abilene Dam continues to progress. The state park also experiences consistent historical road closures during times of flooding. For example, in 2016, Park Road 32 near the entrance of Abilene State Park was washed out when water from the emergency spillway flowed down the tributary and across the road. In 2018, FM 89 and Park Road 32 were closed after heavy rain and releases from the spillway overtopped the roads. The emergency exit for the park is near the spillway and has almost flooded during past events.

As of January 2022, no additional information was available to prepare an assessment of flood infrastructure deficiencies or the reasons for these deficiencies. It is recommended that additional data sources and methodology to determine deficiencies be identified in the next cycle of the Flood Planning Process.

Playa Conservation Initiative

Of the more than 80,000 playa wetlands found in the North American Great Plains, approximately 25,000 are found in the Llano Estacado and Rolling Plains of Northwest Texas. Playa wetlands are ephemeral, clay-lined depressions ranging from a few acres to a couple of hundred acres in size and their inundation is solely dependent upon runoff from heavy rain events. Playas are instrumental in our stormwater system. Healthy playas are important for recharging the Ogallala Aquifer with clean water and they also provide vital habitat to an array of resident and migrating wildlife. Land use practices have greatly altered most of the playas in Texas, leading to permanent loss of functionality for many of these important wetlands. Realization of the mounting threats to playas, and correspondingly, the Ogallala Aquifer, led to the development of a partnership focused on restoring and conserving this valuable resource. The Texas Playa Conservation Initiative (TxPCI)[10] was founded in January 2015 to address playa resource concerns for the benefit of the Ogallala Aquifer, wildlife, and residents and producers in Texas' playa region.

The TxPCI is working to restore playas in the Panhandle region of Texas. The restoration facilitates the recharge of the Ogallala Aquifer, which has a major impact on natural water supply for the region. Healthy playas have higher infiltration rates, so this restoration has a positive impact on provision of storage volume for stormwater runoff as well. In Region 7, the TxPCI has identified 3,353 non-deficient (healthy) playas and 6,756 deficient playas, shown on Figure 1-19. The partnership has funded and coordinated restoration of over 1,100 acres to date and helps drive awareness and support from the many landowners across this area. Landowners who participate receive a one-time incentive payment per acre for restoring their playas so long as they agree not to re-pit (dig out) the playa for 10 years. This is a very landowner-friendly program that benefits the aquifer below the playa of the participating landowner. By having a healthy playa, they are doing the best thing they can do to help put clean water back into the aquifer below their land for their future use. Wildlife, including many game and non-game species, benefit from healthy playas as well.

[10] TxPCI. 2022. Texas Playa Conservation Initiative – Texan By Nature: https://texanbynature.org/projects/texas-playa-conservation-initiative/

The TxPCI goal is to create an abundance of healthy playa wetlands across the Texas Panhandle in order to benefit current and future residents and producers reliant on the Ogallala Aquifer. These efforts also support healthy populations of resident and migrating wildlife that depend on playa wetland habitat and the surrounding upland grasslands that encompass fully functioning playas. They work to do this by educating locals about playas and their link to a healthy ecosystem and to the sustainability and integrity of the Ogallala Aquifer. Currently, TxPCI is completing projects with private landowners that restore, conserve, and protect as many fully functioning playas as possible to help sustain residents and wildlife in the High Plains of Texas.

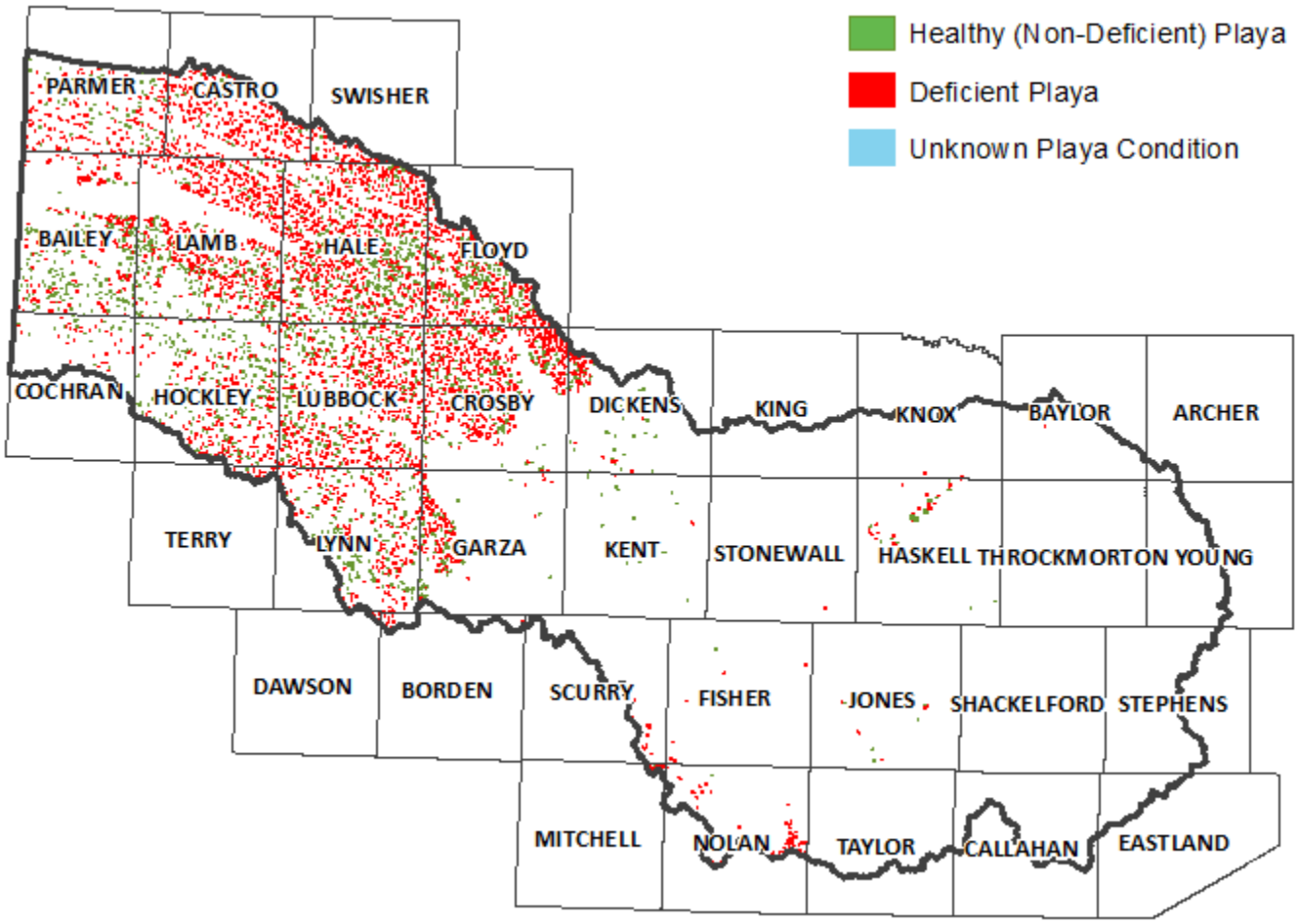


FIGURE 1-19 REGION 7 PLAYA CONDITION

TPWD supports and agrees that playas are one of the most significant ecological features in the Texas High Plains and supports the restoration of deficient playas and the collaborative work with the Texas Playa Conservation Initiative, landowners, and state and local agencies. Continued restoration and preservation of playas provides flood mitigation as well as wildlife habitat and supports aquifer recharge. The Playa Lakes Wildlife Management Area Dimmit Unit is in Castro County and includes 345 acres of farmland that has been planted with native grass and a 77-acre playa basin. The Wildlife Management Area was purchased in 1990 for the purpose of developing an area where soil, water, and wildlife conservation practices are implemented.

Flood Infrastructure Projects

A data request survey was sent out to all stakeholders located within Region 7 to collect information on all flood infrastructure projects within the basin that were in either the planning phase, design phase or construction phase. Stakeholders were also given the option to locate their projects on an interactive mapping tool on the region's website. In addition, the planning group gathered all the existing Hazard Mitigation Plans within Region 7 and evaluated the plans for any planned flood infrastructure projects. These projects are shown on the TWDB-required Appendix B Required Table 2 for Region 7. Table 1-13 lists the previous flood studies considered by the RFPG to be relevant to development of the RFP.

TABLE 1-13 LIST OF PREVIOUS FLOOD STUDIES RELEVANT TO THE RFP

Report Title	Sponsor Entity	Date
Abilene Master Drainage Plan	City of Abilene	2020
Lubbock Master Drainage Plan	City of Lubbock	1997
Lubbock MDP - Update	City of Lubbock	2010
Lubbock MDP – 5-Year CIP	City of Lubbock	2018
Lubbock MDP – Supplement	City of Lubbock	2018-2020
Lubbock System C	City of Lubbock	2019
NWLDIP Phase 3	City of Lubbock	2021
McAlister LOMR	City of Lubbock	2020
Upper Clear Fork Brazos Watershed BLE	FEMA	2017
Archer County HMAP	Nortex Regional Planning Commission	2020
Baylor County HMAP	Nortex Regional Planning Commission	2020
Lubbock County HMAP	Lubbock County	2015
Young County HMAP	Nortex Regional Planning Commission	2020
WCTCOG HMAP Planning Area 1-5	WCTCOG	2020
Archer County FIS	FEMA	2021
City of Albany FIS	FEMA	1986
City of Levelland FIS	FEMA	1990
City of Muleshoe FIS	FEMA	1989
City of Roscoe FIS	FEMA	1988
City of Snyder FIS	FEMA	1980
City of Sweetwater FIS	FEMA	1989
City of Throckmorton FIS	FEMA	1976
Dawson County FIS	FEMA	2011
Eastland County FIS	FEMA	1997
Fisher County FIS	FEMA	2011
Hale County FIS	FEMA	2011
Haskell County FIS	FEMA	1987
Jones County FIS	FEMA	2011

Report Title	Sponsor Entity	Date
Lubbock County FIS	FEMA	2017
Nolan County FIS	FEMA	1990
Stephens County FIS	FEMA	2019
Taylor County FIS	FEMA	2012
Young County FIS	FEMA	2019

Proposed or Ongoing Projects

The data request survey and interactive mapping tool for Region 7 resulted in 25 flood infrastructure projects being identified by the stakeholders in Region 7. Appendix A Map 2 shows the locations of the proposed or ongoing projects in the region.

One flood infrastructure project was identified in Region 7 as being under construction. The project is located in Hale County northwest of Plainview and includes the construction of flood protection dams. There were no nonstructural flood mitigation projects identified in Region 7 as being implemented.

Projects with Dedicated Funding

There is one project within Region 7 that has been identified as a structural flood mitigation project with dedicated funding and a planned completion date. The City of Abilene has identified a project from their Master Drainage Plan that would provide for modifications to the operations of Lake Abilene and Lake Kirby to improve flood control measures in the City. The modifications to the operations of Lake Abilene and Lake Kirby would include maintaining a flood storage capacity in the two reservoirs at an elevation below the existing conservation pool elevation to mitigate downstream flooding during a storm event. The amount of flood storage required to impact downstream flooding would be determined as part to the evaluation phase of the project. The City plans to fund the evaluation and design phases of the project with local funds. It is the City's intent to progress the design phase of the project to a 30% level in order for the project to be eligible for funding through TWDB's regional flood planning program. Table 1-14 summarizes the existing projects in Region 7.

TABLE 1-14 EXISTING PROJECTS

Project Name	Funding	Anticipated Benefit	Anticipated Completion
Abilene Buttonwillow Creek Crossing	Stormwater Fee (Partial)	Reduce road closures & restore emergency access	2022 (not funded)
Abilene Buttonwillow Upstream Detention	Stormwater Fee (Partial)	Reduce road closures & restore emergency access	2022 (not funded)
Abilene Catclaw Creek S. 11th to S. 7th	Stormwater Fee	Reduce peak flows, reduce repetitive loss claims, increase storage	2022 (rescheduled)
Abilene Downtown Railroad Underpasses	Stormwater Fee (Partial)	Supply warning signals at RR under passes. Reduce rescues from flooded vehicles	2022 (not funded)
Abilene Elm Creek Detention below Southwest Dr	Stormwater Fee (Partial)	Reduce peak flows in creek, reduce structural flooding, add detention.	2022 (not funded)

Project Name	Funding	Anticipated Benefit	Anticipated Completion
Abilene Elm Creek Diversion	Stormwater Fee (Partial)	Reduce peak flows & flooding	2022 (not funded)
Abilene Improve Curry Lane Detention Pond	Stormwater Fee (Partial)	Reduce peak flows, remove repetitive loss claims, increase storage	2022 (not funded)
Abilene Little Elm Creek at S. 7th Street	Stormwater Fee (Partial)	Reduce peak flows, reduce structural flooding, add detention	2022 (Rescheduled)
Abilene Operations of Lake Abilene	Stormwater Fee (Partial)	Reduce peak flows in creek, reduce structural flooding, add detention to city system.	2022 (Rescheduled)
Abilene Treadway and S. 27th Street	Stormwater Fee (Partial)	Reduce road closures, restore emergency access.	2022 (not funded)
City of Lubbock Flood Protection Planning for Watersheds	FIF	Update H&H models and maps. Identify flood risk and projects.	2024
City of Lubbock Northwest Drainage Improvements	CWSRF	Restore capacity within the playa lakes.	2022
Fisher County Flood Protection Dam	State, Federal, Taxes	Protect downstream City of Rotan	2024
Hamlin Dam Improvements	State, Federal, Taxes	Per TCEQ, Erosion and earthen stabilization needs	2024
Hamlin South Lake Dam Diversion	State, Federal, Taxes	Investigate diverting stormwater to improve LOS	2024
Idalou Playa Lake Improvements	City	Improve infiltration, re-establish vegetation	2024
Lake Alan Henry Dam Rehab	State, Federal, Taxes	Increase storage capacity.	2023
Lake Benjamin Improvements	State, Federal, Taxes	Stabilize the dam spillway and earthen side to prevent failure or a breech.	2024
Lake Stamford Improvements	State, Federal, Taxes	Improve spillway	2023
McMillan Dam Warning System	State, Federal, Taxes	Warn residents releases	2024
McMillian Dam High Risk Repairs	ARPA (Partial funding)	Rehab dam and spillway, Increase storage capacity	2024
Nolan County Warning System	State, Federal, Taxes	Prepare for disasters	2023
Parmer Buyout Program	State, Federal, Taxes	Buy out repetitive loss structures, expand the local playa and park	2023
Ransom Canyon Evacuation Route	HMAP Grant	Design and construct an evacuation route for residents below the dam	2024
Taylor County Gauge/ Flood Barrier Program	State, Federal, Taxes	Advance warning systems for river flows and overtopping	2024

Task 2. Flood Risk Analyses

An important aspect of developing an RFP involves an accurate assessment of the flood risk in the area. This assessment includes a description of the flood (flooding extents and depth of water), identification of what is at risk (natural and man-made features inside the possible flooding extents), and an estimation of the associated impacts (damage in terms of life, property damage, and/or public welfare).

In this RFP for Region 7, the existing and future conditions flood risk assessment focused on the three main components:

1. Flood hazard analysis to determine the location, magnitude, and frequency of flooding;
2. Flood exposure analysis to identify who and what might be harmed within the Upper Brazos Region; and
3. Vulnerability analysis to identify vulnerabilities of communities and critical facilities.

Task 2A examines the existing flood risks. Task 2B pertains to the future flood risks.

Task 2A. Existing Conditions Flood Risk Analyses

Existing Conditions Flood Hazard Analysis

In terms of flood risk analysis, the existing conditions assessment represents a current snapshot in time of certain elements that contribute to or protect from flooding. These conditions include current land use, estimated precipitation data, and constructed drainage-related infrastructure. These variable factors have the potential to change in the future, which will be discussed in Task 2B. The following summarizes the RFPG's assessment of these three current condition factors.

Land Use

Land use is the spatial and visual representation of features generally seen on the surface of a given area. Land use is an important factor in determining the propensity for flooding in existing conditions. Land use affects the hydrologic processes such as evaporation, natural flow paths, and rain infiltration into the soil. As urban development (characterized by impervious area) increases in a watershed, the hydrologic response of the land changes, and surface runoff often increases.

As detailed in Task 1, most of the urban development in Region 7 is located in and around the existing population centers, most notably the City of Lubbock in Lubbock County and the City of Abilene in Taylor County. On the Caprock, outside of the population centers, the land use is dominated by farming and agricultural land use. However, off the Caprock, the land use is a mix of agriculture and shrubland. Figure 2-1 shows the land use across Region 7.

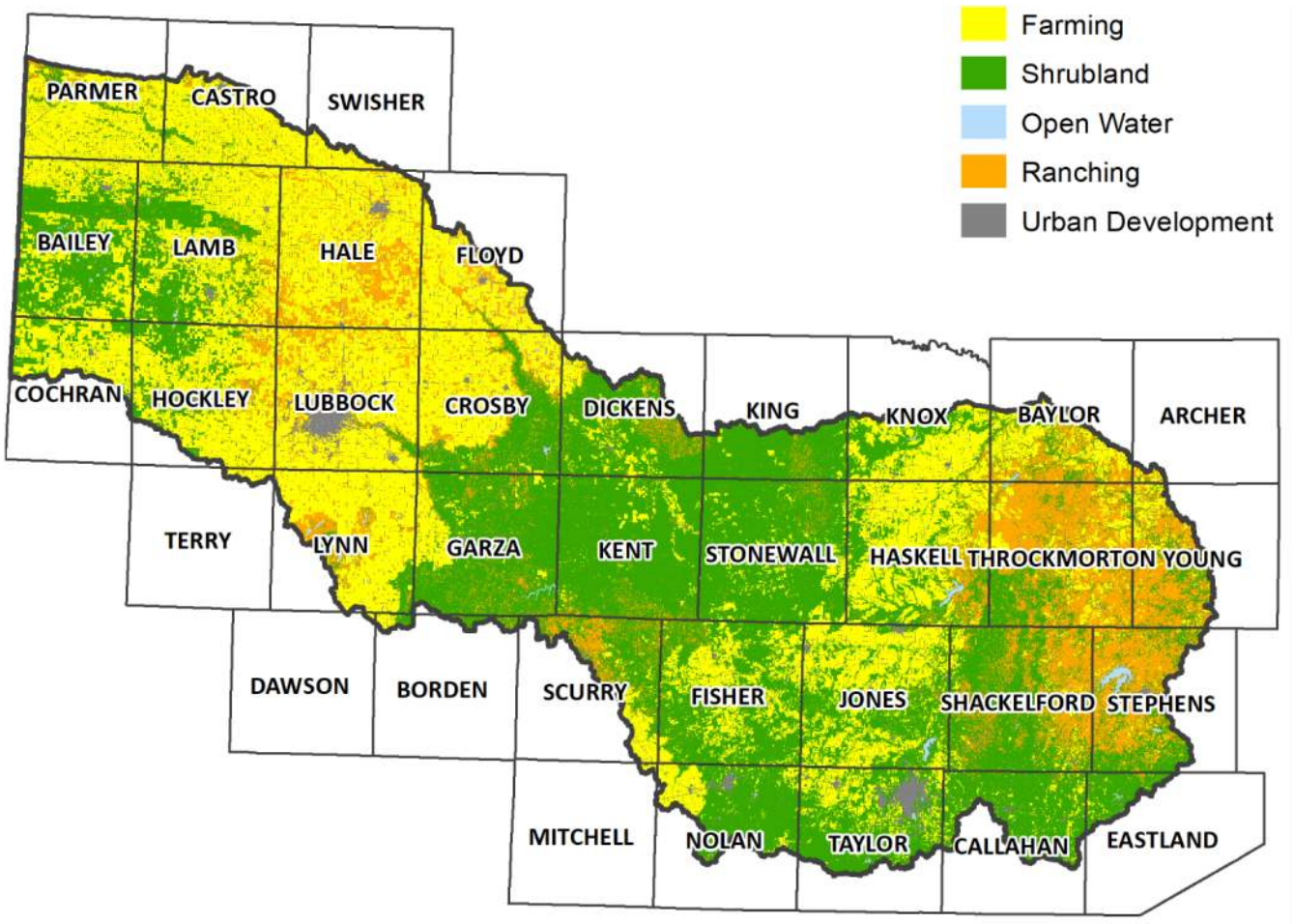


FIGURE 2-1 LAND USE IN REGION 7

Cultivated agricultural and ranch land also change the watershed's response to rainfall. If the rate of development and changes in land use since the last flooding analysis is very high, the previous results can be invalidated. However, if the land use has remained unchanged since the last flood analysis, the results of previous studies may still be used as valid and up-to-date data.

The Upper Brazos Region includes a distinct divide in the topographic features that occurs due to the presence of the Caprock land formation, also known as the Llano Estacado or the High Plains of Texas. The portion of the region on the Caprock is characterized by lower infiltration rates due to B and C soil types. The predominant hydraulic conveyance features are overflow playas, which store water before overflowing to the next playa. The Caprock formation covers the upstream portion of Region 7.

The portion of the Region off the Caprock is distinguished by higher infiltration rates provided by soil types C and D. Hydraulic conveyance mainly occurs through natural channels with visually evident thalwegs. The region that is "off the Caprock" may also be referred to as the Rolling Plains of Texas and constitutes the downstream portion of the region. Figure 2-2 shows the contrasting terrain features between the High Plains and Rolling Plains of Texas as well as the divide caused by the Caprock across Dickens, Crosby, Lubbock, Garza, and Lynn Counties.

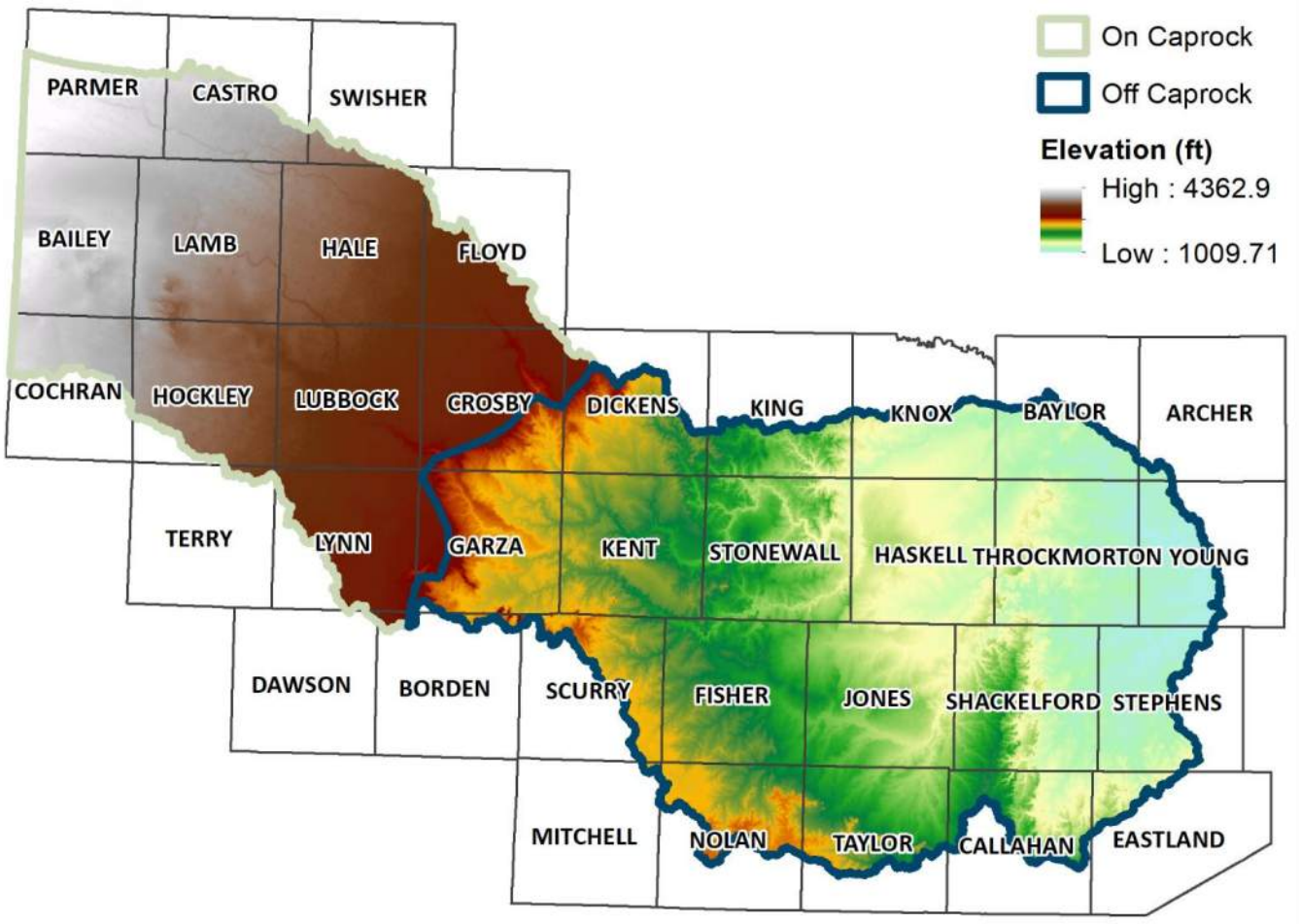


FIGURE 2-2 TOPOGRAPHIC OVERVIEW OF REGION 7

Precipitation

Precipitation is commonly analyzed in terms of inches of rainfall per a 24-hour duration. When planning for existing conditions flood risk, assessing rainfall depths and frequency is crucial.

In 1973, the NFIP set the standard for flood hazard areas based on the 1% annual chance storm event. For the purposes of the State Flood Plan, all risk assessments are based on this recurrence interval.

NOAA recently developed annual chance exceedance rainfall rates for Texas based on historic rainfall data in the Atlas 14 study[11]. The study shows gradually increased rainfall from the previous depths towards the southeast portion of the state. However, the NOAA Atlas 14 study provided minimal

[11] USGS. 2004. Atlas of Depth-Duration Frequency of Precipitation Annual Maxima for Texas: https://pubs.usgs.gov/sir/2004/5041/pdf/sir2004-5041.pdf

differences in previous rainfall statistics for Region 7. Table 2-1 shows rainfall depths in Region 7 for the 50%, 1%, and 0.2% annual chance storm events according to Atlas 14[12].

TABLE 2-1 RANGE OF ATLAS 14, 24-HOUR RAINFALL DEPTHS FOR REGION 7

50% ACE Rainfall Depth (in)	1% ACE Rainfall Depth (in)	0.2% ACE Rainfall Depth (in)
2.24-3.12	5.82-8.76	7.75-12.0

NOAA also created a raster of the 1% ACE, 24-hour storm depths[13]. This information has been overlaid with the Region 7 and is shown in Figure 2-3.

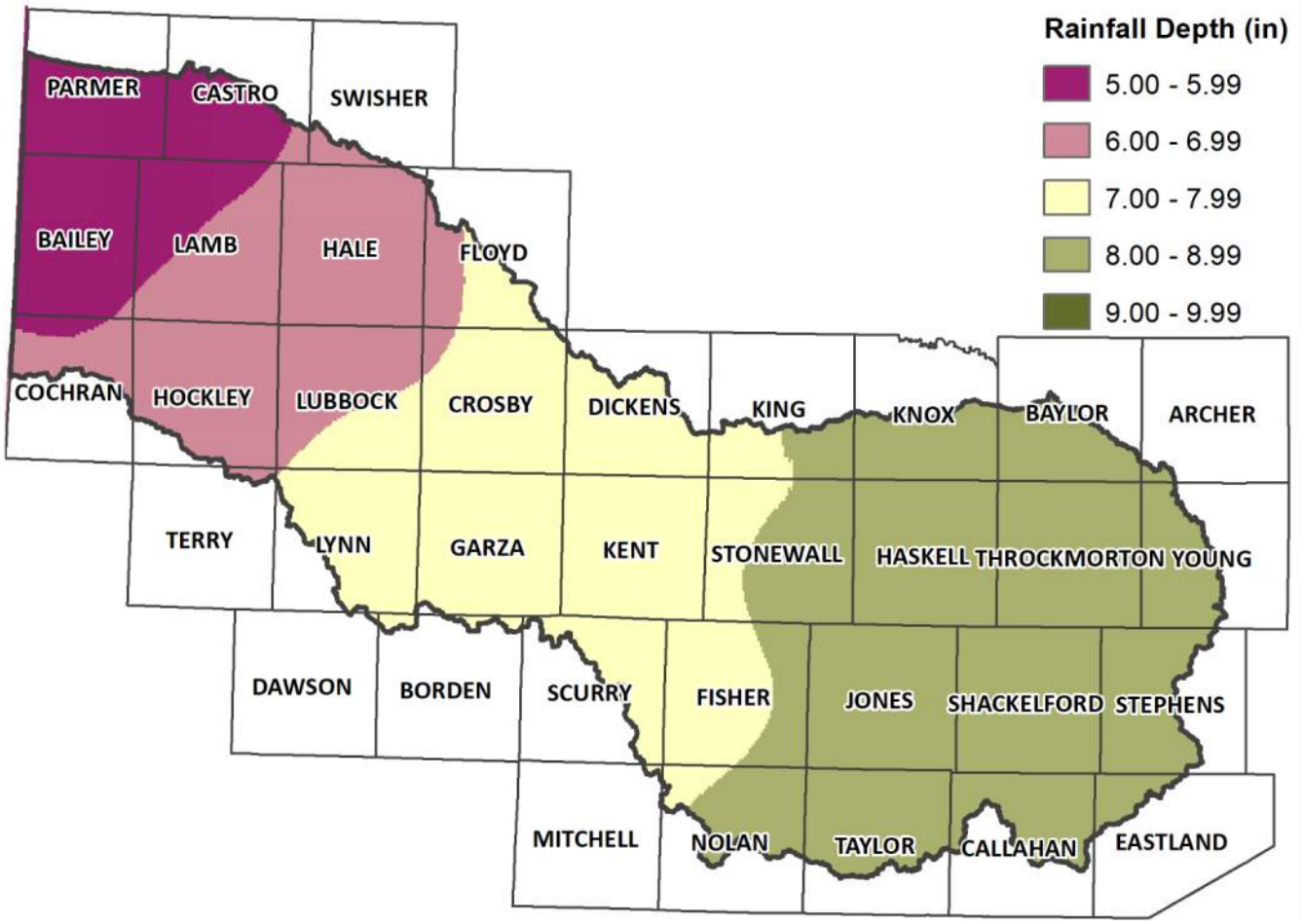


FIGURE 2-3 ATLAS 14 1% ANNUAL CHANCE STORM EVENT, 24-HOUR PRECIPITATION

[12] NOAA. 2022. Atlas 14 Point Precipitation Frequency Estimates: (https://hdsc.nws.noaa.gov/hdsc/pfds/pfds_map_cont.html)

[13] NOAA. 2018. Texas Isopluvials of 100-year 24-hour Precipitation in inches: https://hdsc.nws.noaa.gov/pub/hdsc/data/tx/tx100y24h.pdf.

Infrastructure

Drainage-related infrastructure is a key element in determining the existing condition flood risk. Drainage-related infrastructure includes but is not limited to dams, detention and retention ponds, bridges, channels, culverts, low water crossings, and urban storm drain networks.

Flood control infrastructure is intended to mitigate flood risk. However, outdated, undersized or unmaintained drainage infrastructure can increase flooding or flood risk. Bridges, culverts, and storm drain systems that were designed and constructed before major land use changes and higher standards were implemented may impound floodwater and overtop during major storm events. The result is increased flood risk to both property and life. Infrastructure must be inspected and maintained regularly to perform as designed in the event of a flood. Infrastructure that is in disrepair increases flood risk.

Existing Hydrologic & Hydraulic (H&H) Model Availability

Hydrology includes the study of how rainfall and evaporation affect the amount of water on the earth's surface. Hydraulics investigates the movement or flow of that water as it travels across the region by overflow playas, rivers and streams, or man-made conveyance structures such as storm drains.

H&H modeling is necessary in determining how water moves across the region, which is a vital element in developing effective flood planning strategies. Various entities within Region 7 have developed H&H models to further understand how water impacts their communities. The City of Lubbock and the City of Abilene developed H&H models and have provided them to the region for inclusion in the RFP. Table 2-2 below details these models.

TABLE 2-2 AVAILABLE COMMUNITY-SPONSORED H&H MODELS

Model Title	Software	Study Area	Sponsor Entity	Date
Lubbock Playa System Rapid Assessment Models	ICM	City of Lubbock	City of Lubbock	2015
5-Year Capital Improvements Plan (CIP) Models	ICPR	City of Lubbock	City of Lubbock	2016
Master Drainage Plan (MDP) Update Models	ICPR	City of Lubbock	City of Lubbock	2018-2020
System C Models	ICPR	Playa System C Watershed	City of Lubbock	2019
McAlister Letter of Map Revision (LOMR)	ICPR	Playa System E4A, E4B, and E9	City of Lubbock	2020
Master Drainage Plan Models	HEC-RAS	City of Abilene	City of Abilene	2020
Upper Clear Fork Brazos Base Level Engineering (BLE)	HEC-RAS	Upper Clear Fork Brazos HUC8	FEMA	2017

Best Available Data

Riverine and playa flooding are the two primary types of inundation in Region 7. Urban (sometimes also referred to as pluvial) flooding data were also evaluated for inclusion in the existing flood quilt, where

available. Urban flooding (also called off-floodplain or surface flooding) is caused by impermeable surfaces (such as paved streets and sidewalks) preventing local precipitation from infiltrating the otherwise natural ground, creating increased runoff. This runoff can overwhelm local drainage systems and overflow small waterways. In this instance, the water could enter buildings or cause maneuverability restrictions, resulting in public complaints or concerns.

The most current existing flood hazard mapping data from multiple sources were compiled to create a comprehensive existing floodplain quilt for Region 7. Data were obtained from FEMA, USACE, other federal agencies, regional entities, and local communities. In order of priority, data were obtained from local detailed studies, local approximate studies, BLE studies, First American Flood Data Services (FAFDS) studies, and lastly, Cursory Fathom data.

Detailed Studies

Detailed studies are often sponsored by individual entities for the purpose of identifying causes of known flooding in a relatively small area. These studies are calibrated to available historic flood data and are generally recognized to have water surface elevations within 0.5 feet of actual conditions.

Digital FEMA floodplain datasets were utilized. FEMA data includes effective datasets that are available for NFIP regulatory use and datasets that are within six months to become effective and awaiting a Letter of Final Determination as of April 2022. Preliminary data was issued for public review and due process.

Local approximate studies are similar to detailed studies except that these models are not calibrated to historical storm events. Usually, a validation effort is associated with approximate studies, where general or high-level comparisons between a cataloged historic event and the model are estimated. These studies usually do not identify water surface elevations, though they may identify depth of flooding as well as flooding extents.

Base Level Engineering (BLE)

BLE is a very high-level effort prepared by FEMA to provide a flood base map for areas whose political entities may not otherwise be able to afford such studies. The BLE process uses best available terrain data and automated techniques along with traditional model development procedures to produce approximate, regulatory-quality flood hazard extents for the 1% ACE. BLE may also produce estimates of flood hazard boundaries for multiple recurrence intervals.

BLE modeling undergoes a validation effort, though the final mapping product is still approximate in nature. BLE is useful to estimate flood risk extents and to provide context for flood risk communication.

TWDB is currently completing BLE modeling for the entire state. In Region 7, one HUC8 watershed BLE is complete and all other HUC8 watershed BLEs are in progress. (A hydrologic unit code or HUC is a unique georeferenced watershed number assigned by the U.S. Geological Survey.) Figure 2-4 shows the BLE

status web map[14] for Upper Brazos as of July 2022. BLE flood risk data will be available for the entire region in future planning cycles.

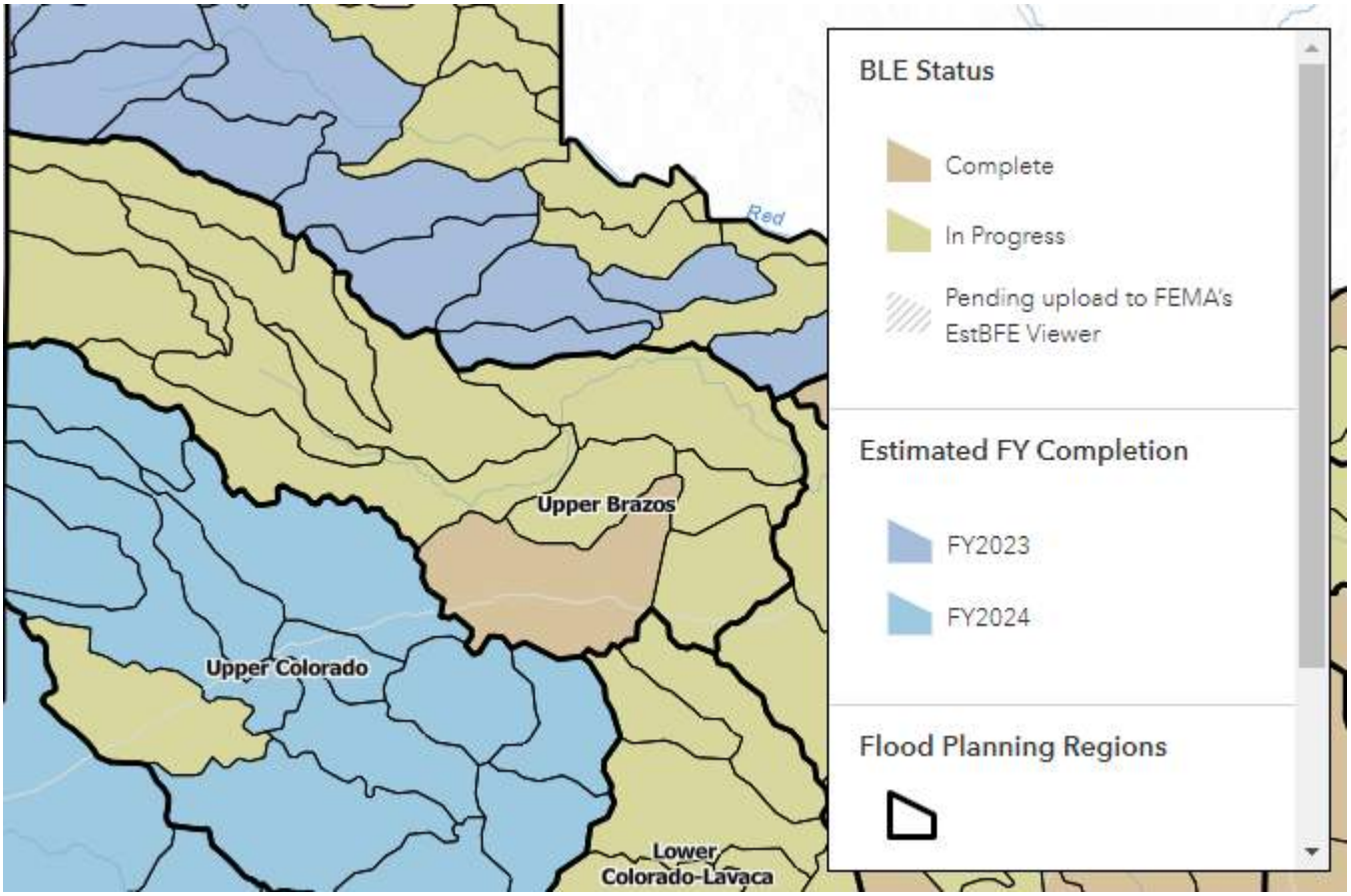


FIGURE 2-4 TWDB BLE STATUS AS OF JULY 2022

Approximate Floodplain Data

Approximate FEMA effective floodplain data (also known as Flood Zone A) follows BLE data in accuracy. Where effective maps show Zone A floodplains, there is no detailed study information, rather the inundation boundaries are determined based on topographical contours and known peak flows by event.

First American Flood Data Services Data (FAFDSD)

FAFDS studies contains digitized flood hazard information from previously published FIRMs and FISs and is not available in FEMA's the National Flood Hazard Layer (NFHL). The data may have originated from detailed studies but are likely outdated. Thus, BLE data is anticipated to be more accurate when it becomes available in Region 7.

[14] TWDB. 2022. Texas BLE Status: https://www.twdb.texas.gov/flood/mapping/ble-status-viewer.html

Cursory Fathom Data

Finally, the TWDB purchased an estimated, statewide floodplain representation known as Cursory Fathom Data[15]. Cursory Fathom Data represents the floodplain generated by a large, state-wide model. This data has not been compared to known studies or validated outside of precipitation estimates. Therefore, the data is considered to be the least accurate of the floodplain data available to the Regional Flood Planning Group. However, in areas where no studies have been done, Cursory Fathom Data is useful to estimate the flood risk in that area. Cursory Fathom Data includes mapping for the 1% and 0.2% annual chance storm events, as well as other storm frequencies.

Cursory Fathom Data was developed by a research group at the University of Bristol, England. The Cursory Fathom model has been peer reviewed and compares reasonably well to FEMA flood data. The results of the Cursory Fathom model have been mapped on 10-ft LiDAR grid throughout Texas to create statewide flood depths for fluvial (riverine) flooding, pluvial (non-riverine) flooding, and coastal flooding. A visual depiction of this is available in Figure 2-5.

FIGURE 2-5 VISUAL REPRESENTATION OF PLUVIAL AND FLUVIAL FLOODING

The fluvial Cursory Fathom model combines river gage data and regression analysis to estimate flood risk from rivers. The pluvial Cursory Fathom model is based on estimated rainfall and LiDAR terrain data to estimate risk outside of riverine areas. The fluvial and pluvial depth data from the Cursory Fathom model for Region 7 were mosaicked together with greatest depth where the datasets overlap. The flood depth data was processed to develop flood polygon boundaries using guidance provided by the TWDB. The Cursory Fathom Data served as a supplemental dataset for the existing flood boundaries where no other data was available.

[15] First Street Foundation. (2021). The 3rd National Risk Assessment: https://assets.firststreet.org/uploads/2021/09/The-3rd-National-Risk-Assessment-Infrastructure-on-the-Brink.pdf

Figure 2-6 shows the source of the components of the flood quilt in the Upper Brazos Region. Table 2-3 lists the FEMA models, the software with which each model was made, the area or entity of focus, and the year the model was completed.

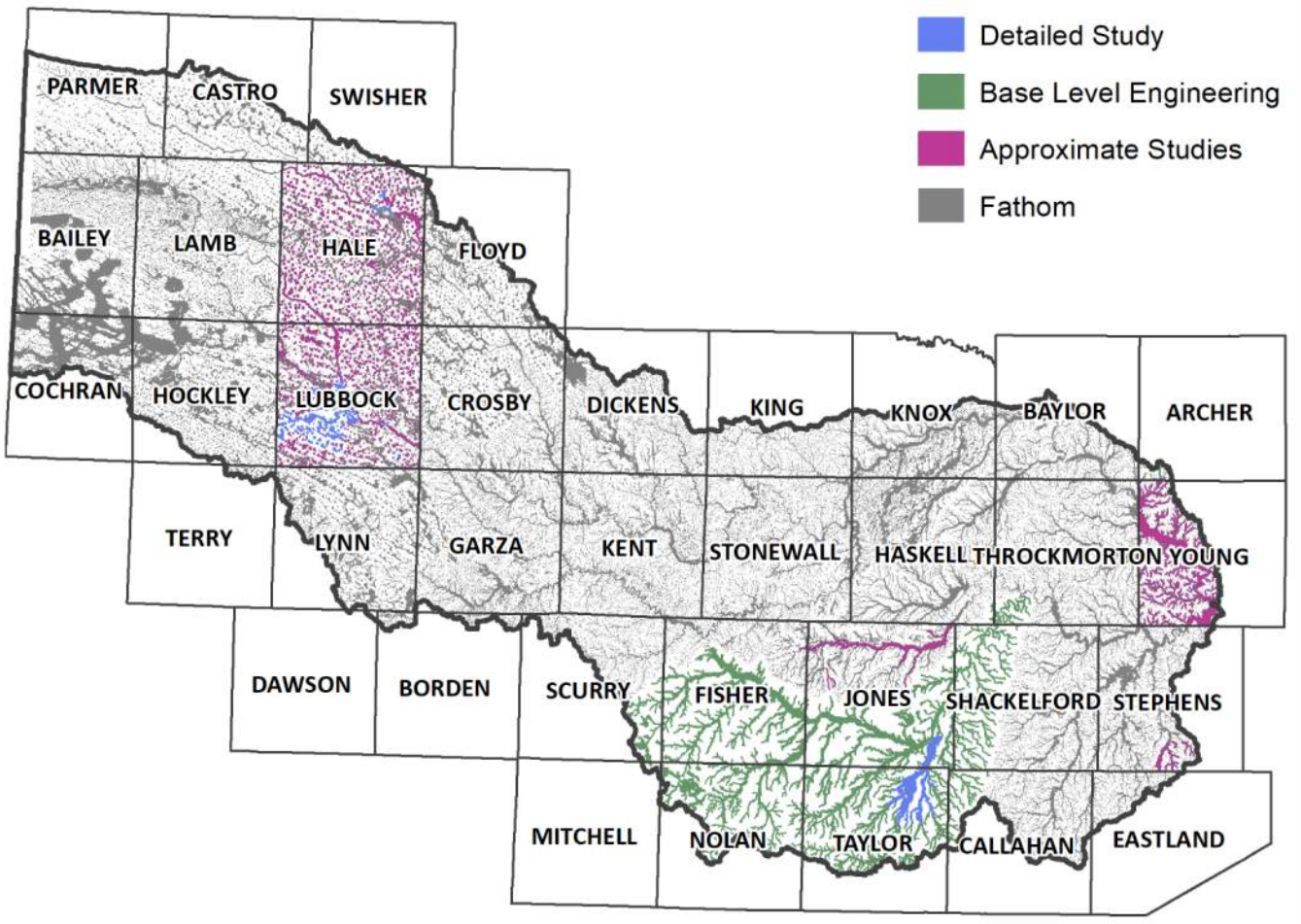


FIGURE 2-6 SOURCE OF FLOOD HAZARD DATA

TABLE 2-3 FEMA-SPONSORED FLOODPLAIN DATA

Model Title	Software	Study Area	Date	Digital Data Available?
Archer County FIS	HEC-HMS, HEC-RAS	Archer County	2021	Yes
City of Albany FIS	NUDALLAS, HEC-2	City of Albany	1986	No
City of Levelland FIS	NUDALLAS	City of Levelland	1990	No
City of Muleshoe FIS	NUDALLAS, HEC-2	City of Muleshoe	1989	No
City of Roscoe FIS	NUDALLAS	City of Roscoe	1988	No
City of Snyder FIS	HEC-2	City of Snyder	1981	No
City of Sweetwater FIS	HEC-2	City of Sweetwater	1989	Yes
City of Throckmorton FIS	HEC-2	City of Throckmorton	1977	No
Dawson County FIS	HEC-RAS	Dawson County	2011	Yes
Eastland County FIS	WSP2	Eastland County	2007	Yes
Hale County FIS	HEC-2	Hale County	2011	Yes
Haskell County FIS	NUDALLAS, HEC-2	Haskell County	1987	No
Jones County FIS	HEC-HMS, HEC-RAS	Jones County	2011	Yes
Lubbock County FIS	HEC-1, HEC-2, XP-SWMM, HEC-RAS, ICPR	Lubbock County	2017	Yes
Nolan County FIS	HEC-2	Nolan County	1990	No
Stephens County FIS	NUDALLAS, HEC-2, HEC-RAS	Stephens County	2019	Yes
Taylor County FIS	HEC-HMS, HEC-RAS	Taylor County	2012	Yes
Young County FIS	NUDALLAS, HEC-2, HEC-RAS	Young County	2019	Yes

Possible Flood-Prone Areas and Other Floodplain Data

Other possible flood-prone areas include areas of historic flooding events and previous flood "hot spots". Reservoir and dam breach inundation areas are also included, where the data are available. Further input was gathered from community representatives and the general public via an online, GIS-based portal that was available for local input in the summer of 2021 (through August 27, 2021).

The various data sources received were compiled according to TWDB's ranking hierarchy as shown in Table 2-4. The table also shows the percentage of area in each county in Region 7 that uses each of the data sources.

TABLE 2-4 REGION 7 DATA HIERARCHY AND PERCENTAGE USED

County	Study 1%	Study 0.2%	Zone AE 1%	Zone AE 0.2%	BLE 1%	BLE 0.2%	Zone A 1%	Zone A 0.2%	Fathom 1%	Fathom 0.2%
Archer	-	-	-	-	17.2	17.2	-	-	82.8	82.8
Bailey	-	-	-	-	-	-	-	-	100	100
Baylor	-	-	-	-	-	-	-	-	100	100
Borden	-	-	-	-	-	-	-	-	100	100
Callahan	-	-	-	-	20.6	20.6	-	-	79.4	79.4
Castro	-	-	-	-	-	-	-	-	100	100
Cochran	-	-	-	-	-	-	-	-	100	100
Crosby	-	-	-	-	-	-	-	-	100	100
Dawson	-	-	-	-	-	-	-	-	100	100
Dickens	-	-	-	-	-	-	-	-	100	100
Eastland	-	-	-	-	-	-	-	-	100	100
Fisher	-	-	-	-	68.6	68.6	0.2	-	31.2	31.4
Floyd	-	-	-	-	-	-	-	-	100	100
Garza	-	-	-	-	-	-	-	-	100	100
Hale	-	-	1	1	-	-	99	-	-	99
Haskell	-	-	-	-	1.2	1.2	-	-	98.8	98.8
Hockley	-	-	-	-	-	-	-	-	100	100
Jones	-	-	2.3	2.3	52	52	8	-	37.7	45.7
Kent	-	-	-	-	-	-	-	-	100	100
King	-	-	-	-	-	-	-	-	100	100
Knox	-	-	-	-	-	-	-	-	100	100
Lamb	-	-	-	-	-	-	-	-	100	100
Lubbock	2.9	2.9	12.5	12.5	-	-	84.6	-	-	84.6
Lynn	-	-	-	-	-	-	-	-	100	100
Mitchell	-	-	-	-	100	100	-	-	-	-
Nolan	-	-	-	-	100	100	-	-	-	-
Parmer	-	-	-	-	-	-	-	-	100	100
Scurry	-	-	-	-	26.5	26.5	-	-	73.5	73.5
Shackelford	-	-	-	-	36.3	36.3	-	-	63.7	63.7
Stephens	-	-	-	-	-	-	8.1	-	91.9	100
Stonewall	-	-	-	-	-	-	-	-	100	100
Swisher	-	-	-	-	-	-	-	-	100	100
Taylor	-	-	13.7	13.7	86.3	86.3	-	-	-	-
Terry	-	-	-	-	-	-	-	-	100	100
Throckmorton	-	-	-	-	5	5	-	-	95	95
Young	-	-	-	-	-	-	100	-	-	100

1% and 0.2% Annual Chance Storm Event Floodplains

The 1% annual chance storm event is the regulatory basis for the NFIP. The 1% annual chance storm event has a 1 in 100 chance of being equaled or exceeded in any given year. It is often referred to as the "100-year flood", the "Special Flood Hazard Area (SFHA)" or the "base flood". This boundary is a convenient tool for assessing vulnerability and risk in communities. The inundation boundary produced by a 1% annual chance storm event is a mapped high-risk flood area, subject to a one percent or greater annual chance of flooding in any given year. The SFHA may also be susceptible to erosion, deposition, and mudflow.

The base flood is the national standard used by the NFIP and other federal agencies for the purposes of regulating development and requiring the purchase of flood insurance. On FIRMs, FEMA plots both the 1% and the 0.2% annual chance storm events' inundation extents.

Existing flood hazard mapping estimation is based on the current land use and precipitation data to estimate hydrologic condition parameters and discharges. The estimated hydrologic condition parameters and discharges are then used to simulate water surface elevations on regional topography to create existing floodplain mapping extents.

The compiled existing flood quilt data for Region 7 is included in the submittal GIS database as layer "ExFldHazard". A larger, more detailed version of this figure is included as TWDB-required Appendix A Required Map 4. Table 2-5 shows a summary of existing flood type (riverine, playa, and urban) by county and frequency. Note that the table does not include coastal flooding quantifications as no portion of the Upper Brazos Basin intersects a coastal area.

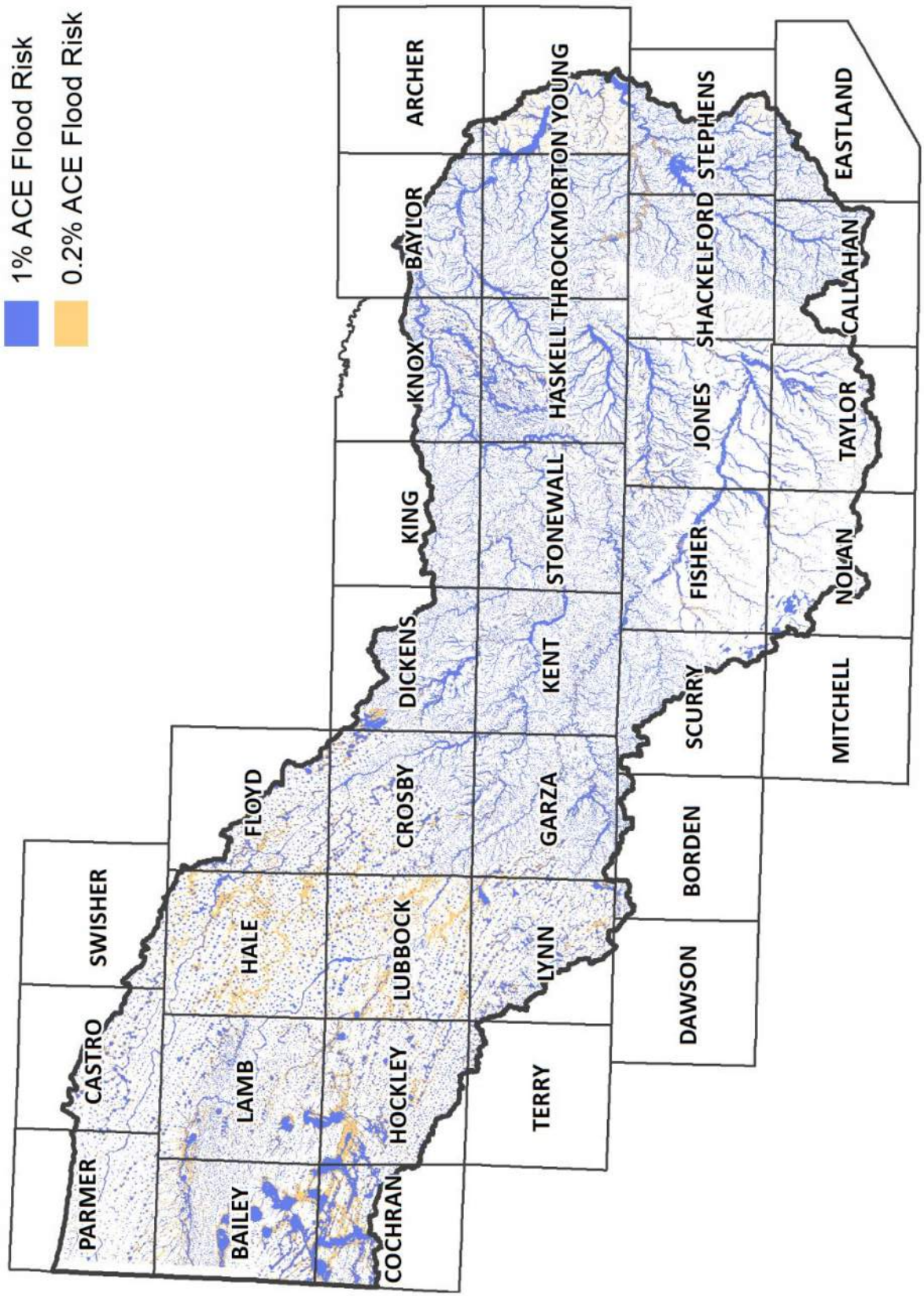


FIGURE 2-7 EXISTING CONDITIONS FLOOD HAZARD

TABLE 2-5 REGION 7 SUMMARY OF EXISTING FLOOD TYPE BY COUNTY

Area by County (sq. mi.)	Riverine 1%	Riverine 0.2%	Playa 1%	Playa 0.2%	Urban 1%	Urban 0.2%
Archer	2.8	3.5	-	-	-	-
Bailey	-	-	181.4	286	-	-
Baylor	97.2	111.6	5.2	5.2	-	-
Borden	6.1	6.6	-	2.4	-	-
Callahan	72.7	80.3	-	-	-	-
Castro	-	-	57.5	82.5	-	-
Cochran	-	-	118.9	189.2	-	-
Crosby	72.6	88.8	92.9	149.8	-	-
Dawson	-	-	0.4	0.6	-	-
Dickens	123.6	147	1.8	2.7	-	-
Eastland	23.3	25.2	-	-	-	-
Fisher	125.5	151.1	-	-	-	-
Floyd	2.6	3.4	68.5	115.8	-	-
Garza	165.4	199.5	23.0	37.4	-	-
Hale	122.6	122.6	-	175.8	-	-
Haskell	234.0	275.2	-	-	-	-
Hockley	-	-	161.6	283.8	-	-
Jones	180.2	213.1	-	-	-	-
Kent	179.7	206.8	-	-	-	-
King	51.2	57.4	-	-	-	-
Knox	125.2	150.4	-	-	-	-
Lamb	-	-	174.9	273.1	-	-
Lubbock	108.9	112.5	-	144.2	5.0	5.8
Lynn	-	-	115.4	183.4	-	-
Mitchell	0.6	0.6	-	-	-	-
Nolan	35.4	42.6	-	-	-	-
Parmer	-	-	42.5	66	-	-
Scurry	54.7	59	-	-	-	-
Shackelford	133.2	156.4	-	-	-	-
Stephens	141.7	165.3	-	-	-	-
Stonewall	173.8	203.5	-	-	-	-
Swisher	-	-	8.6	12.9	-	-
Taylor	74.0	88.7	-	-	-	-
Terry	-	-	6.0	9.1	-	-
Throckmorton	184.6	209.7	-	-	-	-
Young	79.2	121.9	-	-	-	-

Data Gaps

Once the best-available comprehensive existing flood data were compiled, data gaps were assessed to identify any remaining areas where flood inundation mapping was missing. Other deficits that could cause available mapping to be considered a "data gap" include the following:

- Outdated modeling or mapping technology;
- Significant land use or impervious area change;
- New/removed flood control structures;
- Alterations in channel geometry such as erosion, sedimentation, or channelization; and
- Rainfall pattern and/or peak discharge changes.

The gap areas data are included in the GIS database as "Fld_Map_Gaps". Figure 2-8 shows the locations of identified existing flood data gaps. The detailed map is provided as TWDB-required Appendix A Required Map 5.

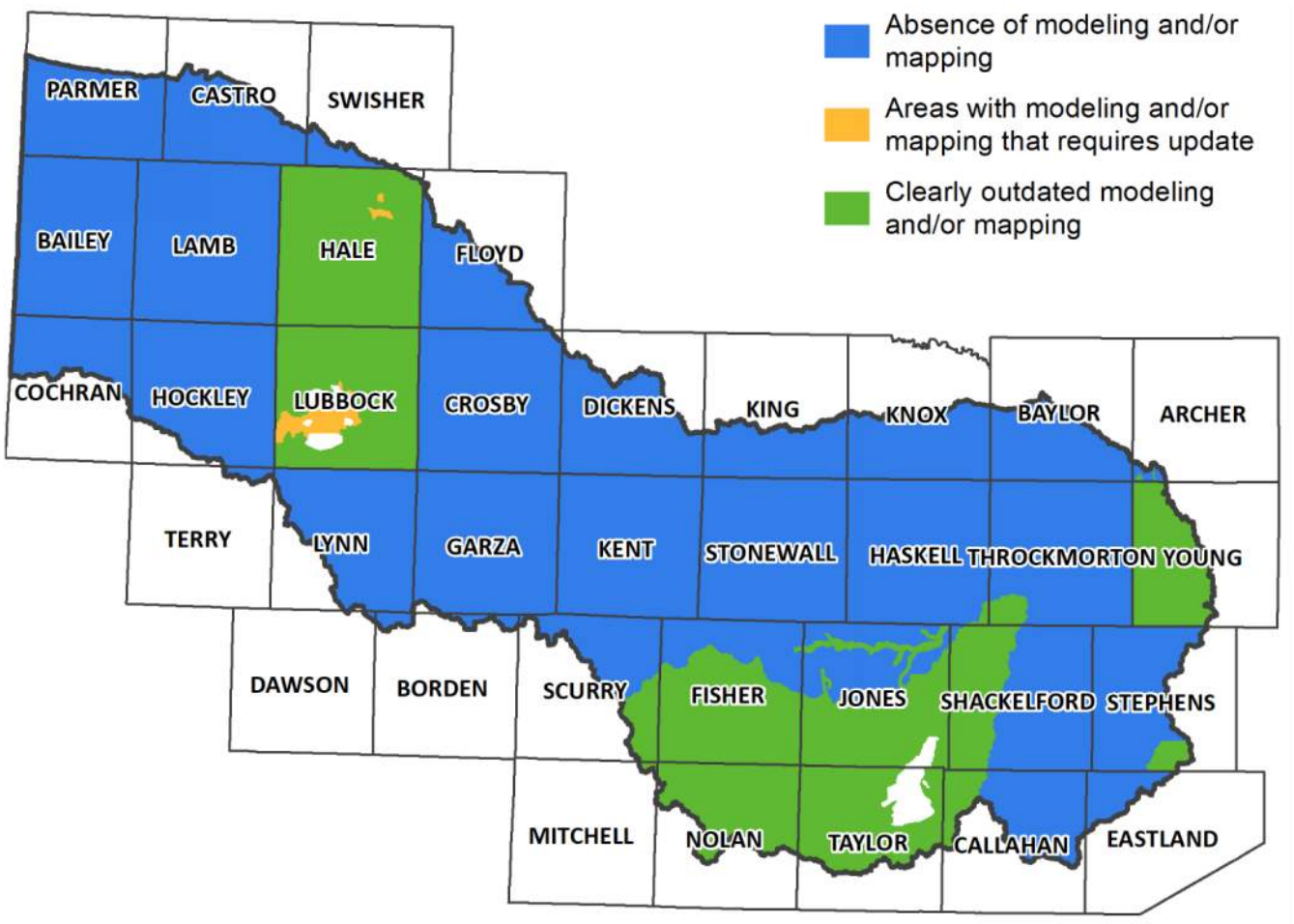


FIGURE 2-8 GAPS IN INUNDATION BOUNDARY MAPPING

Within Region 7, the available effective FEMA FIRMs are 22 years old on average. The oldest FEMA effective map is 46 years old (effective date 1976) and models the City of Throckmorton. The newest

effective map in the basin is one year old (effective date 2021) and models Archer County. Most of the communities in the region do not have modernized, digital, FEMA county-wide effective FIRMs. Model-backed H&H flood data are scarce in the region and vary in age and conformance to current technologies. Almost 75% of the available FEMA data are more than 10 years old (modeled in 2012 or earlier) with the more recent models covering the Counties of Archer, Lubbock, Stephens, Taylor, and Young. The models provided from the City of Lubbock were all developed after 2012.

Existing Conditions Flood Exposure Analysis

In Texas, flooding frequency and intensity have been increasing in recent years, sometimes necessitating state and federal relief, which has risen to record levels. Flooding can become a significant hazard when it inundates the built environment and causes direct damage to buildings, critical facilities, crops, and occasionally injuries or loss of life.

The existing condition flood risk exposure analysis leveraged the compiled existing condition 1- and 0.2percent annual chance floodplains in Region 7 to determine existing flooding exposure to existing development, critical facilities, agriculture, and energy.

FEMA Floodplains

FEMA floodplains are provided as they become available in the Upper Brazos Region. Most FEMA data available in Region 7 includes Zone A floodplains from approximate methods. As previously mentioned, approximate methods are useful for planning purposes, however, true to their name, they generally are not backed by detailed hydraulic analyses that would assist with existing and future condition flood risk determination. The FEMA data are useful to supplement the Cursory Fathom data provided by the TWDB and to validate other sources of floodplains. FEMA data are available for multiple counties throughout the basin, as detailed in Table 2-4.

Existing Development within the Floodplain

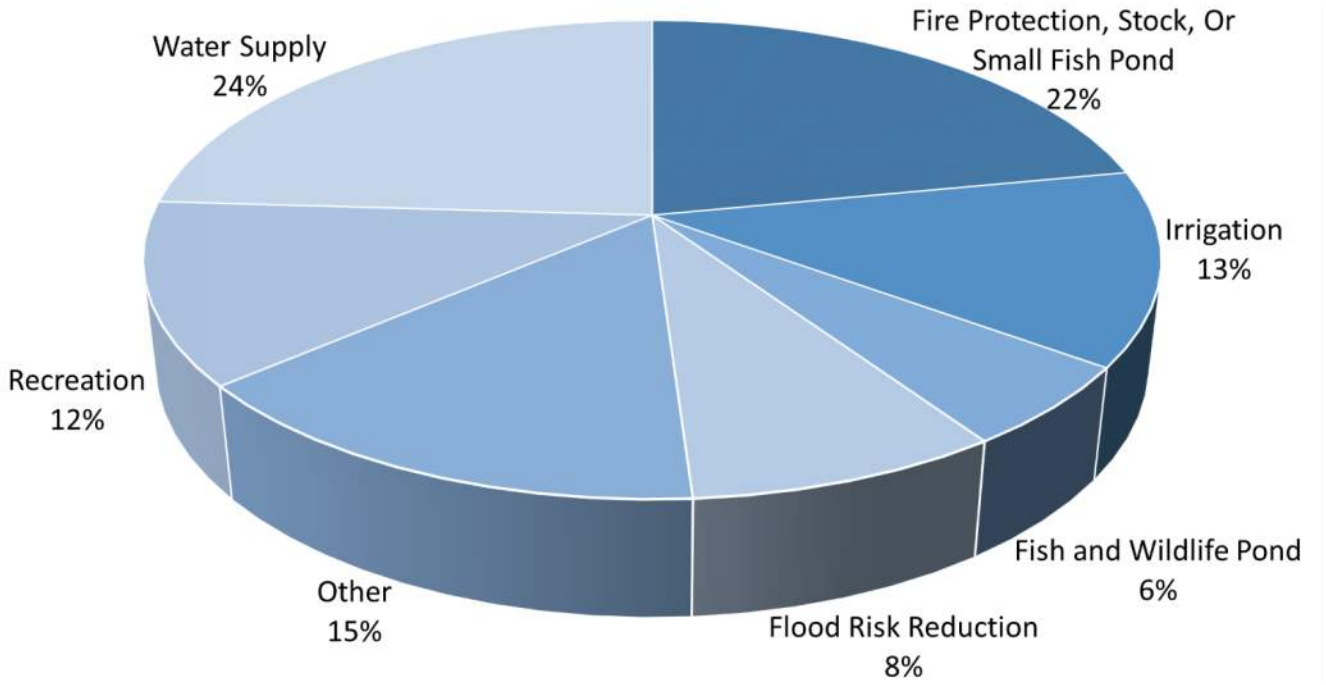
Several features are within the existing conditions floodplain. Exhibit C Table 3 shows a comprehensive quantification of existing flood exposure in the Upper Brazos Region. Table 2-6 shows a basin-wide summary of some key features that are located within existing condition areas of potential flood risk.

TABLE 2-6 SUMMARY OF ASSETS IN EXISTING FLOOD RISK

Regional Asset	In 1% ACE Floodplain	In 0.2% ACE Floodplain
Total Area (sq. mi.)	3,634	5,028
Total Number of Structures	28,532	54,087
Residential Structures	19,838	37,008
Population	60,299	109,284
Roadway Stream Crossings	4,299	4,694
Roadway Segments (mi.)	1,811	2,908
Area of Agriculture (sq. mi.)	126	200
Critical Facilities	81	147

Flood Exposure Due to Existing Levees or Dams

Dams may be constructed for flood control and a variety of other reasons, such as water supply, stock ponds, irrigation, or recreation. However, during flooding events, any dam in the flooded area – regardless of purpose – may be subjected to impounding flood waters. Dams built for the primary purpose of flood control are typically better suited for these events than dams built for other reasons. Figure 2-9 shows the distribution of the primary purpose for each of the 240 dams in Region 7. Note that only 8% are primarily intended for flood risk.



Source: National Inventory of Dams, National Inventory of Dams (army.mil), 2022

FIGURE 2-9 PRIMARY PURPOSE OF DAMS IN REGION 7

The known flood risks of the dams in Region 7 are limited to the FEMA effective data. As updates occur to the National Inventory of Dams website, more information may become available to the RFPG.

One documented levee is located within Region 7 in Jones County. This structure is a non-accredited, agricultural levee. With a length of 0.24 miles, the levee protects 0.064 square miles of an agricultural plot[16].

Potential Flood Exposure

Exposure is the estimated quantification of the people and property at risk of flooding. Multiple assets can be exposed to flooding, including buildings, businesses, infrastructure systems, and even people. Exposure includes the economic values of assets subjected to flood hazards. For the purposes of the Upper Brazos Region, the flood exposure analysis considered residential properties and their associated

[16] USACE. 2022. National Levee Database: https://levees.sec.usace.army.mil/#/levees/system/1605885358/system

populations, non-residential properties, critical facilities, public infrastructure, roadways, and agricultural areas within the basin.

Residential Properties and Associated Population

Residential property data utilized in the RFP included single-family homes, townhomes, mobile homes, and multi-family residences like apartments and condominiums. The spatial footprints of these structures have been attributed with day and night population using 2019 Oak Ridge National Laboratory (ORNL) datasets, as provided by the TWDB. Over 37,000 residential building footprints are within the 1% and/or 0.2% annual chance storm event flood risk in Region 7. An associated population of over 109,000 is estimated of being at risk to flooding, according to the risk analysis performed on the building footprints and their associated population.

Non-Residential Properties

Structure inventory data included agricultural, commercial, industrial, and other public buildings. Over 54,000 building footprints were documented in the floodplain for the existing 1% and 0.2% annual chance storm events in Region 7, and an estimated 30% of these buildings are non-residential. Figure 2-10 shows all structures at flood risk within the Region.

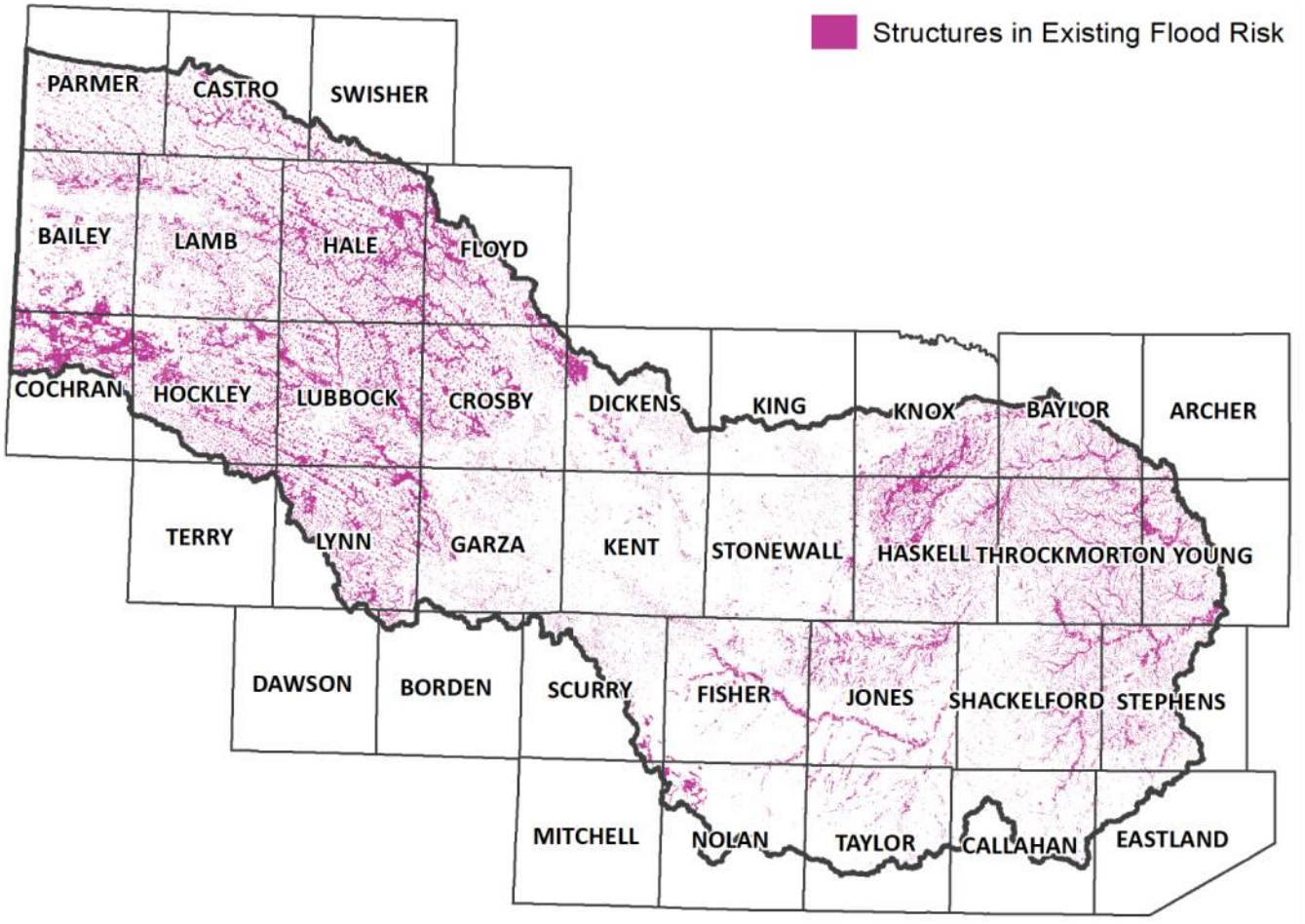


FIGURE 2-10 STRUCTURES WITHIN EXISTING FLOOD RISK

Critical Facilities and Public Infrastructure

A critical facility provides services and functions essential to a community, especially during and after a disaster. In the technical guidelines, TWDB defines critical infrastructure to include all public or private assets, systems, and functions vital to the security, governance, public health and safety, economy, or morale of the state or the nation. Critical facilities include fire stations, hospitals, nursing homes, police stations, emergency shelters, schools (kindergarten through 12th grade), water and wastewater treatment facilities, TCEQ wastewater outfalls, and Superfund sites. Lifeline utility systems data such as petroleum storage tanks, power generating plants, as well as natural gas and electric transmission lines were also collected for exposure analysis.

A total of 147 critical facilities are in existing flood risk in Region 7. An estimated 55% of these critical facilities appear to be at risk to flooding within the 1% annual chance storm event, when proximity to the existing floodplain is considered. Critical facilities in Region 7 that are exposed to the probable existing flood risk are shown on Figure 2-11. No Emergency Action Plans for any of these critical facilities was immediately available, and no record of these critical facilities having flooded was noted.

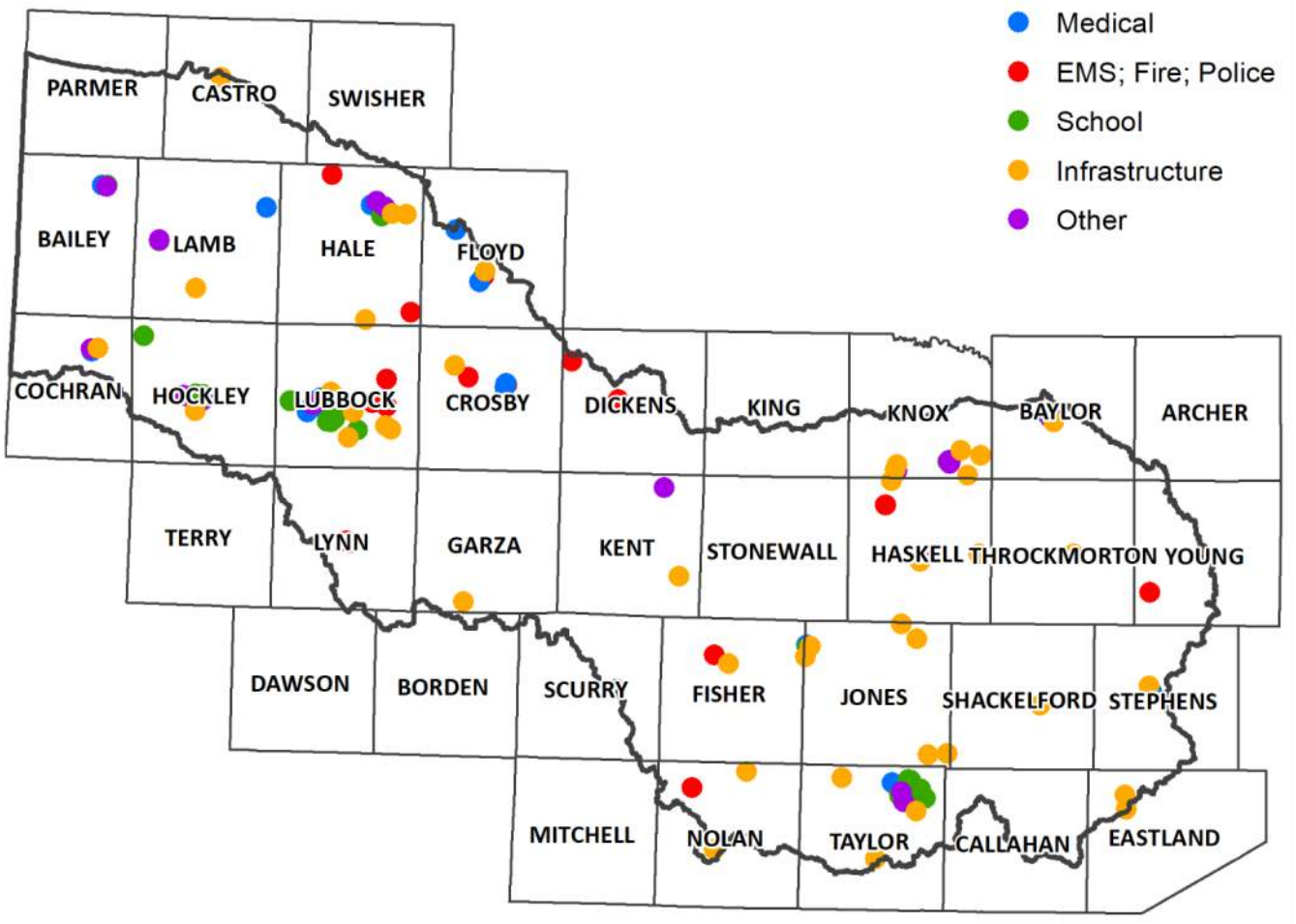


FIGURE 2-11 CRITICAL FACILITIES EXPOSED TO EXISTING FLOOD RISK

A significant portion of Region 7 is known for the large fields of wind turbines, or "wind farms". Though these fields may be within the area of flood risk, the turbines are relatively unaffected by flooding at their bases. The generators and mechanical components of the wind turbines are at the top of the windmill, making damage by flooding exceptionally unlikely. Wind turbine locations within the existing flood risk areas are shown in Figure 2-12. Wind turbine locations were pulled from the United States Wind Turbine Database (USWTDB), a subset of the USGS Energy Resources Program[17].

West Texas is also known for its oil and drilling practices. Petroleum spills and contamination can adversely impact the environment and cause a severe disruption to life and livelihood. For the most part, oil and gas wells are protected from flood dangers. The electrical components of the well are required to be built above the base flood elevation, if known. Furthermore, if oil and gas wells experience a breach (of floodwater in this case), a safety mechanism will shut down the well until it is manually restarted. Active well sites in Region 7 are also shown on Figure 2-12.

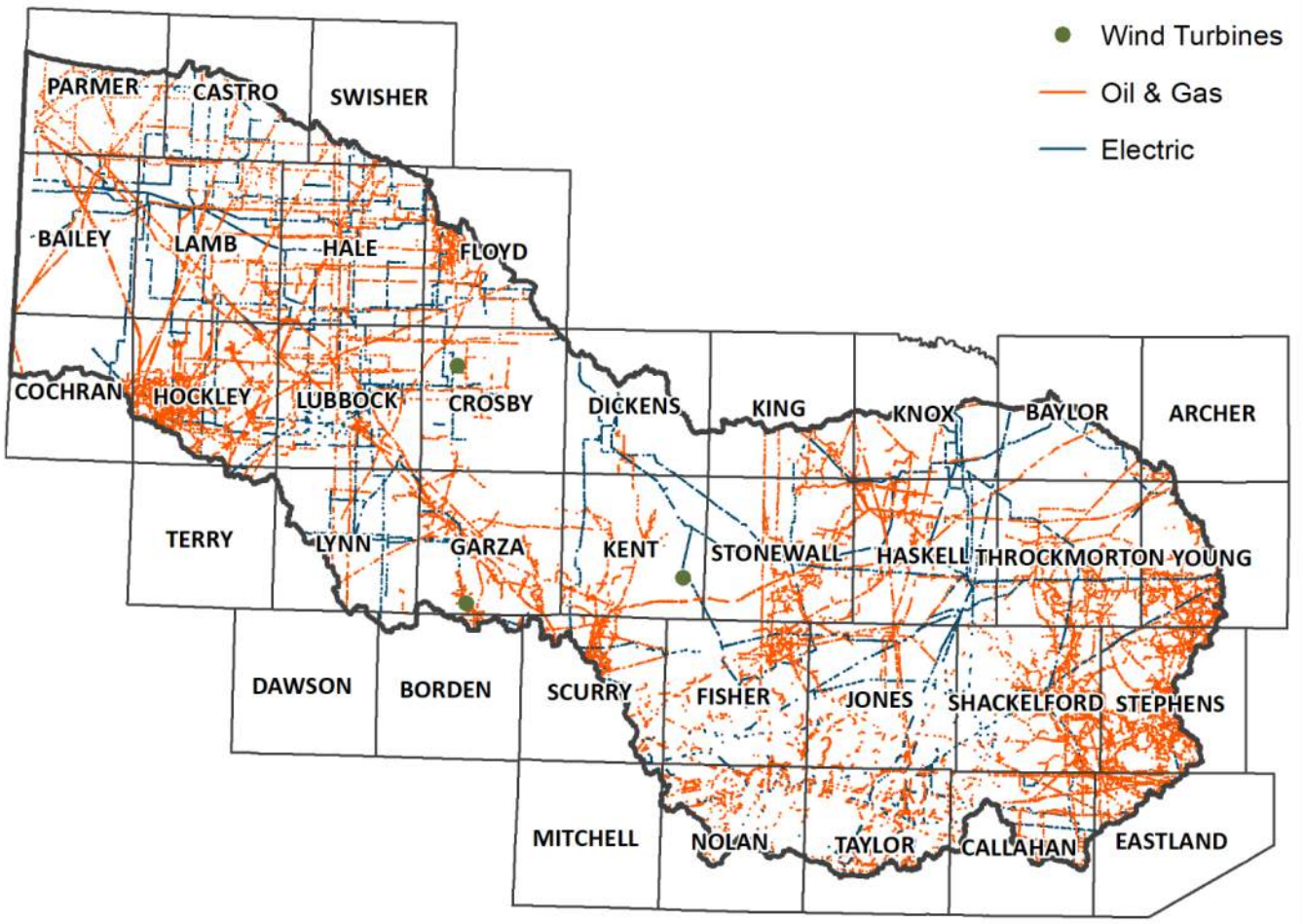


FIGURE 2-12 ENERGY FEAUTRES EXPOSED TO EXISTING FLOOD RISK

[17] U.S. Geological Survey. 2018. The U.S. Wind Turbine Database: https://eerscmap.usgs.gov/uswtdb/

As discussed above, a majority of the Upper Brazos basin does not have FEMA effective flood hazard data, making elevation of electrical components above the BFE difficult. Also, though buried pipelines provide an extra layer of protection against the elements, some pipes are on-grade, HDPE pipes. On-grade HDPE pipes can increase chances of water supply contamination in the event of a flood. In 2010, such a pipe burst after being washed out by heavy rains and threatened contamination of Lake Alan Henry. The Lake Alan Henry contamination occurred after a flooding event in an area where the oil pipeline crossed an ephemeral portion of the river and was left uncovered and unprotected. The contamination threat resulted in the closing the lake for recreation for a week and prompted water quality testing in the area for two weeks[18]. The flood hazard analysis developed as part of the Regional Flood Plan can be used to determine compliance with maintenance and safety regulations for oil and gas operations and storage facilities at reduce the likelihood of a spill or release event.

Transportation

The *Technical Guidelines* defines a low water crossing (LWC) as, a roadway creek crossing that is subject to frequent inundation during storm events or subject to inundation during a 50% annual chance (2-year) storm event. The TWDB guidelines went on to say that the RFPGs have the flexibility to incorporate additional LWCs based on input from local communities. In Region 7, low water crossing data provided by communities through the RFPG's data collection efforts and by the TWDB (through TxDOT) were used to identify exposed road and railway crossings.

In terms of roadway transportation, some amount of roadway flooding is expected in Region 7, especially on the Caprock. The standard engineering design requirement in Region 7 is to convey stormwater in the local streets or public ROW to managed outfall points like playas or streams. Subsequently, during intense or long-duration storm events, all or part of the roadways are used to convey stormwater to low-lying areas. Therefore, roadway flooding in Region 7 is, at least to some extent, intentional. However, these roads are designed to be inundated for short lengths of time under relatively mild flooding depths and velocities. This situation is different than low water crossings where streams intersect roadways and fast moving water at any depth can be hazardous to drivers. It is true, if a ROW conveyance is not functioning appropriately, the depth of flooding can become untraversable and stormwater velocities in the roadway may become hazardous. At this time, limited data are available regarding inundation times, depths, or velocities on roadways and is highly variable around the region.

Airports are also susceptible to flood risk. The buildings and towers surrounding air transportation must be protected as they contain significant equipment vital for communication and guidance of aircraft. Particular care must also be taken for the pavement as runways cannot be inundated during takeoff or

[18] Lubbock Online. 2010. Tests for Oil Keep Lake Alan Henry Closed. https://www.lubbockonline.com/story/news/local/2010/07/08/tests-oil-keep-lake-closed-2/15269562007/

landing of aircraft. Airports and airfields, as well as roadways within the potential existing flood risk, are shown in Figure 2-13.

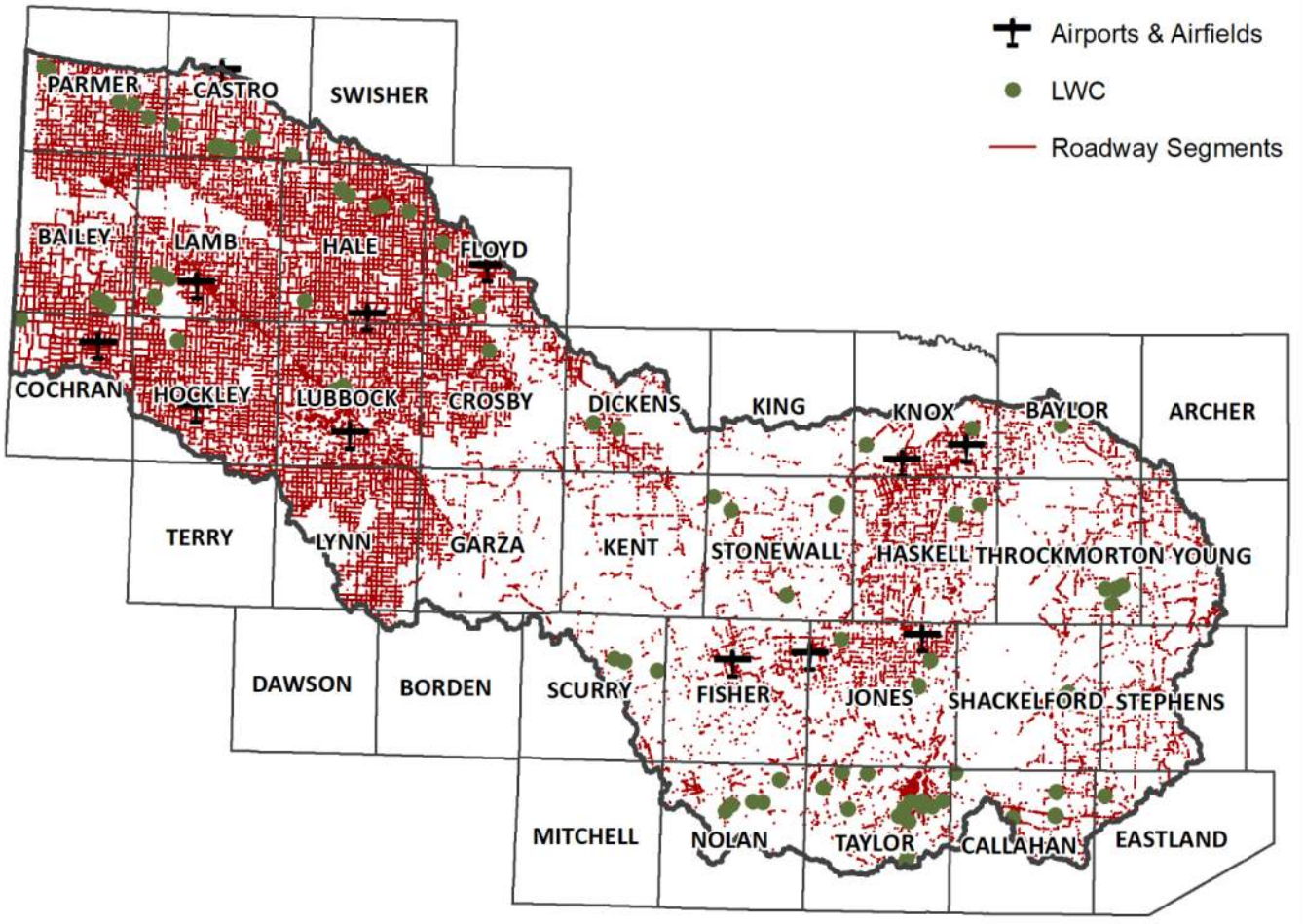


FIGURE 2-13 TRANSPORTATION FEATURES EXPOSED TO EXISTING FLOOD RISK

Agriculture

While water is a vital commodity for agriculture and ranching, flooding can destroy crops, dwindle herd numbers, or contaminate livestock and farming exports. Agricultural land use data in Region 7 were obtained from the 2020 Texas Cropland Data layer developed by the USDA National Agricultural Statistics Service (NASS)[19]. In Region 7, the vast majority of land use is agricultural or grazing land. Agricultural land use at risk in Region 7 is shown on Figure 2-14.

[19] USDA, National Agricultural Statistics Service. 2020. 2020 Texas Cropland Data Layer: https://nassgeodata.gmu.edu/CropScape/

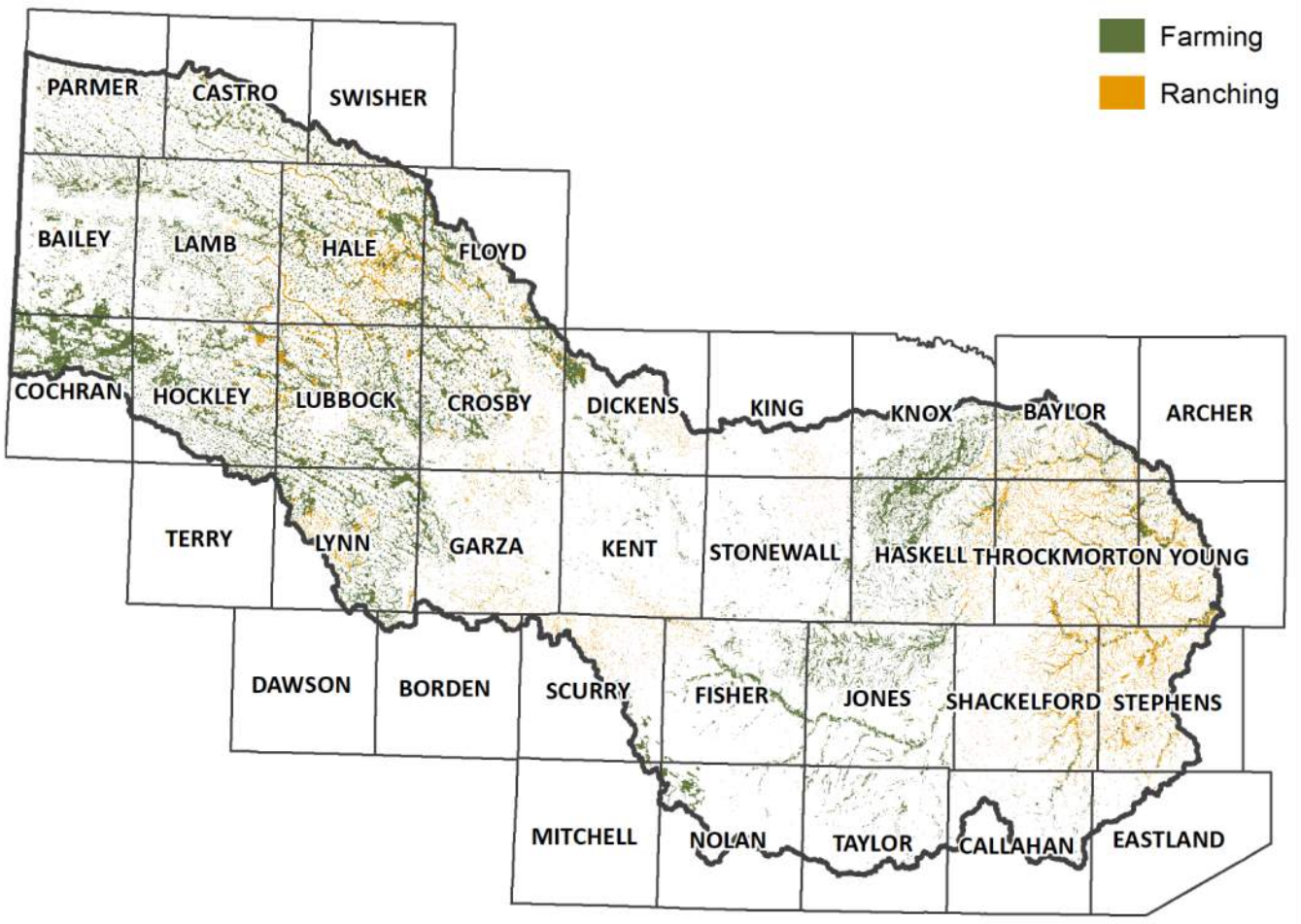


FIGURE 2-14 AGRICULTURAL LAND USE WITHIN EXISTING FLOOD RISK

Expected Loss of Function

Severe flooding results in a loss of function for a community's residential and critical infrastructure which has an impact on the socio-economic systems supported by them. These impacts include disruptions to life, business, and public services. Some public services are essential to a community during and after a flood event. Flood inundation depth and duration are typically considered the best flood characteristics in predicting expected functionality losses. Inundated structures and critical facilities are often not functional during the flood event and through the recovery process. Closure length is dependent on the severity of damage to the structure, interrupted access, and lingering health hazards. A nationwide study by the First Street Foundation[20] finds that 2,840 critical infrastructure facilities in Texas, including power stations, are at operational flood risk. The following sections describes the expected loss of function of features in Region 7.

[20] First Street Foundation. (2021). The 3rd National Risk Assessment: https://assets.firststreet.org/uploads/2021/09/The-3rd-National-Risk-Assessment-Infrastructure-on-the-Brink.pdf

Inundated Structures

TWDB provided the building footprints in Region 7, updated in November 2021. This dataset was created using multiple sources including TWDB, Texas Natural Resources Information System (TNRIS), Centers for Disease Control (CDC), and ORNL. This dataset also includes the estimated daytime and nighttime populations of each structure.

Inundated structures are quantified by overlaying the existing condition floodplains over the building footprints in the region. Elevation certificates for every structure within the region are not available and would be impractical to analyze for the entire area of the region. This approach assumes that the building footprint is essentially constructed at-grade and does not consider elevated foundations. Therefore, the approach may assume more structures are at risk of flooding in a 1% annual chance flood event than would be at risk if structure's elevation was considered. This information is available to view in the TWDB-required Table 3 as well as in Table 2-7.

TABLE 2-7 STRUCTURES EXPOSED TO EXISTING FLOOD RISK

County	1% ACE	0.2% ACE	County	1% ACE	0.2% ACE
Archer	0	1	**Kent**	38	65
Bailey	475	1,472	**King**	3	3
Baylor	361	886	**Knox**	968	1,395
Borden	10	14	**Lamb**	438	1,081
Callahan	81	158	**Lubbock**	6,880	15,943
Castro	51	165	**Lynn**	81	267
Cochran	278	964	**Mitchell**	1	1
Crosby	279	929	**Nolan**	264	373
Dawson	0	0	**Parmer**	51	155
Dickens	195	293	**Scurry**	13	16
Eastland	116	170	**Shackelford**	347	550
Fisher	119	225	**Stephens**	657	992
Floyd	116	471	**Stonewall**	67	103
Garza	158	349	**Swisher**	5	18
Hale	1,318	3,091	**Taylor**	11,167	14,677
Haskell	788	1,398	**Terry**	4	4
Hockley	1,770	5,360	**Throckmorton**	98	169
Jones	1,145	2,066	**Young**	190	263

Transportation

Transportation structures at flood risk can be quantified by roadway crossings or routes that are impacted by flood events, such as poorly drained stretches of road or low water crossings. Roadway segments impacted by flooding result in loss of transportation routes that are needed by the first responders and the public alike.

As discussed previously, Region 7 is different from other regions in that for much of the region, especially on the Caprock, the curb-and-gutter roadways are intended for stormwater conveyance during heavy storm events. Thus, a simple inundation of lanes does not necessarily indicate deficient infrastructure in a given area. Due to the limitation of the data available, however, inundation extents are the only method available to determine at-risk roadway infrastructure. There are approximately 6,000 miles of roadway segments and 1,500 low water crossings at-risk during the 1% annual chance storm; and there are approximately 9,500 miles of roadway and 1,675 low water crossings at-risk during the 0.2% annual chance storm event. Table 2-8 shows a general summary of flood risk impacts by county on roadways.

TABLE 2-8 QUANTIFICATION OF EXISTING FLOOD RISK ON ROADWAY STRUCTURES

County	Number of LWCs	Roadway (mi.)	County	Number of LWCs	Roadway (mi.)
Archer	0	1.9	**Kent**	38	40.6
Bailey	0	499.0	**King**	8	7.2
Baylor	58	53.9	**Knox**	31	130.5
Borden	0	4.8	**Lamb**	5	612.3
Callahan	73	56.1	**Lubbock**	88	357.5
Castro	14	280.9	**Lynn**	1	475.2
Cochran	0	246.1	**Mitchell**	0	1.6
Crosby	20	349.6	**Nolan**	72	41.0
Dawson	0	3.0	**Parmer**	22	343.3
Dickens	43	111.9	**Scurry**	27	17.9
Eastland	12	11.7	**Shackelford**	66	43.3
Fisher	99	89.1	**Stephens**	79	64.2
Floyd	27	254.5	**Stonewall**	45	49.3
Garza	31	97.7	**Swisher**	0	46.6
Hale	43	221.6	**Taylor**	218	244.6
Haskell	120	226.4	**Terry**	0	27.4
Hockley	22	625.7	**Throckmorton**	78	65.3
Jones	163	189.0	**Young**	74	53.1

Transportation can also mean other methods of travel, such as airports. Table 2-9 shows a summary of airfields impacted by the existing flood risk.

TABLE 2-9 SUMMARY OF AIRFIELDS WITH EXISTING FLOOD RISK

County	Number of Airfields at Risk	County	Number of Airfields at Risk
Castro	1	**Hockley**	1
Cochran	1	**Jones**	2
Fisher	1	**Knox**	2
Floyd	1	**Lamb**	1
Hale	1	**Lubbock**	1

Health and Human Services

Floods can have an extensive impact on the health of the public, directly and indirectly. Most flood-related deaths are from drowning, but physical trauma, heart attacks, electrocution, carbon monoxide poisoning, and fire also account for flood-related mortalities. Furthermore, flooding can damage and restrict access to health care infrastructure, leading to loss of health care. Two hospitals are within the 1% annual chance storm event floodplain, and a total of nine hospitals are within the 0.2% annual chance storm event floodplain. Table 2-10 shows a summary of hospitals at risk

TABLE 2-10 SUMMARY OF HOSPITALS WITH EXISTING FLOOD RISK

County	Number of Hospitals at Risk	County	Number of Hospitals at Risk
Cochran	1	**Jones**	1
Crosby	1	**Lubbock**	3
Floyd	1	**Stephens**	1
Hockley	1		

Water Supply and Water/Wastewater Treatment

Floods can contaminate water supply sources such as wells, springs, and lakes/ponds through polluted runoff laden with sediment, bacteria, animal waste, pesticides, and industrial waste and chemicals. Floods can also damage or render inoperable water treatment plants to further incapacitate a community's water supply.

Due to their usual proximity to active water bodies such as rivers and streams, multiple wastewater outfalls are located in the 1% annual chance storm event floodplain. Whether or not these outfalls have appropriate backflow preventers or other safety measures for high water events is undocumented. A total of 27 wastewater outfalls are located in the 1% annual chance storm event floodplain. Table 2-11 shows the quantification of wastewater outfalls in the floodplain by county.

TABLE 2-11 WASTEWATER OUTFALLS IN THE 1% ACE FLOODPLAIN

County	Count of WW Outfalls	County	Count of WW Outfalls
Baylor	1	**Lubbock**	5
Eastland	2	**Nolan**	2
Hale	2	**Shackleford**	1
Haskell	2	**Stevens**	1
Jones	4	**Taylor**	3
Knox	3	**Throckmorton**	1

Utilities and Energy Generation

A total of three power plants are within the Region 7, 1% annual chance storm event floodplain, and four total are within the 0.2% annual chance storm even floodplain. A summary of power plants at risk in Region 7 is in Table 2-12.

TABLE 2-12 POWER PLANTS WITH EXISTING FLOOD RISK

County	Number of Power Plants at Risk	County	Number of Power Plants at Risk
Crosby	1	**Garza**	1
Haskell	1	**Kent**	1

Region 7 is also known for oil and gas drilling, and the landscape is dotted with pumps, storage tanks, and other refining equipment. Natural resources, such as petroleum, often are found in conjunction with water; therefore, there are a significant number of oil and gas features within the floodplain in Region 7, totaling more than 7,200. Table 2-13 shows the number of oil and gas features at-risk by county.

TABLE 2-13 OIL AND GAS FEATURES WITH EXISTING FLOOD RISK

County	Count of Oil and Gas Facilities at Risk	County	Count of Oil and Gas Facilities at Risk
Archer	131	**Kent**	114
Bailey	0	**King**	59
Baylor	126	**Knox**	221
Borden	5	**Lamb**	36
Callahan	448	**Lubbock**	214
Castro	0	**Lynn**	41
Cochran	57	**Mitchell**	0
Crosby	196	**Nolan**	47
Dawson	0	**Parmer**	0
Dickens	63	**Scurry**	116
Eastland	68	**Shackelford**	800
Fisher	204	**Stephens**	635
Floyd	1	**Stonewall**	198
Garza	558	**Swisher**	0
Hale	67	**Taylor**	137
Haskell	174	**Terry**	1
Hockley	1142	**Throckmorton**	451
Jones	435	**Young**	543

Emergency Services

Fire stations, law enforcement facilities, and shelters are all key components of emergency response. When these critical facilities are at flood risk their ability to respond to others during a flood event is limited. Table 2-14 summarizes the emergency services in Region 7 at risk.

TABLE 2-14 EMERGENCY SERVICES WITH EXISTING FLOOD RISK

County	Number of Fire Stations at Risk	Number of Law Enforcement Facilities at Risk	Number of Shelters at Risk
Bailey	0	2	1
Baylor	0	0	2
Cochran	1	1	1
Crosby	0	2	0
Dickens	1	1	0
Fisher	1	0	0
Floyd	0	1	0
Hale	2	0	2
Haskell	1	3	2
Hockley	0	3	2
Kent	0	0	1
Knox	2	1	2
Lamb	0	0	2
Lubbock	3	4	1
Lynn	0	2	0
Nolan	1	0	0
Taylor	0	0	2
Young	1	0	0

Agriculture

The 2020 FEMA National Risk Index data was used to calculate an estimated value of agricultural areas (crops and livestock) exposed to flooding. The FEMA National Risk Index only analyzes the existing 1% annual chance storm event flood risk. This approach does not include potential agricultural losses if a 0.2% annual chance storm event (or greater) was to occur. The value of agricultural areas exposed to flooding are documented in Table 2-15 and summarized by county.

TABLE 2-15 AGRICULTURAL AND RANCHING AT EXISTING FLOOD RISK

County	Total Value	Value at 100-year Risk	% of Value at Risk
Archer	$72.44 M	$297,000	0.4%
Bailey	$357.02 M	$317,000	0.1%
Baylor	$53.75 M	$1,109,000	2%
Borden	$28.79 M	$2	0%
Callahan	$31.24 M	$3,800	0.01%
Castro	$1,121.60 M	$98,210,000	9%
Cochran	$87.62 M	$7,500	0.01%
Crosby	$86.90 M	$40,000	0.1%
Dawson	$121.30 M	$2,565,000	2%
Dickens	$26.86 M	$2,000	0.01%
Eastland	$23.52 M	$969,000	4%
Fisher	$35.74 M	$17,000	0.1%
Floyd	$0.00 M	$0	0%
Garza	$22.12 M	$1,000	0.01%
Hale	$411.70 M	$50,699,000	12%
Haskell	$54.32 M	$1,938,000	4%
Hockley	$92.02 M	$10,554,000	12%
Jones	$41.49 M	$3,040,000	7%
Kent	$9.87 M	$0	0%
King	$13.77 M	$0	0%
Knox	$60.53 M	$13,000	0.02%
Lamb	$537.32 M	$517,000	0.1%
Lubbock	$219.47 M	$27,238,000	12%
Lynn	$111.43 M	$21,000	0.02%
Mitchell	$21.74 M	$660,000	3%
Nolan	$36.61 M	$1,294,000	4%
Parmer	$893.34 M	$64,000	0.01%
Scurry	$45.15 M	$1,403,000	3%
Shackelford	$16.61 M	$1,270,000	8%
Stephens	$10.62 M	$1,308,000	12%
Stonewall	$15.54 M	$3,000	0.02%
Swisher	$623.92 M	$67,244,000	11%
Taylor	$31.54 M	$3,266,000	10%
Terry	$136.94 M	$15,738,000	12%
Throckmorton	$27.26 M	$2,366,645.25	9%
Young	$21.69 M	$2,562,000	12%

Existing Conditions Vulnerability Analysis

This task uses the data from the existing flood exposure analysis to determine the vulnerability of exposed structures and population to flooding. Vulnerability is an assessment of the potential negative impact of flood hazard to communities as well as a description of the impacts. The existing condition vulnerability analysis uses the 2018 SVI data developed by the CDC.

The CDC calculates the SVI at the census tract level within a specified county using 15 social factors, including poverty, housing, ethnicity, and vehicle access, and groups them into four related themes: socioeconomic status, household composition, race/ethnicity/language, and housing/transportation. Each tract receives a separate ranking for each of the four themes, as well as an overall ranking. Figure 2-15 shows the CDC themes used in the SVI calculation.

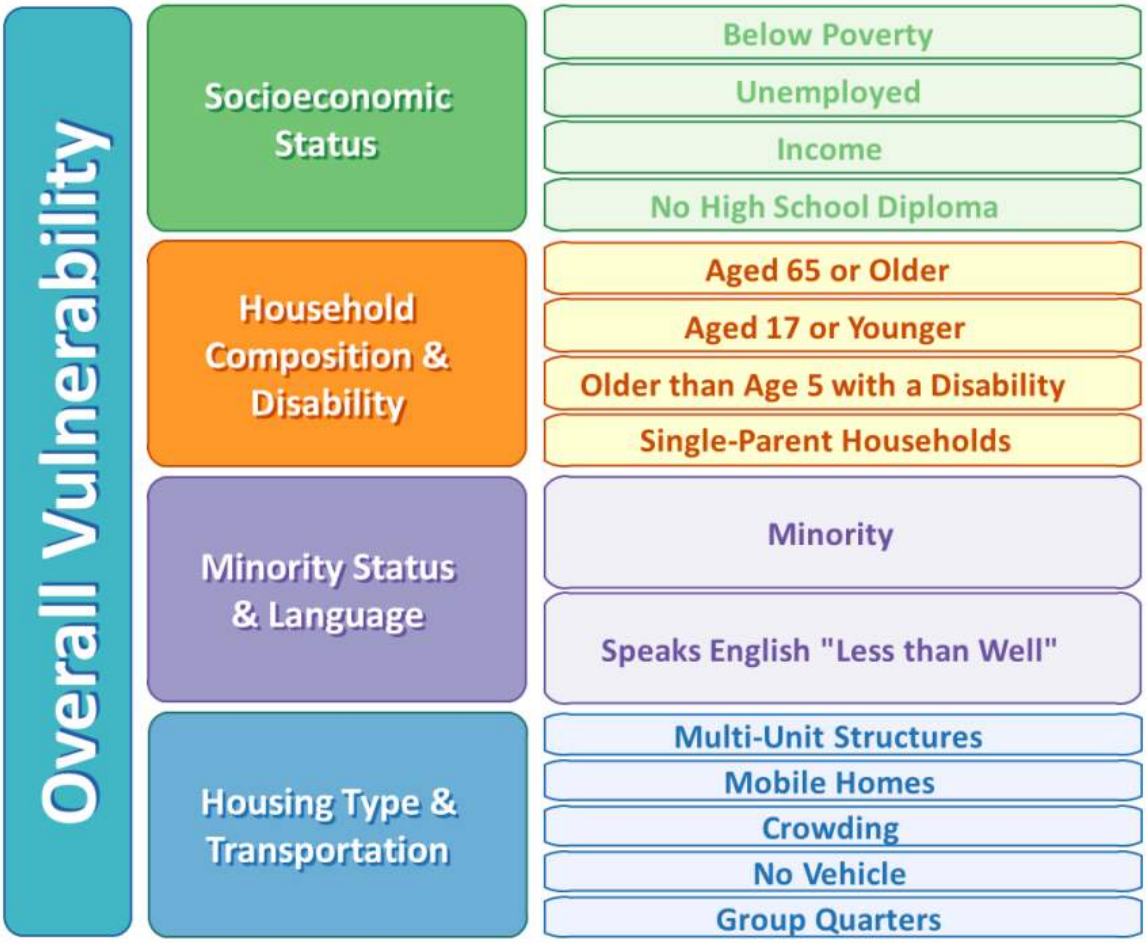


FIGURE 2-15 CDC THEMES CONSIDERED IN SOCIAL VULNERABILITY INDEX

Social vulnerability is a risk factor that represents the susceptibility of social groups to natural hazards, like floods. An SVI rating represents the relative level of a community's vulnerability compared to other similar communities. An entity's social vulnerability score is proportional to the entity's risk; a higher SVI score results in a higher Risk Index score. In other words, a community with a score closer to 0.0 is less vulnerable to the hazard. A community with a score closer to 1.0 is more vulnerable to the hazard.

The SVI is normally calculated by census tract. Within Region 7, 35 census tracks have an average SVI value higher than 0.75. Figure 2-16 shows the counties overlaid on the census tracts according to the range of SVI scores.

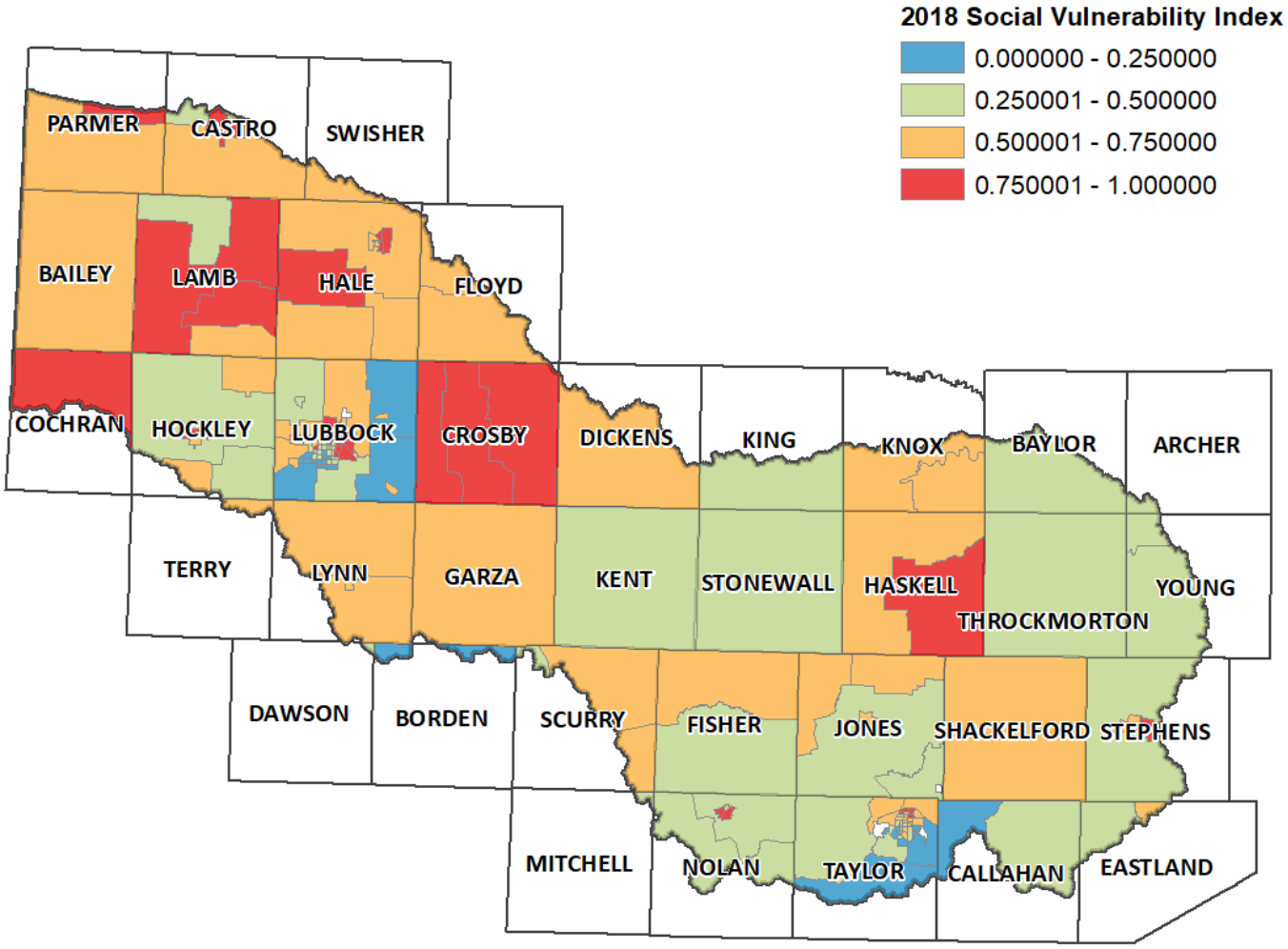


FIGURE 2-16 SOCIAL VULNERABILITY INDEX BY CENSUS TRACT

The census tracts can be averaged by area to produce SVI scores for each county. Table 2-16 shows the SVI score for each of the counties in Region 7. High SVI values (over 0.75) have been highlighted in red.

TABLE 2-16 SOCIAL VULNERABILITY INDEX BY COUNTY

County	SVI	County	SVI
Archer	0.09	**Kent**	0.44
Bailey	0.80	**King**	0.20
Baylor	0.16	**Knox**	0.80
Borden	0.06	**Lamb**	0.90
Callahan	0.30	**Lubbock**	0.75
Castro	0.78	**Lynn**	0.89
Cochran	0.86	**Mitchell**	0.62
Crosby	0.94	**Nolan**	0.89
Dawson	0.95	**Parmer**	0.76
Dickens	0.88	**Scurry**	0.70
Eastland	0.81	**Shackelford**	0.69
Fisher	0.43	**Stephens**	0.89
Floyd	0.83	**Stonewall**	0.32
Garza	0.72	**Swisher**	0.97
Hale	0.93	**Taylor**	0.69
Haskell	0.98	**Terry**	0.99
Hockley	0.90	**Throckmorton**	0.27
Jones	0.63	**Young**	0.55

Resiliency of Communities

Community resilience is a measure of the ability of a community to prepare for anticipated natural hazards, adapt to changing conditions, and withstand and recover rapidly from disruptions. FEMA has created a Resilience Analysis and Planning Tool (RAPT) that calculates the resiliency of a community (in this case, by county) when compared to other, similar communities. RAPT takes into consideration a multitude of factors by county, including but not limited to the following:

- Population over age 65
- Population with a disability
- Population without a high school diploma
- Unemployed population
- Population lacking health insurance
- Households with limited English proficiency
- Single-parent households
- Households without a vehicle
- Public schools per 5,000 residents
- Hospitals per 10,000 residents

Community resilience score is inversely proportional to a community's risk. A higher community resilience score results in a lower risk index score. Zero is average resilience for similar communities. A positive number between 0 and 1 indicates better resilience than similar communities, and a negative number between -1 and 0 indicates less resilience than similar communities. Table 2-17 shows the resiliency score for the counties in Region 7 as calculated by RAPT.

TABLE 2-17 RESILIENCY SCORE BY COUNTY

County	Resiliency Score*	County	Resiliency Score*
Archer	0.33	**Kent**	-0.40
Bailey	-0.08	**King**	0.23
Baylor	0.32	**Knox**	-0.01
Borden	0.19	**Lamb**	-0.18
Callahan	-0.10	**Lubbock**	-0.01
Castro	-0.25	**Lynn**	-0.22
Cochran	-0.24	**Mitchell**	0.06
Crosby	-0.18	**Nolan**	-0.15
Dawson	-0.36	**Parmer**	-0.01
Dickens	-0.48	**Scurry**	0.00
Eastland	-0.20	**Shackelford**	0.00
Fisher	0.18	**Stephens**	-0.24
Floyd	-0.05	**Stonewall**	0.66
Garza	-0.24	**Swisher**	-0.36
Hale	-0.11	**Taylor**	0.07
Haskell	-0.44	**Terry**	-0.41
Hockley	-0.07	**Throckmorton**	0.07
Jones	-0.23	**Young**	-0.03

*0 is average resilience for similar communities. A positive number indicates better resilience, and a negative number indicates less resilience.

Certain documentation can help promote a community's flood resiliency, such as HMAPs or floodplain ordinances. The creation of these and similar publications indicate an awareness of guidelines and best practices where flood resiliency is concerned. Table 2-18 shows which communities have HMAPs and/or floodplain management ordinances.

HMAPs are not an indicator of the likelihood of a given hazard. HMAPs simply provide a structure for response in the case that a hazard occurs. Counties may choose to not prepare HMAPs due to a perceived lack of hazards, as is well within their rights. That being said, counties and communities without HMAPs can be considered to be less resilient than those with HMAPs, sheerly from a preparedness standpoint. Currently, TDEM has an HMAP on file for 28 of the counties in Region 7 (78%). Eight counties (22%) do not have an HMAP on file with TDEM, or the plan on file has expired.

Like HMAPs, floodplain ordinances (FOs) are also not an indicator of a flood event; however, they are an indicator of resiliency in a community. Much of the state is experiencing unprecedented population growth and development along with a likely increase in rainfall caused by climate variability. While Region 7 may not be as significantly impacted by these factors, floodplain ordinances help guide the community to develop safely and with minimal impacts to the day-to-day lives of their constituents in the case of a flood event. Currently, only 21 of the counties (58%) in Region 7 have floodplain ordinances on file with the NFIP or with the TWDB. Fifteen counties (42%) do not have floodplain ordinances on file.

This listing does not consider any individual cities, towns, or other smaller jurisdictions within a county that may have adopted more stringent floodplain ordinances than the counties where they reside.

TABLE 2-18 AVAILABILITY OF RESILIENCY FEATURES BY COUNTY

County	HMAP?	FO?	Year of FIRM?	County	HMAP?	FO?	Year of FIRM?
Archer	Yes	Yes	2021	**Kent**	Yes	Yes	-
Bailey	No	Yes	-	**King**	No	No	-
Baylor	Yes	Yes	-	**Knox**	Yes	No	-
Borden	No	Yes	-	**Lamb**	Yes	No	-
Callahan	Yes	Yes	-	**Lubbock**	Yes	Yes	2017
Castro	Yes	Yes	-	**Lynn**	Yes	No	-
Cochran	Yes	Yes	-	**Mitchell**	Yes	Yes	-
Crosby	No	Yes	-	**Nolan**	Yes	No	1990
Dawson	No	No	2011	**Parmer**	Yes	No	-
Dickens	Yes	Yes	-	**Scurry**	Yes	No	-
Eastland	Yes	Yes	1997	**Shackelford**	Yes	Yes	-
Fisher	Yes	No	2011	**Stephens**	Yes	Yes	2019
Floyd	No	Yes	-	**Stonewall**	Yes	No	-
Garza	Yes	Yes	-	**Swisher**	Yes	No	-
Hale	No	Yes	2011	**Taylor**	Yes	Yes	2012
Haskell	Yes	No	1987	**Terry**	Yes	No	-
Hockley	No	No	-	**Throckmorton**	Yes	Yes	-
Jones	Yes	No	2011	**Young**	Yes	Yes	2019

The last visible feature to consider concerns the date of the FIRM data in the area, where available. FIRM data may be considered outdated if a county has experienced significant development, land use changes, or topographic alterations (such as riverine erosion or similar) since the FIRM was created.

In the case of Region 7, it is assumed that counties with Flood Insurance Study (FIS) data have relatively current data due to the rural nature of the basin and the hardy soils that do not promote erosion. Much of the basin has not had an FIS completed, with FEMA flood data available for only 12 counties (33%).

Vulnerability of Critical Facilities

The 2018 CDC SVI data was overlaid with the critical facility dataset for Region 7 in order to attribute their associated SVI values. The SVI values for the critical facilities are summarized and compared to county averages in Table 2-19. High SVI values (over 0.75) have been highlighted in red.

TABLE 2-19 SUMMARY OF SVI VALUES

County	County-wide Average	Critical Facility Average	Difference (County – Crit. Facility)
Bailey	0.75	0.75	0.00
Baylor	0.31	0.31	0.00
Castro	0.64	0.79	-0.15
Cochran	0.79	0.79	0.00
Crosby	0.78	0.78	0.00
Dickens	0.69	0.69	0.00
Eastland	0.41	0.40	0.01
Fisher	0.49	0.65	-0.17
Floyd	0.71	0.71	0.00
Garza	0.69	0.69	0.00
Hale	0.76	0.60	0.15
Haskell	0.78	0.77	0.01
Hockley	0.71	0.69	0.01
Jones	0.50	0.56	-0.05
Kent	0.41	0.41	0.00
Knox	0.65	0.65	0.00
Lamb	0.73	0.82	-0.08
Lubbock	0.48	0.48	-0.01
Lynn	0.64	0.75	-0.11
Nolan	0.45	0.42	0.02
Shackelford	0.62	0.62	0.00
Stephens	0.68	0.86	-0.17
Taylor	0.45	0.37	0.08
Throckmorton	0.42	0.42	0.00
Young	0.46	0.46	0.00

Not all counties are listed in the table as not all counties in Region 7 have critical facilities within their limits, speaking to the rurality of the region. For Bailey, Baylor, Cochran, Crosby, Dickens, Garza, Kent, Shackelford, Throckmorton, and Young counties, the critical facility SVI closely matches the county average. For the remaining counties, a positive result indicates that the critical facility is less vulnerable than the community on average, which is usually a more desirable result. The negative result, however, means the critical facility is more vulnerable to disasters than the rest of the county on average. For Castro, Fisher, and Stephens counties, the critical facilities are especially at risk.

Summary of Existing Conditions Flood Exposure Analysis and Vulnerability

The existing flood risk, exposure, and vulnerability for Region 7 are summarized in Appendix B Required Table 3. Appendix B Required Table 3 provides the results of the existing flood exposure and vulnerability analysis by county as outlined in the *Technical Guidelines* for Regional Flood Planning.

Task 2B. Future Conditions Flood Risk Analyses

Future Conditions Flood Hazard Analysis

For the 2020 – 2023 planning cycle, RFPGs were tasked with performing a future condition flood evaluation to determine the potential location of both the 1% and 0.2% annual chance storm event flood hazard. The estimated floodplain changes will be used solely for the purpose of estimating the general magnitude of potential future increases in flood risk under the equivalent of a "do-nothing" or "no-action" alternative. The projected future floodplain extents within the regional flood planning context will not, in any way, be used for developing new flood extent maps for any regulatory purposes.

In areas where future condition flood hazard data are not already available, the *Technical Guidelines* for Regional Flood Planning outlines the following 4 methods for performing future condition flood identification.

- Method 1: Increase floodplain extents based on projected population increase (as proxy for development of land areas)
- Method 2: Utilize the existing condition 0.2% annual chance storm event floodplain as a proxy for the future 1% annual chance storm event floodplain
- Method 3: Combination of methods 1 and 2 or an RFPG-proposed method
- Method 4: Request TWDB for a Desktop Analysis

The Upper Brazos RFPG was presented options from the 4 methods and selected two unique approaches for future conditions flood analysis for the two topographic regions found in the basin. The following summarizes the direction of the RFPG.

- The RFPG selected to maintain the existing flood extents for the 1% and the 0.2% annual chance storm events for the approximation of future risk on the Caprock.
- The RFPG selected an off Caprock approach for the potential future 1% annual chance flood extent to be approximated as a range of the existing 1% ACE as a minimum and existing 0.2% annual chance event as a maximum. The RFPG selected holding the existing 0.2% annual chance flood extent as the future 0.2% annual chance flood extent until further studies are available in the Region.
- The RFPG also expressed concerns regarding the public perception of the potentially larger future flood risk extents and the possibility of these flood risk areas being used for regulatory purposes. Both of these concerns have been addressed by the Technical Consultant.

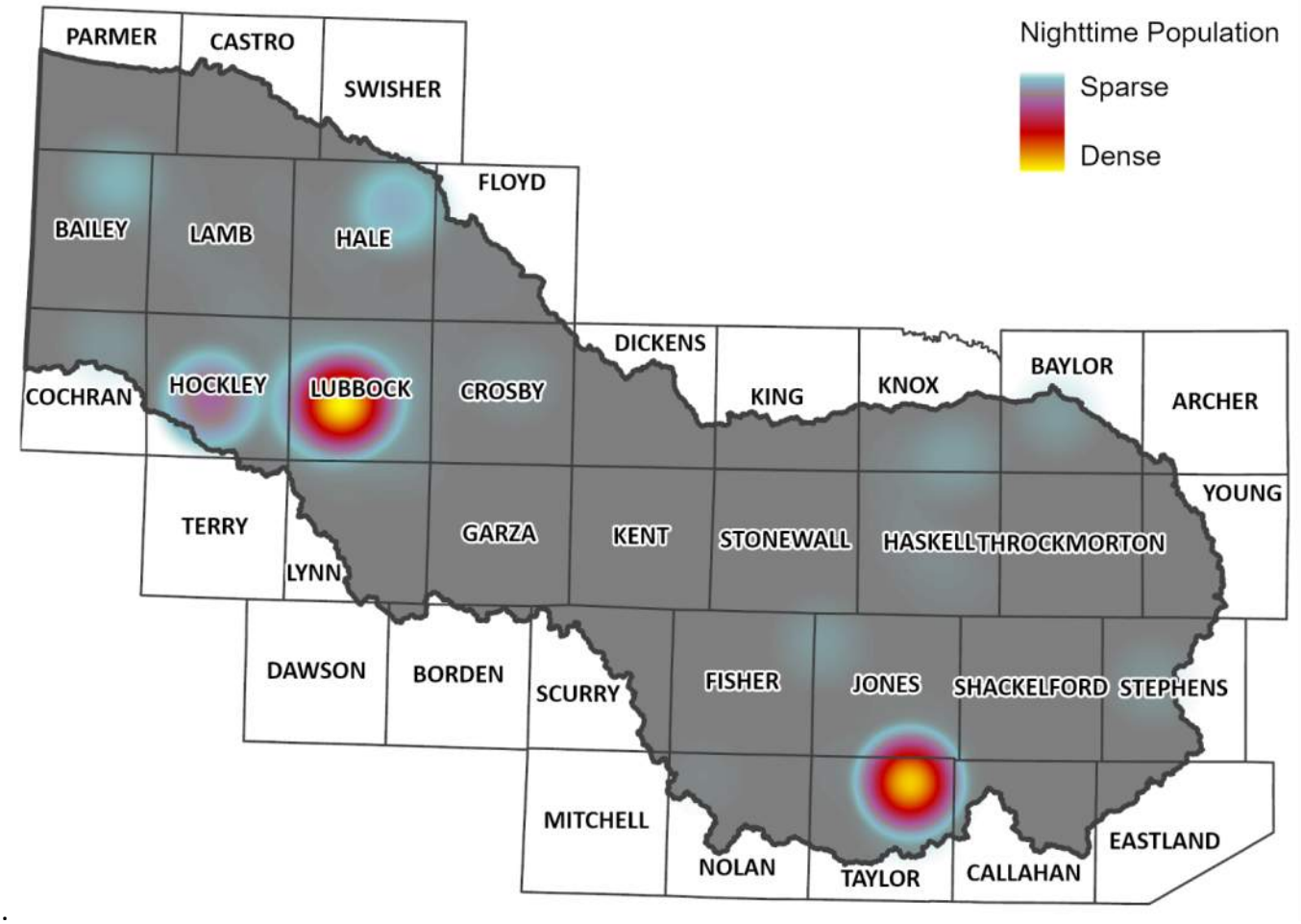
The following sections discuss the considerations for the Future Conditions Flood Hazard Analysis.

Future Conditions Based on "No Change" Scenario

Population Increase

On average, Region 7 is anticipating approximately 20% growth over the next 30 years. The largest population centers in the region are the cities of Lubbock (Lubbock County) and Abilene (Taylor County). Additional municipalities on the Caprock that have significant populations relative to the region include Plainview (Hale County) and Levelland (Hockley County). Off the Caprock, the second-largest population center to Abilene is Sweetwater (Nolan County). Of these five entities, the projected population growth ranges between 5% and 15% over the next 30 years, except for Lubbock County, which anticipates a 35% population increase.

Population increases typically lead to more development that produces higher rates of runoff, directly impacting the potential future flood risk in communities. Since projected population growth is largely isolated to the five significant population centers within the Region, the extent of population growth due to increased development is considered limited. Thus, population increases are not anticipated to have a large impact on the potential future flood risk. Figure 2-17 shows the nighttime population heat map for the Upper Brazos Region.



.

FIGURE 2-17 NIGHTTIME POPULATION HEAT MAP

Land Use and Development Trends Under Current Floodplain Management Practices

As indicated by the Nighttime Population Heat Map, most of the development is expected to occur around the two current population centers: one on the Caprock (City of Lubbock) and one off the Caprock (City of Abilene).

The anticipated population growth in the City of Lubbock over the next 30 years indicates that development, too, will expand around the city with comparable rates for land use changes. The City of Lubbock is the major population center on the Caprock that is anticipated to see the greatest population increase in the future. The City already proactively requires future fully developed conditions analysis and flood mitigation for new development that are intended to mitigate anticipated growth impacts on potential future flood risk. The portion of the region on the Caprock outside of Lubbock County is anticipated to see smaller future population increases. Lower population increases correlate to fewer expected land use changes.

The City of Abilene is off the Caprock. The development in and around the City of Abilene is expected to grow at a slower rate of increase than the City of Lubbock; however, the projected growth will impact land use and should not be ignored. Abilene is anticipating a 15% approximate growth rate in the next 30 years.

Case Study – Land Use

To help understand the potential impacts of land use changes on the Caprock, City of Lubbock models were acquired:

- FEMA's FIS Detailed Study (existing conditions) and
- Lubbock's Current Master Drainage Plan (future fully developed (FFD) conditions).

These models were compared against each other to assess differences in WSEL during the 1% and the 0.2% annual chance storm event. Since this area is largely controlled by the playa system, these comparisons were made based on storage and conveyance of the overflow and non-overflow playas in Lubbock and the surrounding area.

A comparison was made between the 1% annual chance storm event WSELs for existing conditions reported in the Lubbock County FIS and the FFD condition results from the City of Lubbock's ongoing MDP studies. The average WSEL differences are located in Table 2-20.

TABLE 2-20 PLAYA AVERAGE WSEL COMPARISONS (LAND USE)

Playa Type	Existing vs Future Land Use 1% ACE
Overflow	0.5 ft
Non-Overflow	0.6 ft

Region 7 as a whole is not anticipating widespread land use changes. The City of Lubbock, where the most significant development is occurring, is proactively accounting for the increase in development by requiring FFD analysis and mitigation in the undeveloped and developing portions of the city. The flood

risk within the City and its annexed areas is being redefined through the City's ongoing MDP effort to account and plan for the potential future flood hazard due to development. Outside of the City of Lubbock, the development in Region 7 is minimal, thus reducing the need to account for land use changes in future conditions for the next 30 years.

Future Changes in Rainfall Patterns

Rainfall patterns may change in the future, which is an important consideration when considering future impacts to flood risk. The State Climatologist has analyzed the weather trends and patterns within Texas to estimate potential future rainfall characteristics[21].

The Climatologist's Report suggested future rainfall depths for urbanized areas across Texas should increase 12% to 20% from current rainfall depths. In Region 7, the projected population increases are limited to the City of Lubbock on the Caprock and the City of Abilene off of the Caprock. The City of Lubbock MDP was leveraged by the Technical Consultant to run a sample increased rainfall analysis. The results of the analysis are detailed in the section below, Case Study – Future Rainfall Patterns.

The Climatologist's Report also notes that future rainfall events are anticipated to be more intense, but less frequent. Therefore, while the annual rainfall depth totals may not change much, but the intensity of storms in the area could increase significantly.

Case Study – Future Rainfall Patterns

The City of Lubbock's current MDP was developed using FFD land use, and appropriately represents the maximum impervious cover. Samples of overflow and non-overflow playas were selected for analyzing the future condition 1% annual chance storm event. The future 1% annual chance storm event was simulated by increasing the existing 1% annual chance rainfall depths by 12%, the maximum as recommended by the Climatologist's report. A 12% increase was used as opposed to a 20% increase due to the indication that rural areas will see smaller rainfall depth increases than urban areas.

Comparisons between the resulting WSELs based on simulations with the current Atlas 14 rainfall and the 12% increase in rainfall were made for the 1% annual chance storm event only. The current Atlas 14, 1% annual chance storm event, 24-hour depth for the City of Lubbock is 6.8 in. With a 12% increase, the depth rises to 7.62 in. The differences in water surface elevations are summarized below in Table 2-21.

TABLE 2-21 PLAYA AVERAGE WSEL COMPARISONS (FUTURE RAINFALL PATERNS)

Playa Type	Future 1% ACE vs 12% Rainfall Increase
Overflow	0.1 ft
Non-Overflow	0.4 ft

Non-overflow playas showed a 0.4-foot increase, suggesting that using the existing 0.2% annual chance storm event as the future 1% annual chance storm event would likely overestimate the future flood

[21] Office of the Texas State Climatologist. 2021. Climate Change Recommendations for Regional Flood Planning: https://climatexas.tamu.edu/files/CliChFlood.pdf

extents. Overflow playas showed an increase of 0.1 feet, which was considered negligible when evaluating floodplain mapping impacts.

Additionally, the Office of the State Climatologist stated that future rainfall pattern change is negligible in areas of limited projected population growth. The projected population increase on the Caprock is largely limited to the City of Lubbock where playa maintenance occurs to maintain storage volumes. Thus, the impacts of future rainfall patterns are considered negligible. Off the Caprock, the population centers are limited to the City of Abilene, with the rest of the off-the-Caprock area also experiencing minimal growth in terms of population and development.

Infiltration Impacts

Rural areas have an additional layer of complexity that factors into the impacts of climate variability: soil infiltration. Increases in rainfall amounts and the efficiency at which the soil absorbs the water may impact the acreage of crops that are put into production or even the types of crops that can grow in the area.

Despite the potential increase in rainfall, rural areas also must consider soil moisture as a factor in the resulting stream flows and flood events from more intense precipitation. According to the Climatologist's Report, more intense rainfall may not translate to higher flood risk if the soil moisture is low enough at the beginning of the intense rainfall event. Therefore, for the purposes of future condition flood risk, the minimum net increase in rainfall in rural areas may be a negative percentage. This phenomenon is present in Table 2-22, which details percentages of projected increase for rainfall across Region 7.

TABLE 2-22 RANGE OF POTENTIAL FUTURE RAINFALL INCREASE

Location	2021 Minimum	2021 Maximum	2050-2060 Minimum	2050-2060 Maximum
Urban Areas	5%	12%	12%	20%
Rural Areas/River	-2%	5%	-5%	10%

Since Region 7 is projected to have limited population growth, most of the region will fall in the rural future flood risk range of -5% to +10%. Even in the population centers, the region does not anticipate any large increase of impervious cover typically brought on by development. Therefore, this low population range suggests an average negligible change in the foreseeable future. Areas of high population growth will want to evaluate future impacts as development occurs within their jurisdictions.

Sedimentation

A large part of the surface water runoff patterns on the Caprock depend on the playas. Recent growth on the Caprock has sparked some concern over the potential sedimentation in the playas that would ultimately impact the available flood storage capacity within the playa systems.

There is limited data and research on playas that serve as storm water storage and conveyance systems such as the playa system in West Texas. Urbanized areas on the Caprock, such as the City of Lubbock, have playa maintenance and operation measures in place to ensure the community playas continue to

provide flood storage capacity. Bathymetric analyses as well as additional research and evaluation of playa sedimentation and disturbance to compacted playa soils could update previous studies and inform the potential future impacts on playa infiltration rates to the aquifers and the water table. The Texas Playa Conservation Initiative discussed in Task 1 is a project striving to protect playa infiltration rates and promote land practices to limit sedimentation in playas.

Sedimentation can also impact the rivers in Region 7. Report 268, Erosion and Sedimentation by Water in Texas[22] compiles studies completed for the state by the U.S Soil Conservation Service, considering 20-plus years of data and the impacts of erosion and sedimentation to water ways. Due to the playa systems, the Caprock was considered to be a non-contributing area to sediment in the overall study and analysis of the Brazos River Basin.

Future Conditions Hydrologic & Hydraulic Model Availability

As there are very few H&H models for existing conditions available in Region 7, it is not surprising that there are few future condition models available. The City of Lubbock is currently the only entity within Region 7 that produces future condition projections in their case for land use and development within the city limits as part of their MDP. These future condition land use projections indicate where development is expected to occur and what type of development (residential, commercial, industrial, etc.) is anticipated. The City of Lubbock requires developers to use this data to determine the anticipated increases in runoff and drainage in their designs and to mitigate these increases associated with the proposed development based on future conditions.

These models were used to inform the Upper Brazos RFPG of future conditions in the area but are site-specific and cannot suffice for the entire region. Furthermore, the Lubbock MDP does not account for changes in future rainfall, only changes in future land use. The City of Lubbock models were used to inform the future condition flood risk approach; however, they were not the only items considered in the creation of the future condition flood risk.

Hydrologic & Hydraulic Models without Future Conditions

While the City of Lubbock is the only entity currently developing models with future land use considerations, other entities within the region have models that represent current conditions. These models are not appropriate for estimating future conditions without additional information, so they have not been used to determine the future condition floodplains. However, they are useful in quantifying the impact of anticipated development in the area.

Best Available Data

The Upper Brazos Region has limited available studies and thus is utilizing the Cursory Fathom floodplains to estimate existing flood risk in approximately 86% of the region. Compared to traditional flood studies, these cursory floodplains identify a significant increase in potential flood risk.

---

[22] Texas Department of Water Resources. 1979. Report 268 Erosion and Sedimentation by Water in Texas: https://www.twdb.texas.gov/publications/reports/numbered_reports/doc/R268/R268_opt.pdf

Due to the expansive nature of the cursory floodplains as compared to available studies, the RFPG was concerned about the overestimation of flood risk if a horizontal buffer were to be utilized for future conditions. Furthermore, the RFPG was wary of how the public may respond to increased floodplain extents. Since the existing 1% annual chance Cursory Fathom floodplain extents are more expansive than the current FEMA floodplains in the Region, applying a buffer to the existing conditions hazard area would overly exaggerate flood risk, potentially causing unfavorable public perception.

The Upper Brazos RFPG is aware that BLE efforts are currently underway and should be completed by 2024. This effort will provide high level engineering models that could be used to validate existing and future flood risk in future planning cycles.

1% and 0.2% Annual Chance Storm Event Floodplains

A procedure for generating potential future 1% and 0.2% annual chance flood risk data that generally follows the TWDB's *Technical Guidelines* was developed for Region 7. However, due to the significant differences between the regions on the Caprock and off the Caprock, two different approaches were necessary. The future conditions approach for each watershed are shown in Appendix D Task 2 Future Conditions Approach Map.

On the Caprock

Due to the limited projected population growth and minimal rainfall changes anticipated for western Texas in the future, the RFPG selected to hold the current existing 1% and 0.2% annual chance flood extents for future conditions. The main population center on the Caprock, the City of Lubbock, has existing floodplain management practices that account for future conditions. Although at this time there is no research to suggest sedimentation of playas to be a concerning factor to storm water facilities, the region would benefit from further evaluation of potential long-term impacts of playa sedimentation and infiltration.

Off the Caprock

A noted lack of data hindered analyses to determine the effects of land use and future rainfall pattern changes off the Caprock. Changes in future rainfall patterns are considered negligible for most if not all of Region 7 due to the largely undeveloped nature of the basin. Land use is expected to develop minimally off the Caprock, however, some development is anticipated.

To account for the slight changes in land use and lack of stormwater maintenance as seen on the Caprock in developing areas, the RFPG determined that the future 1% annual chance potential flood risk areas should be represented by a "range" of possible flooding extents. The minimum extent shall be represented by the existing 1% annual chance storm event and the maximum extent represented by the existing 0.2% annual chance storm event. The future 0.2% annual chance storm event is to be maintained as-is and is therefore represented by the existing 0.2% annual chance storm event extents.

These methodologies were selected after reviewing the case studies mentioned above and anticipated impacts throughout Region 7. The region is not anticipating an overall large change in population or development within the next 30 years, except in very select areas. Furthermore, according to the State

Climatologist's Report, the increase in rainfall depths in rural areas (which comprise most of Region 7) is minimal. Accompanied by the soil infiltration increases, changes in future rainfall patterns will likely produce a minimal effect on the floodplains within Region 7. Overall, conditions in Region 7 in 30 years are expected to remain similar to current existing conditions.

Table 2-23 shows a summary of future flood type (riverine, playa, and urban) by county and frequency. Note the table does not include coastal flooding quantifications as no portion of the Upper Brazos Basin intersects the coastline.

TABLE 2-23 REGION 7 SUMMARY OF FUTURE FLOOD TYPE BY COUNTY

Area by County (sq. mi.)	Riverine 1%	Riverine 0.2%	Playa 1%	Playa 0.2%	Urban 1%	Urban 0.2%
Archer	3.4	3.4	-	-	-	-
Bailey	-	-	181.4	286.0	-	-
Baylor	111.6	111.6	-	-	-	-
Borden	6.6	6.6	5.2	7.5	-	-
Callahan	80.4	80.4	-	-	-	-
Castro	-	-	57.5	82.5	-	-
Cochran	-	-	118.9	189.2	-	-
Crosby	88.9	88.9	92.9	149.8	-	-
Dawson	-	-	0.4	0.6	-	-
Dickens	147.0	147.0	1.8	2.7	-	-
Eastland	25.2	25.2	-	-	-	-
Fisher	151.1	151.1	-	-	-	-
Floyd	3.5	3.5	68.5	115.8	-	-
Garza	199.6	199.6	23.0	37.4	-	-
Hale	122.6	122.6	-	175.8	-	-
Haskell	275.1	275.1	-	-	-	-
Hockley	-	-	161.6	283.8	-	-
Jones	213.1	213.1	-	-	-	-
Kent	206.8	206.8	-	-	-	-
King	57.3	57.3	-	-	-	-
Knox	150.5	150.5	-	-	-	-
Lamb	-	-	174.9	273.0	-	-
Lubbock	108.9	112.4	-	144.2	5.0	5.8
Lynn	-	-	115.4	183.4	-	-
Mitchell	0.6	0.6	-	-	-	-
Nolan	42.5	42.5	-	-	-	-
Parmer	-	-	42.5	66.0	-	-
Scurry	59.1	59.1	-	-	-	-
Shackelford	156.4	156.4	-	-	-	-
Stephens	165.3	165.3	-	-	-	-
Stonewall	203.5	203.5	-	-	-	-
Swisher	-	-	8.6	12.9	-	-
Taylor	88.7	88.7	-	-	-	-
Terry	-	-	6.0	9.0	-	-
Throckmorton	209.7	209.7	-	-	-	-
Young	121.9	121.9	-	-	-	-

Data Gaps

The lack of available studies within the region limits the data that could be used to validate potential future flood risk assumptions. The RFPG understands the Cursory Fathom floodplains provide estimated flood risk beyond the extents of traditional H&H modeling and may underestimate or overestimate existing flood risk in some areas. The same data gaps exist for future conditions mapping as existing conditions mapping since the existing conditions were used to develop the future extents.

The RFPG is aware that BLE efforts are currently underway and should be completed by 2024, providing high level engineering models that could be used to validate existing and future flood risk in future planning cycles.

Future Condition Flood Exposure Analysis

Existing Development within the Existing Conditions Floodplains

The Upper Brazos Region, as is true for most of Texas, is not anticipating a population decrease in or around any of its population centers. Therefore, it is unlikely that any of the existing development in the floodplain would be removed or condemned on basis of disuse.

Communities with assets in the current floodplain could decide to relocate those assets or have them reconstructed to be outside of the floodplain, however, there is no indication of any such plans throughout the region.

Existing and Future Development within the Future Conditions Floodplains

Considering that both on and off the Caprock, the maximum possible 0.2% annual chance event extents both align to the existing 0.2% annual chance event, the area of total flood risk itself is not expected to increase in the next 30 years. However, the 1% annual chance event maximum extents of future flood risk can extend as far as the existing 0.2% annual chance event flood risk. Therefore, the assets with future flood risk will increase for some areas as seen in Table 2-24. Exhibit C Table 5 also shows a more extensive quantification of future flood exposure in Region 7.

TABLE 2-24 SUMMARY OF ASSETS IN FUTURE FLOOD RISK

Regional Assets	Potential Future 1% ACE Risk	Potential Future 0.2% ACE Risk
Total Area (sq. mi.)	4,063	5,028
Total Number of Structures	35,954	54,087
Residential Structures	24,645	37,008
Population	72,040	109,284
Roadway Stream Crossings	4,632	4,694
Roadway Segments (mi.)	1,963	2,908
Area of Agriculture (sq. mi.)	140	200
Critical Facilities	100	147

Potential Flood Mitigation Projects

As previously mentioned, the data collection tool developed by the technical consultant team brought to light 17 flood-related projects in the planning phase. Additional information on potential FMPs will be discussed in Task 4.

Future Conditions Flood Exposure

The potential increase of the 1% annual chance flood risk occurring off the Caprock raises the projected impacts associated with the future 1% annual chance storm event across the Upper Brazos Region. Since the future 0.2% annual chance flood extents align with the current 0.2% annual chance storm event extents, the associated impacts do not increase and are not shown in the following tables. The existing 0.2% annual chance flood risk impacts (which are the same as the future 0.2% annual chance flood risk impacts) are available to review in Existing Conditions Flood Risk Analyses.

Inundated Structures

Elevation certificates for every structure within the region are not available and are impractical to pursue based on the large size of the analysis area. The same building footprints provided by TWDB for the existing conditions flood risk analysis were used for this future condition analysis.

Inundated structures are quantified by overlaying the existing condition floodplains over the building footprints in the region. This approach assumes that the building footprint is essentially constructed at grade and does not consider elevated foundations. Therefore, the approach may assume more structures are at risk of flooding in a 1% annual chance flood event than would be at risk if foundation elevation was considered. This information is also available to view in the Appendix B Required Table 3, as well as in Table 2-25.

TABLE 2-25 STRUCTURES IN 1% ACE FUTURE CONDITION FLOOD RISK

County	Structures in Future 1% ACE Risk	County	Structures in Future 1% ACE Risk
Archer	1	**Kent**	65
Bailey	475	**King**	3
Baylor	886	**Knox**	1,395
Borden	10	**Lamb**	438
Callahan	158	**Lubbock**	6,880
Castro	51	**Lynn**	81
Cochran	278	**Mitchell**	1
Crosby	397	**Nolan**	373
Dawson	0	**Parmer**	51
Dickens	293	**Scurry**	16
Eastland	170	**Shackelford**	550
Fisher	225	**Stephens**	992
Floyd	118	**Stonewall**	103
Garza	274	**Swisher**	5
Hale	1,318	**Taylor**	14,677
Haskell	1,398	**Terry**	4
Hockley	1,770	**Throckmorton**	169
Jones	2,066	**Young**	263

Transportation

Transportation infrastructure can be quantified by roadway crossings or routes that are impacted by flood events, such as poorly drained stretches of road or low water crossings. Roadway segments impacted by flooding result in loss of transportation routes that are needed by first responders and the public alike. These stretches were identified by overlaying the roadway network of the Upper Brazos Basin with the identified future floodplains.

Low water crossings are a common occurrence in Region 7. Additionally, runoff conveyance in many urban portions of the Caprock occur within the roadways themselves. During severe rain events, these transportation corridors may be untraversable. There are approximately 9,500 miles of roadway and 1,675 low water crossings at risk in future conditions. This information is broken down by County in Table 2-26.

TABLE 2-26 ROADWAYS IN FUTURE 1% ACE FUTURE CONDITION FLOOD RISK

County	Number of LWCs	Roadway (mi.)	County	Number of LWCs	Roadway (mi.)
Archer	1	2.6	**Kent**	41	58.6
Bailey	0	499.0	**King**	8	8.4
Baylor	63	75.8	**Knox**	31	166.3
Borden	0	5.0	**Lamb**	5	612.6
Callahan	76	67.2	**Lubbock**	89	357.5
Castro	15	280.9	**Lynn**	1	475.2
Cochran	0	246.1	**Mitchell**	0	1.7
Crosby	26	368.5	**Nolan**	80	51.3
Dawson	0	3.0	**Parmer**	22	343.5
Dickens	44	168.3	**Scurry**	30	21.0
Eastland	14	13.6	**Shackelford**	70	54.3
Fisher	104	115.5	**Stephens**	81	79.2
Floyd	29	256.7	**Stonewall**	47	73.1
Garza	32	127.3	**Swisher**	0	46.7
Hale	43	222.0	**Taylor**	230	298.0
Haskell	135	282.3	**Terry**	0	27.4
Hockley	22	625.7	**Throckmorton**	89	78.4
Jones	168	243.2	**Young**	80	82.8

Airports were previously mentioned as an impacted asset of interest. The airports listed as impacted in Section 2A are the same for future conditions, with no expectation of expanded impacts.

Health and Human Services

Two hospitals are within the 1% annual chance storm event flood extents, and a total of 9 hospitals are within the 0.2% annual chance storm event floodplain as detailed in Task 2A. The hospitals listed as impacted for existing conditions are the same for future condition.

Water Supply and Water Treatment

Floods can contaminate water supply sources such as wells, springs, playas, and lakes/ponds through polluted runoff laden with sediment, bacteria, animal waste, pesticides, and industrial waste and chemicals. Floods can also damage or render inoperable water treatment plants to further incapacitate a community's water supply.

Due to their usual proximity to active water bodies such as rivers and streams, multiple wastewater outfalls are in the 1% annual chance floodplain. Like existing conditions, 27 wastewater outfalls are located in the future conditions 1% annual chance floodplain.

No further impacts on water supply and water treatment were noted due to the possible expansion of flood risk in future conditions.

Utilities and Energy Generation

No further impacts on utilities and energy generation were noted due to the possible expansion of flood risk in future conditions.

Emergency Services

No further impacts on utilities and energy generation were noted due to the possible expansion of flood risk in future conditions. A total of 51 emergency services are at risk for flooding impacts as discussed in Task 2A.

Agriculture

The existing condition impact to agriculture is provided by the 2020 FEMA National Risk Index, but only for the 1.0% annual chance storm event. The future flood extents may cover as little as the 1.0% annual chance existing flood risk or as much as the 0.2% annual chance existing flood risk. Subsequently, a minimum of just under $295 million of agricultural lands are exposed to the future condition flood risk in the Upper Brazos Region.

Future Condition Vulnerability Analysis

Resiliency of Communities

Community resilience is a measure of the sustained ability of a community to prepare for anticipated natural hazards, adapt to changing conditions, and withstand and recover rapidly from disruptions. No anticipated changes are expected to the SVI scores for counties in Region 7. Furthermore, resiliency scores are not calculated for future conditions.

Vulnerabilities of Critical Facilities

Since the flood extents are not changing for the 0.2% annual chance floodplain, no anticipated changes are expected to the critical facilities' SVI scores as the county scores themselves are not changing from existing conditions.

The anticipated impact to critical facilities was determined by overlaying the critical facilities' locations with the future floodplains. As the future 1.0% and future 0.2% annual chance storm event are considered to not exceed the existing 0.2% annual chance floodplain, no changes are noted to the count of impacted critical facilities. Furthermore, as no future development of critical facilities has been specifically stated, the count of critical facilities at risk of flooding impacts remains the same as existing conditions. Emergency Action Plans were not immediately available for any of the critical facilities within the future condition flood risk, nor was any record of these facilities flooding otherwise noted.

Summary of Future Conditions Flood Exposure Analysis and Vulnerability

The future flood risk does not add more structures or people that are potentially impacted by flooding due to the future condition being based on existing condition extents. Furthermore, no area is added to the floodplain as the 0.2% existing and future condition flood risk extents are the same.

The future flood risk, exposure, and vulnerability assessments for Region 7 are summarized in TWDB-Appendix B Required Table 5. Table 5 provides the results per county of the future flood exposure and vulnerability analysis as outlined in the *Technical Guidelines* for Regional Flood Planning.

Task 3. Floodplain Management Practices and Flood Protection Goals

The Upper Brazos RFPG was tasked with evaluating and recommending floodplain management practices (Task 3A) and flood mitigation goals (Task 3B) within the region. This chapter describes the processes undertaken by the RFPG to achieve these tasks and summarizes the outcomes of this endeavor. While cities and counties have the authority to establish their own policies, standards, and practices to manage land use in and around areas of flood risk, the Upper Brazos RFPG is not a regulatory entity and can only recommend best practices appropriate for this region.

Task 3A. Evaluation and Recommendations on Floodplain Management Practices

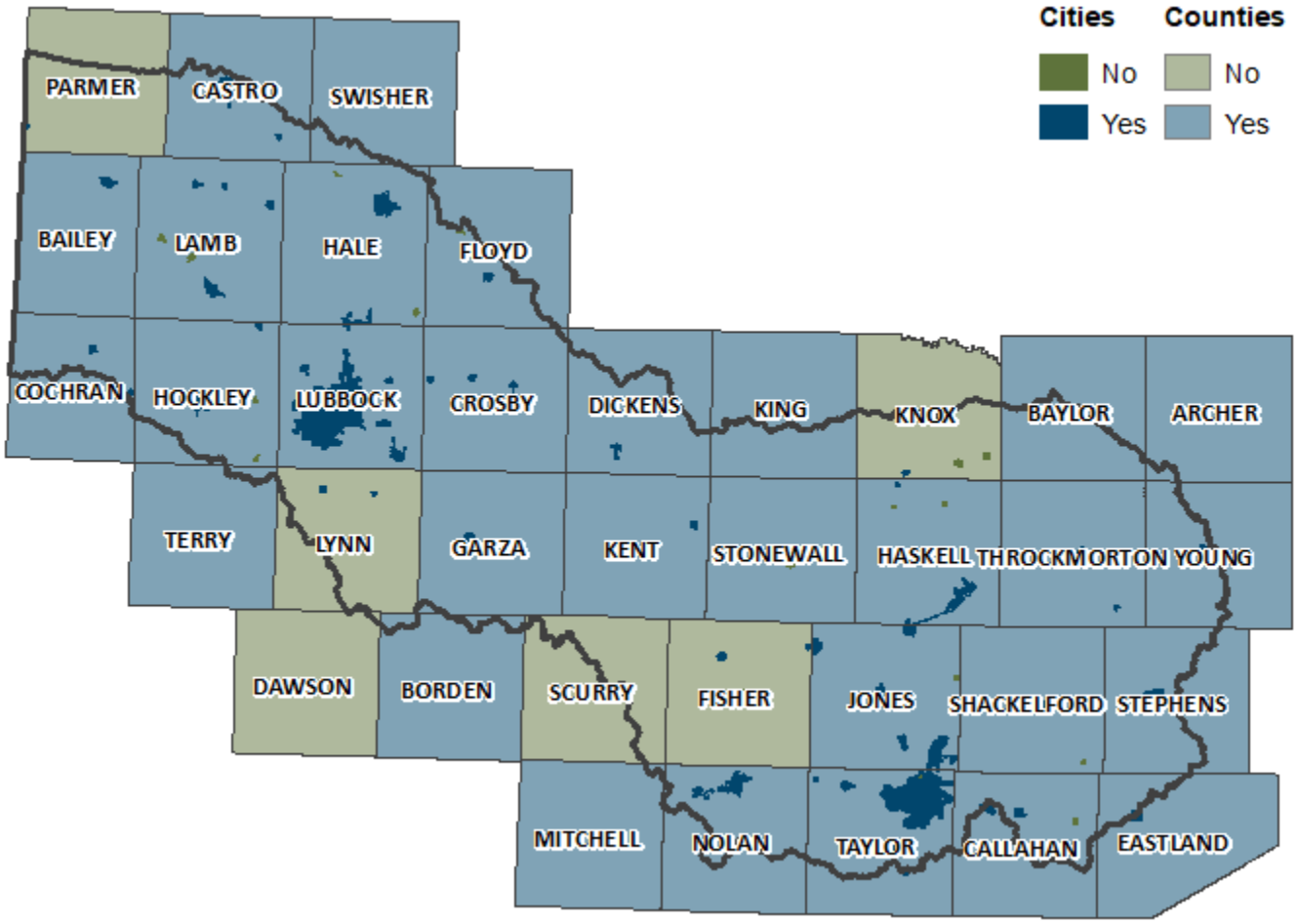


FIGURE 3-1 COMMUNITIES WITH FLOODPLAIN MANAGEMENT REGULATIONS

The initial effort under Task 3A was to collect and perform a qualitative assessment of current floodplain management regulations within the region (i.e., floodplain ordinances, court orders, drainage design standards, and other related policies). Floodplain management regulations that were readily available

on the regulatory entity's websites were first collected. Parallel to this effort, a web-based survey was sent out to each regulatory entity in the region to gather additional information.

Based on the data collected in this effort, a total of 30 out of 36 counties (83%) and 60 out of 81 cities/towns (74%) within the Region have some form of floodplain management regulation, shown on Figure 3-1. A complete inventory of floodplain management practices can be found in Appendix B Required Table 6. The remaining regulatory entities were classified as "Not Applicable" as data was not provided through the survey or data could not be found online.

Current Floodplain Management and Land Use Practices Impact to Flood Risks

Floodplain management and land use practices look at regulations, policies, and trends in the region. From a flood risk perspective, these management practices improve protection of life and property. Floodplain management and land use practices may vary widely from one entity to another. FEMA manages the NFIP program that provides the minimum standards for development in and around the floodplain.

In 1968, Congress established the NFIP through the National Flood Insurance Act of 1968 to provide federally subsidized flood insurance protection. The program has been updated multiple times since then to strengthen the program, provide fiscal soundness, and inform the public of flood risk through insurance rate maps. Title 44 of the Code of Federal Regulations (44 CFR) includes the rules and regulations of the program. 44 CFR Part 60 established the minimum criteria that FEMA requires for NFIP participation, which includes identifying SFHAs within the community.

Cities and counties who participate in the NFIP provide their residents and businesses the opportunity to purchase flood insurance to reduce the socio-economic impacts of floods, as well as makes the community eligible for disaster assistance following a flood event. Region 7 is primarily sparsely populated agricultural and ranch land, therefore many entities in the region have very small local governments with quite limited resources. Many of these rural local governments do not have the resources to enact, adopt, and enforce specific floodplain management practices, nor have they worked with FEMA to develop SFHAs and FIRMs. For this reason, most of the existing practices found in the region come from its large cities. Figure 3-2 shows the current NFIP participation across Region 7. A complete inventory of community participation in the NFIP can be found in Appendix B Required Table 6.

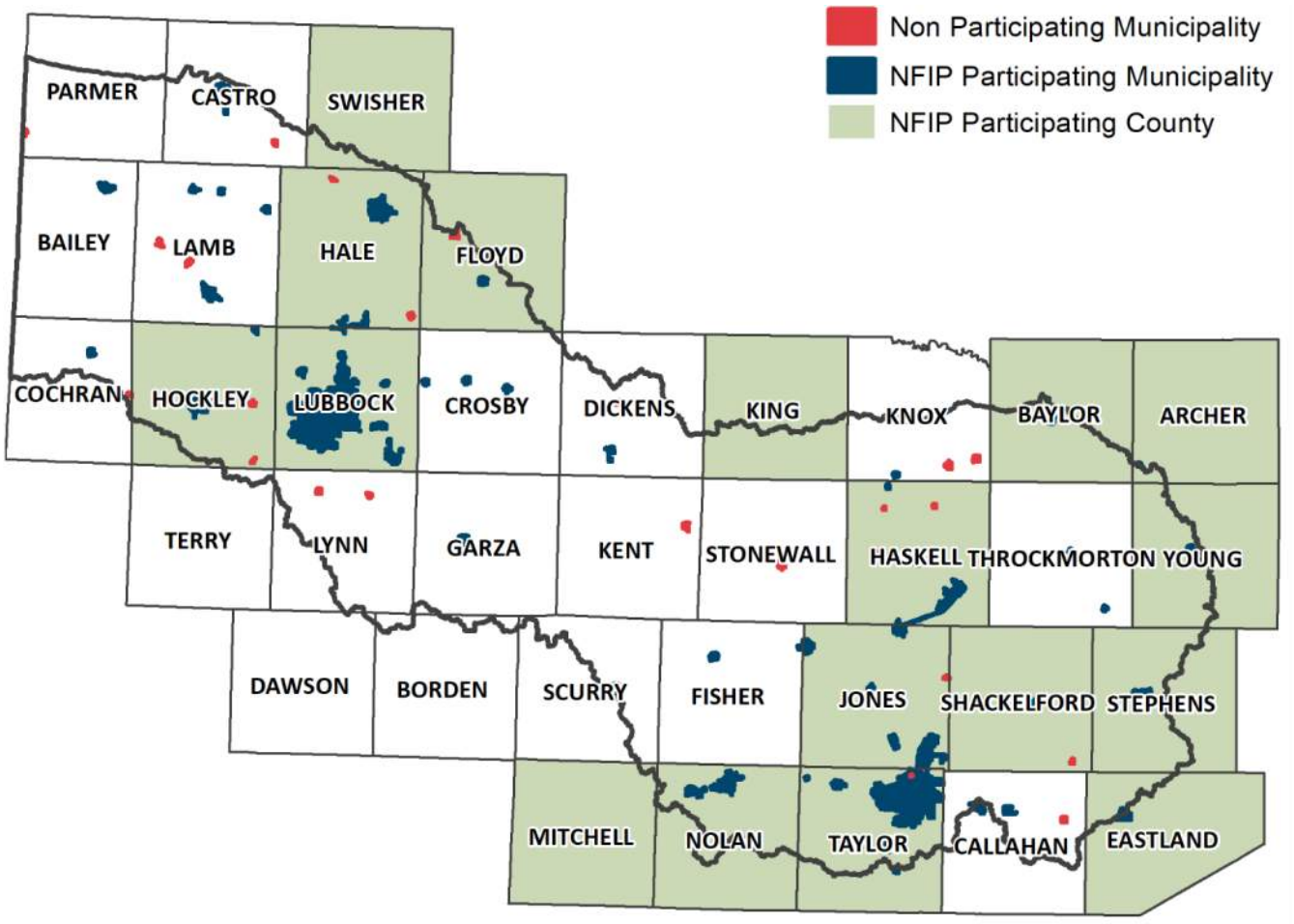


FIGURE 3-2 RATE OF NFIP PARTICIPATION

Cities and counties that choose to participate in the NFIP work with FEMA to establish BFEs and SFHAs around playas and along rivers, creeks, and large tributaries that are shown on FIRMs. The BFE is the elevation of surface water that has a 1% probability of occurring each year, also known as a 100-year flood. Communities use the FIRM, BFE, and SFHA data in their floodplain permitting processes as a requirement for participating in the NFIP. Insurance agents use FIRMs to determine flood risk, which determines the flood insurance rate for individual properties. Only 14% of the area in Region 7 has FIRMs to communicate flood risk to the public.

Cities and counties have the authority to establish their own policies, standards, and practices to manage land use in and around areas of flood risk. Participating NFIP communities (cities and counties) have the responsibility and authority to permit development that is reasonably safe from flooding. They can adopt and enforce higher standards than the FEMA NFIP minimum standards to better protect people and property from flooding. FEMA supports entities who choose to establish higher standards to better protect life and property. Communities were asked to rate their floodplain management practices in the May 2021 initial data collection survey. Communities' floodplain management practices were rated strong, moderate, low, or none. The consultant team then supplemented the survey responses

with ratings developed by reviewing available drainage criteria and ordinances. The following criteria was provided by the TWDB *Technical Guidelines*.

- None (no floodplain management practices in place)
- Low (regulations meet the minimum NFIP standards)
- Moderate (some higher standards, such as freeboard, detention requirements, or fill restrictions)
- Strong (e.g., significant regulations that exceed NFIP standard with enforcement, or community belongs to the CRS)

A summary of level of floodplain management practices is shown in Figure 3-3 below.

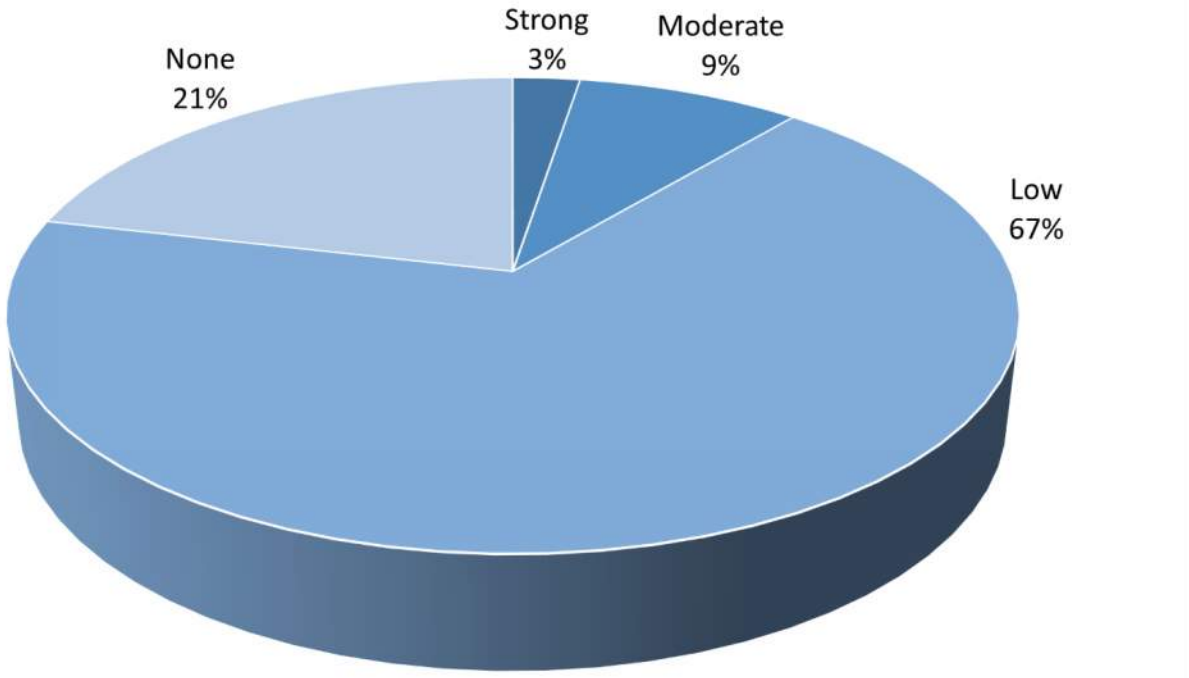


FIGURE 3-3 UPPER BRAZOS FLOODPLAIN MANAGEMENT PRACTICES

With so much of the basin lacking flood risk information in the form of FIRM maps, it follows that the practices associated with minimizing flood risk are not widely used. Communities were also surveyed on the level of enforcement of practices. The level of enforcement and other floodplain management practice data collected for each community is listed in Appendix B Required Table 6. The following criteria was provided by the TWDB *Technical Guidelines* for level of enforcement of practices.

- High – actively enforces the entire ordinance, performs many inspections throughout construction process, issues fines, violations, and Section 1316s where appropriate, and enforces substantial damage and substantial improvement
- Moderate – enforces much of the ordinance, performs limited inspections and is limited in issuance of fines and violations
- Low – provides permitting of development in the floodplain, may not perform inspections, may not issue fines or violations
- None – does not enforce floodplain management regulations

FEMA also provides an opportunity for entities to discount their communities' flood insurance premium rates through the Community Rating System (CRS). CRS is a voluntary incentive program that recognizes and encourages community floodplain management practices that exceed the minimum requirements of the NFIP. In CRS communities, flood insurance premium rates are discounted to reflect the reduced flood risk resulting from the community's efforts that address the three goals of the program; reduce and avoid flood damage to insurable property, strengthen and support the insurance aspects of the NFIP, and foster comprehensive floodplain management. As of October 2021, FEMA reports two communities in Region 7 participate in the CRS program. Participating in the CRS program and documenting activities with FEMA can be a labor and time intensive process. Additional communities in the region have practices that would make them eligible for CRS credits but may lack the resources to devote to participation.

TABLE 3-1 REGION 7 ENTITIES PARTICIPATING IN CRS PROGRAM

Community Name	Current Class	% Discount SFHA	% Discount Non-SFHA
Lubbock, City of	7	15%	5%
Sweetwater, City of	9	5%	5%

As the residents of Region 7 learn more about flood risk and related mitigation practices, local policies and efforts to decrease local flood risks can be developed. Developing flood inundation mapping is a key first step to establish floodplain management practices.

Existing Population and Property

Multiple resources were considered in determining the extent to which current floodplain management and land use practices impact flood risk to existing population and property. Cities and counties have the ability to approve floodplain ordinances or court orders, respectively. Therefore, the NFIP participants are limited to these entities, and the results included in this section of the report are limited to cities and counties.

Communities that participate in the NFIP are required to have a floodplain ordinance or court order that meets or exceeds the NFIP minimum standards. As of October 2021, 17 counties (47%) and 52 cities (64%) in Region 7 participate in the NFIP, although only four counties and nine cities have adopted higher standards.

CFR 44 Part 60 establishes minimum standards that a city or county must meet to be eligible to participate in the NFIP. The minimum standards require buildings to be constructed at or above the BFE, provide for floodproofing options for buildings, and mandate provisions specific to the elevation and anchoring of manufactured houses. The BFE is the elevation of surface water resulting from a flood that has a one percent chance of occurring in any given year. The BFE is typically based on FEMA FIRMs (maps) and associated Flood Insurance Studies (models). The minimum standards are based on maps that represent "current" conditions, which may in reality be based on outdated topography, rainfall, and runoff data. Therefore, minimum standards set at the BFE leave no room for safety factors, map errors, or outdated data resulting in limited protection from flood damages.

According to the TWDB *Technical Guidelines*, the term "higher" standard is defined as freeboard, detention requirements, or fill restrictions in excess of minimum standards. FEMA defines freeboard as additional height above the BFE that serves as a factor of safety when determining the elevation of the lowest floor. Less than 1% of Region 7 has FEMA-established BFEs; however, the local community may have an established BFE developed by local studies they regulate to that may not be incorporated into a FEMA mapping product.

According to the data collected as part of Task 3A, 12 entities within the region include a freeboard requirement as a part of their floodplain management regulations. Table 3-2 documents various freeboard requirements identified in 2018/2019 Texas Floodplain Management Association (TFMA) Higher Standards Survey, TWDB data, CEP Tool data, and CAC Tracker Data.

TABLE 3-2 COMMUNITIES ADOPTING HIGHER STANDARDS

Entity	Feet above FFD BFE	Feet above Existing BFE	Feet above FEMA 0.2% ACE	Feet above Street or Curb
Abernathy	-	1	-	-
Abilene	-	1	-	1.5
Ransom Canyon	0	1	0	0
Levelland	0	0	1	0
Lubbock (City of)	1	1	0	0
Lubbock County	0	1	0	0
Plainview	-	1	-	-
Slaton	-	1	0	-
Stephens County	-	2	-	-
Sweetwater	-	0	-	-
Taylor County	1	-	-	-
Young County	-	2	-	-

While Region 7 does have approximately 50% participation in the NFIP by entities, 86% of the region by area has no effective floodplain data or outdated detailed studies, shown in Figure 3-4. These limitations in reliable data produced significant challenges in the development of the RFP. To improve the effectiveness of the flood plan, the RFPG has established goals to encourage higher participation in the NFIP, adoption of minimum FEMA standards and building construction regulations, and local ordinances to encourage prevention of flood damages.

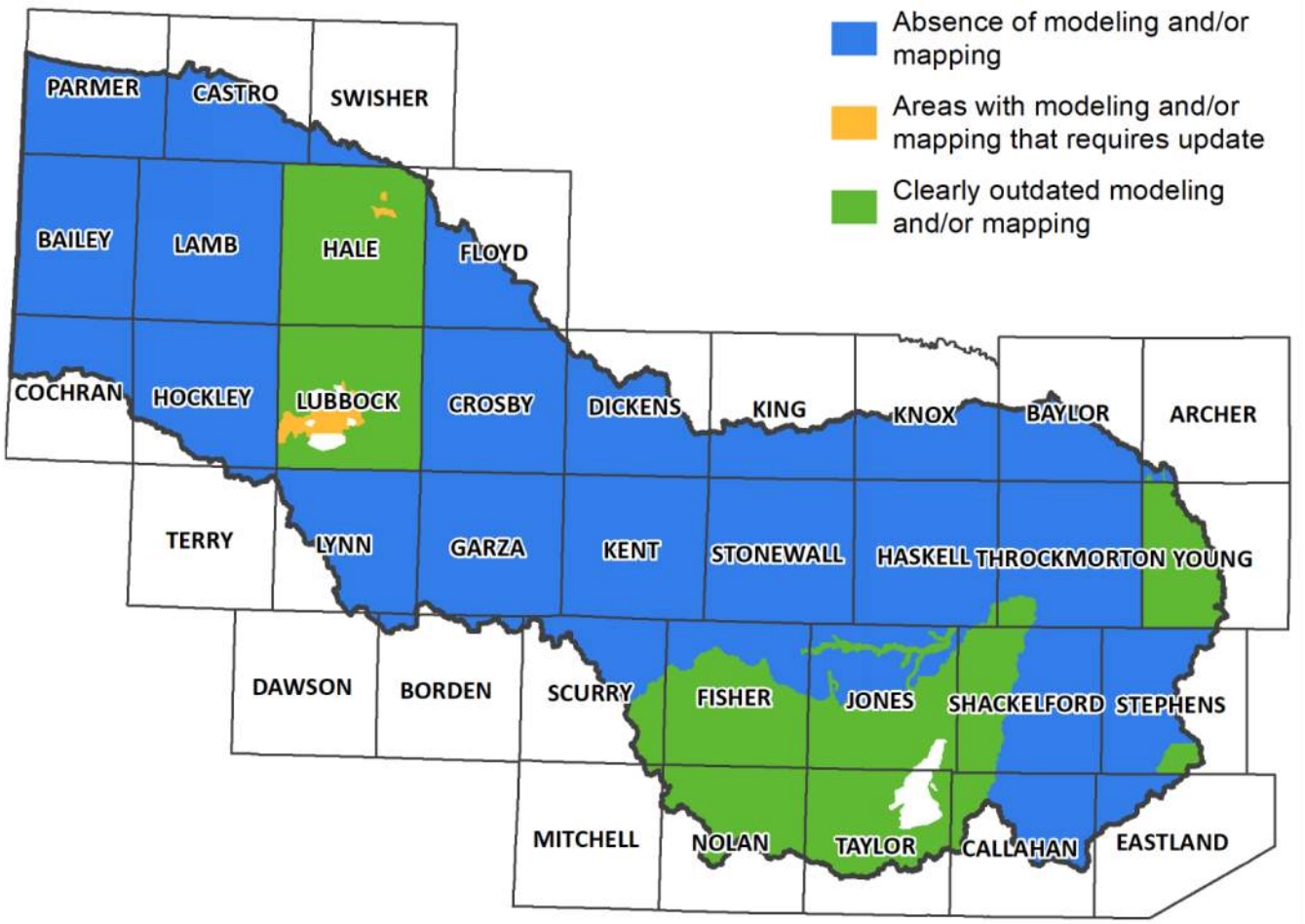


FIGURE 3-4 AREAS WITH LIMITED RELIABLE FLOODPLAIN DATA

Future Population and Property

Region 7 is expected to experience a 50-year population growth of 35%. Some of the existing floodplain ordinances with higher standards may continue to protect future population and property as long as they are enforced. However, the gap in key floodplain management practices across the region poses an increasing level of flood risk as population continues to increase in certain areas. Local floodplain regulations with minimum standards should be adopted. Outreach programs explaining the need for minimum standards and why higher standards would be preferred are key goals in the region. Key objectives will be to explain why enforcing these standards will better protect both existing and future population and property.

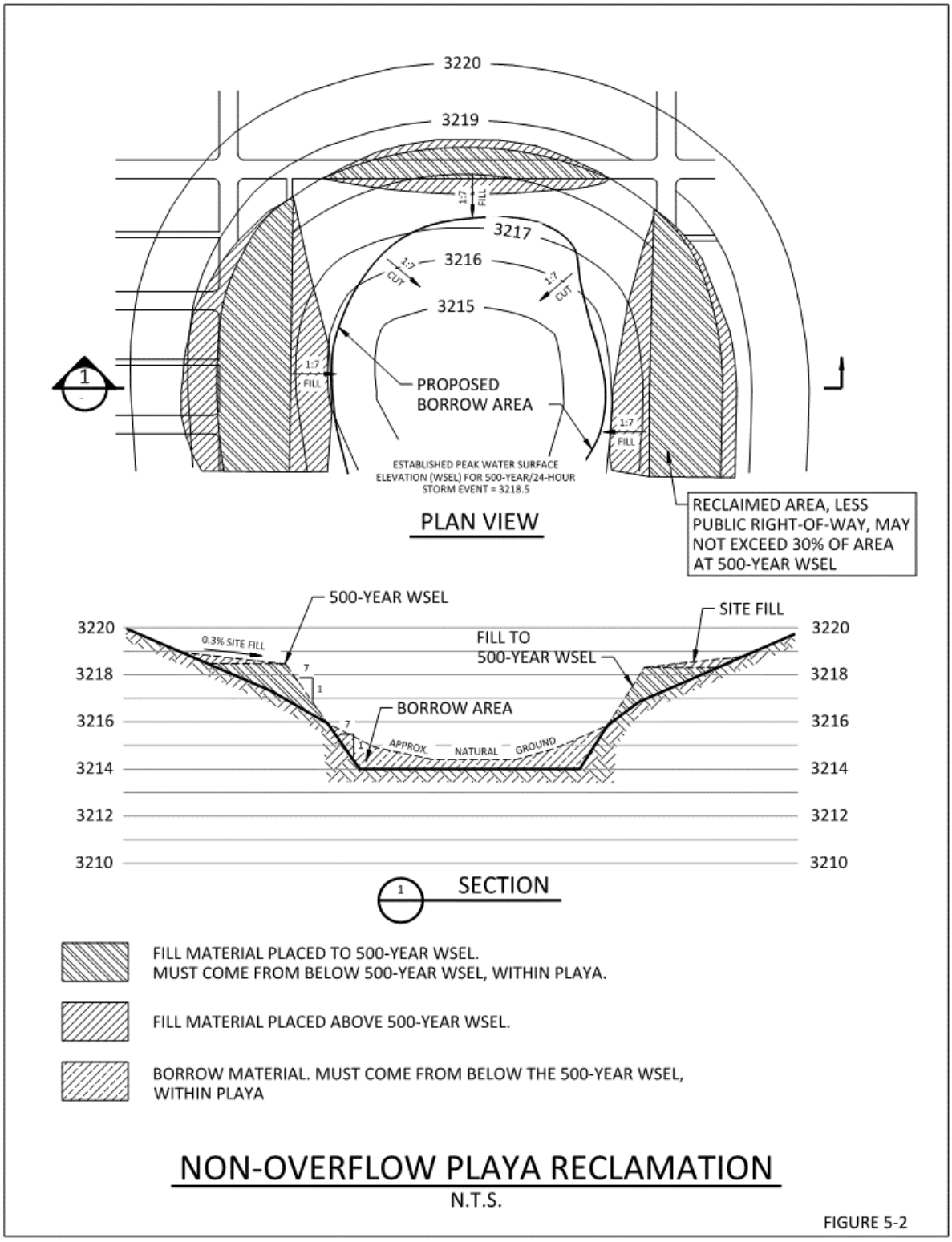
Future floodplains are uncertain. However, it is anticipated that the future floodplains will look different from existing floodplains in some areas. The H&H models used to generate floodplain maps are updated with new topography, survey, precipitation, runoff, and other data as development occurs in and around floodplains. Maps are refined with improved technology and better data as both become available. The future BFE could increase with increased development and population. Cities and counties can develop comprehensive future land use plans considering areas of anticipated population growth and development within their communities that can be used to anticipate what future floodplains could look like. However, the existing and future floodplains are not necessarily components of the future land use

plan. Incorporating the existing and future floodplains will allow cities and counties to plan future development around flood potential areas avoiding the risk of future flooding and damages, therefore reducing future flooding damages to people and property. Some of the region's cities and counties have already incorporated requirements where H&H analyses should be based on FFD land use conditions. Entities who currently use future flood conditions as part of their design criteria provide a factor of safety that reduces future flood hazard exposure for new and existing developments.

Another factor of safety that can be implemented to reduce future flood hazard exposure is freeboard. Freeboard provides additional height above the BFE as discussed above. While the BFE is likely to change in the future with increased development, the freeboard is intended to allow the structure to remain above the unanticipated future water surface elevation, protecting people and property from potential flood risk and damage.

Across the state, multiple methods are used to mitigate the impacts associated with developed land use changes that increase impervious surfaces and provide more efficient drainage infrastructure design to convey the runoff from a developed property to downstream outlets. The approach is typically dependent upon the watershed conditions. Playas typically require a volume-based system that can operate differently than a riverine setting. In West Texas communities, large rain events are less frequent, and the annual rainfall volumes are smaller than is typical for the eastern parts of the state. The standard engineering design requirement in Region 7 is to convey stormwater in the local streets or public rights of way to managed outfall points like playas or streams. This method has worked well with smaller communities, but as development increases the need for stormwater mitigation with additional conveyance or detention ponds also increases. Detention ponds are designed to mitigate increases in the peak runoff rate to existing conditions. Incorporating this requirement mitigates increased runoff in the future, which in turn can reduce future flood hazard exposure.

Few entities within the region currently incorporate stormwater detention requirements in their design criteria. In lieu of detention ponds, many communities in Region 7 allow stormwater mitigation through volumetric mitigation at playas through reclamation and/or alteration. By preserving the storage functions at these naturally low-lying features, these communities are providing similar benefits to regional detention ponds. Figure 3-5 shows an example volumetric mitigation criterion from the 2019 City of Lubbock DCM. In Region 7, additional conveyance improvements are also more common than detention. Additional conveyance is typically seen as parallel channels along roadways at maximum depth limitations.



Source: 2019 City of Lubbock Drainage Criteria Manual

FIGURE 3-5 EXAMPLE VOLUMETRIC MITIGATION CRITERA IN REGION 7

Areas without maps and models or with outdated maps and models are at greater risk in terms of future population and property development within the floodplain. Entities need comprehensive and updated maps to direct development away from flood-prone areas before they can take additional measures to reduce flood risk like freeboard and detention. Future floodplain maps and models are anticipated to be updated with higher resolution data, best available data, and advanced modeling techniques in the years to come. Reducing floodplain mapping gaps within the Region and increasing mapping accuracy should reduce flood risk uncertainty and translate into life and property savings in the future. Future conditions inundation gaps are shown on Appendix A Required Map 9.

Consideration of Recommendation or Adoption of Minimum Practices

The Upper Brazos RFPG was required to consider the possibility of recommending or adopting consistent minimum floodplain management standards and land use practices for the entire region. Recommended practices encourage entities with flood control responsibilities to establish minimum floodplain management standards over the next several years to reduce or eliminate potential flooding areas.

The Upper Brazos RFPG considered all the information gathered and analyzed as part of Task 3A while deliberating on whether to recommend or adopt minimum floodplain management standards. This topic was first introduced during the September 2021 RFPG meeting. During this public meeting, an interactive web-based polling session (MENTI) was conducted to start gathering feedback from the RFPG and members of the community with regards to the following topics.

- Main flooding concerns
- Issues considered the main impediments to effective floodplain management
- Recommending or adopting minimum standards for all entities within the Region
- Types of minimum standards to be considered
- Most important outcomes of the Regional Flood Planning effort

The qualitative assessment of current floodplain management regulations described previously, and the results of this MENTI survey (Appendix C) served as a guide to compile a preliminary set of minimum standards, which were presented and debated during the October 2021 RFPG meeting. One of the main outcomes from this meeting was to **recommend, but not adopt, minimum standards for the region**.

Table 3-3 presents the final recommended minimum standards as approved by the RFPG for consideration by local entities within the region. These recommended minimum standards were compiled in parallel with the flood mitigation and floodplain management goals developed as part of Task 3B. Therefore, the recommended minimum standards also reflect the vision and objectives that were captured in the goals for the region. The flood protection standards are consistent with existing standards in practice for some communities within the region. For each infrastructure category, the minimum and most stringent standards in practice withing the region were considered. Several recommended standards consider the WSEL for various storm events. This is similar to the BFE but is intended to consider areas of potential flood risk that may or may not be the FEMA regulatory floodplain.

TABLE 3-3 REGION 7 RECOMMENDED INFRASTRUCTURE FLOOD PROTECTION STANDARDS

Infrastructure	Type / Condition	Recommended Flood Protection Standard
Residential and Commercial Buildings	New Construction or Pre-Existing (Retrofit)	• Finished floor elevations at or above 1% ACE WSE. • All Playas: Elevate structures 1-ft minimum above 1% ACE WSEL and 1-ft above the nearest crown in street or curb (whichever is higher) near playa floodplains. • Overflow Playas: Elevate structures 2-ft minimum above overflow elevation or 1% ACE WSE. • Non-overflow Playas: Elevate 1-ft above 0.2% ACE WSE.
Critical Facilities	New Construction	• Construct facilities outside the SFHA.
	Pre-Existing (Retrofit)	• Elevate or floodproof electrical components
Roadways	New Construction	• All streets designed to convey stormwater runoff shall convey the 1% ACE flow within the right-of-way (ROW) limits and / or specifically dedicated easements. • Major roads constructed at or above the SFHA.
	Pre-Existing (Retrofit)	• Provide ROW conveyance to lower depth in existing streets where 1% ACE flow depths exceed 18-in, limiting access by emergency vehicles. • Provide / construct additional means of access into single-entry neighborhoods where 1% ACE ROW conveyance is not feasible.
Culverts / Bridges	New Construction	• Culverts and bridges should be designed to convey the 1% ACE flow. • Where a maximum allowable flow depth over the roadway is allowed, warning / signage systems should also be implemented.
	Pre-Existing (Retrofit)	• Improve safety at low water crossings through structural improvements for 4% ACE event and / or warning / signage systems.
Storm Drainage Systems	New Construction or Pre-Existing (Retrofit)	• Convey the 1% ACE flow within the ROW limits and / or specifically dedicated easements and drainage infrastructure.
Detention Facilities / Playas	New Construction or Pre-Existing (Retrofit)	• Implement volumetric mitigation criteria to preserve natural storage function of playas.
Dams	TCEQ Regulatory Dams as defined by 30 TAC §299.1(a)(2)	• Follow design, construction, and operations & maintenance regulations as defined by 30 TAC §299.
Property Acquisition	N/A	• Consider adopting voluntary acquisition program for repetitive loss properties and other areas at flood risk.

Communities may consider higher standard practices as appropriate to their community. For example, TPWD would like communities to consider stream crossing designs that allow for sediment transport and passage of aquatic organisms. This type of design includes bridges that span the creek where possible or culverted crossings designed with a low flow culvert. The low-flow culvert would be large enough to handle a 1.5-year flow to help maintain natural flow patterns. To consider aquatic organisms, the bottoms of these lower culverts should be set at least a foot below grade to allow natural substrate to cover the culvert bottom and to allow for aquatic organism passage.

Finally, the RFPG recognizes the importance of increasing and improving floodplain mapping coverage across the region as a means to reduce flood risk uncertainty and improve the tools for regulating development within the area of potential flood risk. As development continues within the region, it is important to leverage best available data and modeling tools to establish BFEs, update approximate floodplain boundaries (FEMA Zone A), and create new floodplain maps where they are nonexistent. At that point it will become more likely to advance the flood mitigation practices and floodplain management goals across the entire basin.

Task 3B. Flood Mitigation and Floodplain Management Goals

One of the critical components of the inaugural State Flood Plan process was the development of flood mitigation and floodplain management goals. The objective of Task 3B was to define and select a series of goals that will serve as the drivers of the regional flood planning effort. As such, the Upper Brazos RFPG spent a significant amount of time and resources exploring values and discussing what they felt were the best goals for the region.

The overarching goal of all regional flood plans must be “to protect against the loss of life and property” as set forth in the Guidance Principles (31 TAC §362.3). This goal is further defined to

1) Identify and reduce the risk and impact to life and property that already exists, and
2) Avoid increasing or creating new flood risk by addressing future development within the areas known to have existing or future flood risk.

The RFPG must identify goals that are specific and achievable and, when implemented, will demonstrate progress towards the overarching goal set by the state. According to TWDB requirements and guidelines, the goals selected by the RFPG must include the information listed below.

- Description of the goal
- Term of the goal set at 10 years (short-term) and 30 years (long-term)
- Extent or geographic area to which the goal applies
- Residual risk that remains after the goal is met
- Measurement method that will be used to measure goal attainment
- Association with overarching goal categories

The RFPG utilized the existing and future condition flood risk analyses from Task 2 and the assessment of current floodplain management and land use practices from Task 3A as guides for developing and

defining the goals for the region. After careful consideration of these factors, the Upper Brazos RFPG adopted the flood mitigation and floodplain management goals listed in Table 3-4. These specific goals were reviewed and approved by the Upper Brazos RFPG on October 2021 during the RFPG public meeting. The adopted goals apply to the entire flood planning region; no sub-regional goals were identified. The information requirements listed above are presented for each goal in Appendix B Required Table 11.

The selected specific goals will guide the development of the Flood Management Strategies (FMSs), Flood Management Evaluations (FMEs), and Flood Mitigation Projects (FMPs) for the Upper Brazos Flood Planning Region. They build upon TWDB regional flood planning guidance and provide a comprehensive framework for future strategy development focused on reducing flood risk to people and property without adding risk to adjacent areas. The process for defining, refining, and selecting these goals is described in the following sub-sections.

TABLE 3-4 REGION 7 FLOOD MITIGATION AND FLOODPLAIN MANAGEMENT GOALS

Category	Short Term (10 year)	Long Term (30 year)
Confirm Flood Risk	Increase the availability of flood hazard data that uses the best available land use and precipitation data to reduce gaps in floodplain mapping by 25%.	Increase the availability of flood hazard data that uses the best available land use and precipitation data to reduce gaps in floodplain mapping by 75%.
Improve Safety	Improve safety at 20% of low water crossings through structural improvements and / or warning / signage systems.	Improve safety at 50% of low water crossings through structural improvements and / or warning / signage systems.
	Establish a baseline of the risks associated with high and significant hazard and NRCS dams within the region, including coordination with the Texas State Soil & Water Conservation Board dam maintenance plan.	Participate in projects to bring 50% of deficient dams up to current state and / or federal standards.
Reduce Flood Losses	Reduce structures in 1% existing flood hazard layer by 5%.	Reduce structures in 1% existing flood hazard layer by 15%.
	Establish a baseline of the flood risk to agriculture, ranching, energy, and forestry and the associated flood-related losses.	Encourage best practices to reduce the vulnerability of agriculture, ranching, energy, and forestry to flood-related losses through community outreach.
Enhance Flood Awareness	Improve the participation of community stakeholder entities in the regional flood planning process by 25%.	Improve the participation of community stakeholder entities in the regional flood planning process by 75%.
Public Outreach	N/A	Encourage annual public outreach and education activities to improve awareness of flood hazards, flood planning, and projects associated with emergency response associated with flooding.

Category	Short Term (10 year)	Long Term (30 year)
Create Dedicated Funding Sources	Locate dedicated funding sources for 25% of cities with populations over 10,000 and 10% of counties. Locate funding sources for communities with populations less than 10,000.	Locate dedicated funding sources for 50% of cities with populations over 10,000 and 30% of counties. Locate funding sources for communities with populations less than 10,000.
Enhance Floodplain Management Standards	Increase the number of entities that have floodplain standards that meet or exceed the NFIP-minimum standards to 90% of cities with populations over 10,000 and 85% of counties.	Increase the number of entities that have floodplain standards that meet or exceed the NFIP-minimum standards to 100% of cities with populations over 10,000 and 100% of counties.
	Increase the number of entities that designate the 1% annual chance floodplain on future land use plans that serve as the basis for zoning regulations to 90% of cities with populations over 10,000 and 85% of counties.	Increase the number of entities that designate the 1% annual chance floodplain on future land use plans that serve as the basis for zoning regulations to 100% of cities with populations over 10,000 and 100% of counties.
	N/A	Encourage all communities to avoid new exposure to flood hazards by adopting comprehensive plans and subdivision regulations that direct development away from the floodplain.

Flood Mitigation and Floodplain Management Goal Selection Process

The preliminary set of goals was presented and considered during the August 2021 RFPG public meeting. After presenting each category and associated goals, a live web-survey was conducted to help determine if there was general agreement with the goal categories. Both the RFPG and members of the community were allowed to participate and select all the potential goal categories they felt should be included in the region's plan. A total of 10 respondents answered this question. These preliminary results are shown on Figure 3-6. After reviewing and discussing survey results, the RFPG decided to eliminate the Increased NFIP Participation and More Flood Insurance Policies categories.

Discussion of the goals continued during the September 2021 RFPG public meeting to further refine long term and short-term goal metrics. Based on the feedback received during this meeting, the preliminary goals and targets were refined (Table 3-4) and presented for a vote and formal adoption during the October 2021 RFPG public meeting.

Goals will continue to be refined in future planning cycles. A significant challenge in Region 7 is the uncertainty of existing flood risk with the majority of the region relying on approximate Cursory Fathom floodplain data. As the flood risk knowledge gaps are reduced, additional measurable goals will be considered by the Upper Brazos RFPG. Additional information on goals selected is included in the discussion below. In general, the RFPG only selected specific goals in areas where the Flood Planning

process could contribute. For areas where the RFPG does not have authority, the RFPG selected goals to encourage best practices.

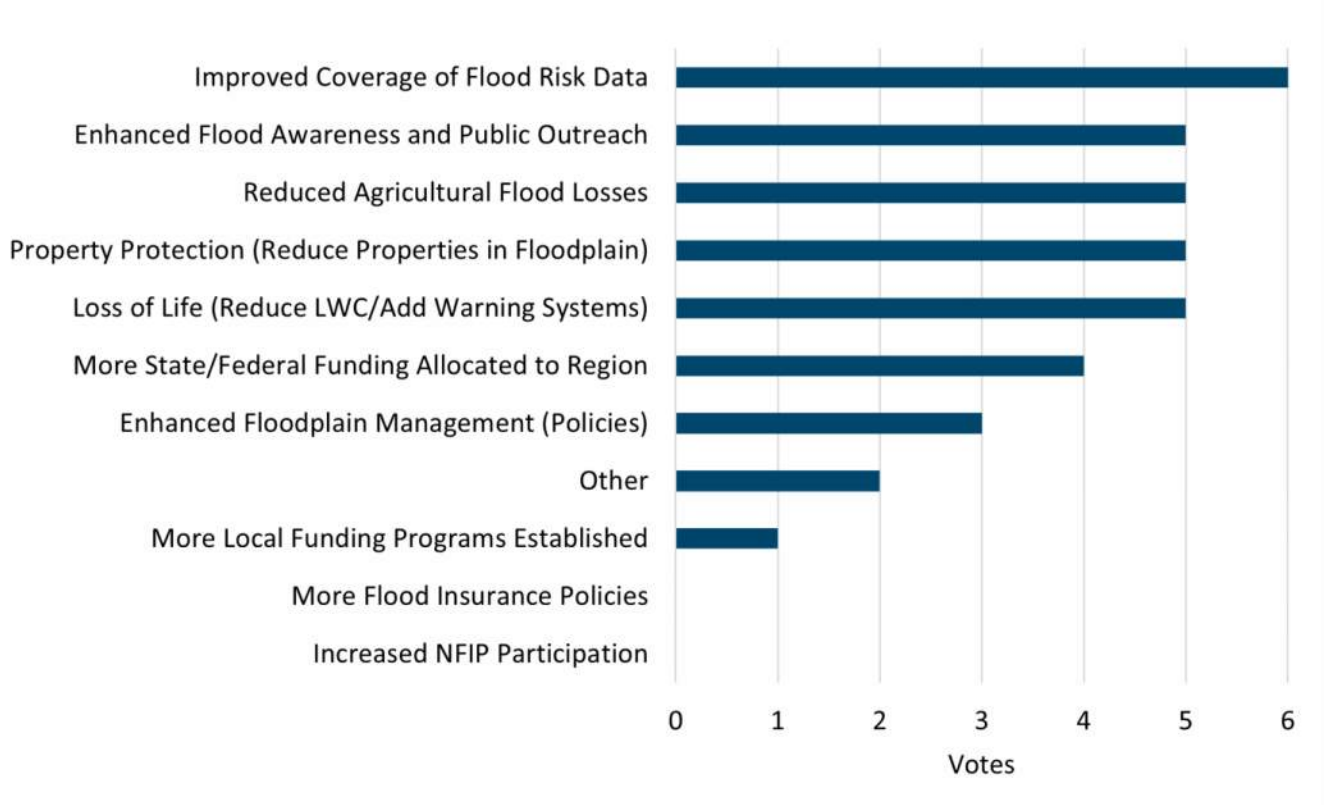


FIGURE 3-6 GOAL CATEGORY RANKING RESULTS

Confirm Flood Risk

Within Region 7, the available effective FEMA FIRMs are 22 years old on average with the majority of the region having no effective FIRMs. The RFPG acknowledged the need for communities to understand their flood risk as a foundational step toward additional floodplain management practices. The RFPG selected goals to increase the availability of flood hazard data that uses the best available land use and precipitation data to reduce gaps in floodplain mapping by 25% (short term) and 75% (long term).

Improve Safety

The RFPG identified the two areas in the region relevant to flood related injury and loss of life as low water crossings and dams.

The RFPG selected goals to improve safety at 20% (short term) and 50% (long term) of low water crossings through structural improvements and/or warning/signage systems. With the flat topography of the region, it is not practical to eliminate low water crossings everywhere through structural improvements, so the RFPG included warning and signage systems as a solution to improve safety at hazardous crossings.

The RFPG is aware of a number of dams that may be nearing the end of their design life cycle in the region, but limited knowledge is available on the risk associated with these structures. The RFPG selected a goal to establish a baseline of the risks associated with high and significant hazard and NRCS dams within the region, including coordination with the Texas State Soil & Water Conservation Board dam maintenance plan as the initial step in improving safety around dams. Once this baseline is established, the RFPG would like to participate in projects to bring 50% of deficient dams up to current state and/or federal standards.

Reduce Flood Losses

For a majority of the Upper Brazos region, the flood hazard analysis completed as part of this Regional Flood Plan is the first floodplain delineated. The RFPG selected a goal to reduce structures in 1% existing flood hazard layer by 5% (short term) and 15% (long term).

A unique challenge in Region 7 is the majority of flood losses are not related to structures. Often flood losses related to agriculture and other rural industries are hard to capture. The RFPG selected a goal to establish a baseline of the flood risk to agriculture, ranching, energy, and forestry and the associated flood-related losses and encourage best practices to reduce the vulnerability of agriculture, ranching, energy, and forestry to flood-related losses through community outreach.

Enhance Flood Awareness

The RFPG selected to improve the participation of community stakeholder identities in the regional flood planning process by 25% (short term) and 75% (long term).

Public Outreach

The RFPG selected to encourage annual public outreach and education activities to improve awareness of flood hazards, flood planning, and projects associated with emergency response associated with flooding.

Create Dedicated Funding Sources

A majority of communities in the Upper Brazos region do not have funding sources for flood related activities. The RFPG selected a goal to locate dedicated funding sources for 25% (short term) and 50% (long term) of cities with populations over 10,000 and 10% of counties and additionally to locate funding sources for communities with populations less than 10,000.

Enhance Floodplain Management Standards

Region 7 is primarily sparsely populated agricultural and ranch land, therefore many entities in the region have very small local governments with quite limited resources. Many of these rural local governments do not have the resources to enact, adopt, and enforce specific floodplain management practices, nor have they worked with FEMA to develop SFHAs and FIRMs. For this region, the RFPG focused their goals related to enhancing floodplain management standards on communities that potentially have the resources to participate in floodplain management practices.

The RFPG selected goals to increase the number of entities that have floodplain standards that meet or exceed the NFIP-minimum standards to 90% of cities with populations over 10,000 and 85% of counties (short term) and 100% of cities with populations over 10,000 and 100% of counties (long term).

The RFPG selected to encourage all communities to avoid new exposure to flood hazards by adopting comprehensive plans and subdivision regulations that direct development away from the floodplain and increase the number of entities that designate the 1% annual chance floodplain on future land use plans that serve as the basis for zoning regulations to 90% of cities with populations over 10,000 and 85% of counties (short term) and 100% of cities with populations over 10,000 and 100% of counties (long term).

Benefits and Residual Risk after Goals are Met

The adopted goals were developed in a manner to set the stage for specific actions that can be quantified and measured in future regional and state flood planning cycles. Future data collection efforts or implementation of evaluations, strategies, and/or projects may be used to establish baseline data for future measurements to determine progress towards achieving the goals. Implementation efforts will also demonstrate progress towards the overall purpose and intent of the regional flood planning process and will provide various benefits to individuals, communities, and the region as a whole. Specific benefits of the recommended flood mitigation actions will be discussed further in Task 6. Achieving the adopted goals will reduce current and future levels of flood risk in the region.

However, it is recognized that it is not possible to protect against all potential flood risks. In selecting the flood risk reduction goals, the RFPG is inherently determining the accepted residual risk for the region. In general, residual risks for flood risk reduction goals could be characterized as follows

1. While a new development may be constructed outside the 1% floodplain, flood events of greater magnitude will inundate areas beyond those preserved as a floodplain.
2. Flood events may exceed the level of service for which infrastructure was designed.
3. Communities depend on future funding and program priorities to maintain, repair, and replace flood protection assets. Routine maintenance of infrastructure is required to maintain its design capacity. Maintenance is sometimes overlooked due to budget, staff, and time constraints.
4. Policies, regulations, and standards reduce adverse impacts associated with development activity but do not eliminate it.
5. The lack of local enforcement of floodplain regulations also creates risk.
6. In our representative government, policy changes that adversely impact budgets, prior plans, assets, and standards are always possible.
7. Practical (time and money) limits the conceptual understanding and technical precision associated with studies, models, and plans.
8. Human behavior is unpredictable, as people may choose to ignore flood warning systems or cross over flooded roadways for a variety of reasons.

The residual risk for each of the specific goals adopted for Region 7 are presented in Appendix B Required Table 11.

Task 4. Assessment and Identification of Flood Mitigation Needs

Task 4A. Flood Mitigation Needs Analysis

This chapter describes the process adopted by the RFPG to conduct the Flood Mitigation Needs Analysis (Task 4A), resulting in identifying the areas with the greatest gaps in flood risk knowledge and the areas of greatest known flood risk and mitigation needs. The Task 4A process is a big picture assessment that helps guide the subsequent Task 4B effort of identifying FMEs, FMPs, and FMSs. Table 4-1 provides a summary of the TWDB guidance and factors that were considered in the Flood Mitigation Needs Analysis.

TABLE 4-1 TWDB GUIDANCE AND FACTORS TO CONSIDER

Guidance	Factors to Consider
1. Most prone to flooding that threatens life and property	• Buildings within flood hazard layer • Critical facilities impacted by flooding • Low water crossings • Agricultural areas at risk of flooding
2. Locations, extent and performance of current floodplain management and land use policies and infrastructure	• Communities not participating in NFIP or without NFIP equivalent standards • Disadvantaged / Underserved communities
3. Inadequate inundation mapping	• Presence of Cursory Fathom Data / BLE / Zone A flood risk data • Detailed FEMA models older than 10 years
4. Lack of H&H models	• Communities with limited/no models
5. Emergency need	• Damaged or failing infrastructure
6. Existing models and flood risk mitigation plans	• Exclude flood mitigation plans already in implementation • Leverage existing models, analyses, and plans • Benefit-Cost Ratio > 1
7. Previously identified and evaluated flood mitigation projects	• Exclude FMPs already in implementation • Leverage existing FMP • Benefit-Cost Ratio > 1
8. Historic flooding events	• Disaster declarations • Flood insurance claim information • Other significant local events
9. Previously implemented FMPs	• Exclude areas where FMPs have already been implemented.
10. Additional other factors deemed relevant by RFPG	• Alignment with RFPG goals • Alignment with TWDB guidance principles

Process and Scoring Criteria

The main objectives of Task 4A are to identify the areas of greatest known flood risk and areas where the greatest flood risk knowledge gaps exist. The Task 4A analysis is based on a geospatial process that combines information from multiple datasets representing several of the factors listed in Table 4-1 and provides a basis for achieving the Task 4A objectives. The geospatial process was developed in GIS and was based on the data collected in Task 1 through Task 3. A variety of data sources were used in this assessment, including GIS data collected directly from entities during outreach efforts. During the data collection phase, responders participated in an online survey during which they were able to respond geographically on a map. The responses, as of December 1, 2021, were directly applied to this assessment.

The geospatial assessment was prepared at a HUC-12 watershed level of detail, which is consistent with the minimum watershed size for Task 4B specified in the *Technical Guidelines* (at least one square mile). A HUC is a unique code assigned to watersheds in the United States. As the watersheds get smaller, the number of digits to identify them increase. The smallest unit of division used to identify a watershed is 12 digits long, or a HUC-12. Region 7 has a total of 468 HUC-12 watersheds, with an average size of 42.8 square miles.

A total of 12 data categories were used in the geospatial assessment. A scoring range was determined for each data category based on the distribution of the data. The scoring ranges vary for each category based on the values found in the region. A uniform scoring scale of zero to five was developed and each HUC-12 was assigned an appropriate score for each category. The scores for each HUC-12 under each category were then added to obtain a total score that was used to calculate the areas of greatest known flood risk. A separate score was also determined for each HUC-12 to calculate the areas where the greatest flood risk knowledge gaps exist. The second score was based on two of the data categories that represented flood risk data gaps discussed below.

Flood Risk Knowledge Gaps

The following section gives a brief description of the data categories included and how each HUC-12 watershed was scored related to flood risk knowledge gaps. Note that the objective of the Task 4A process is to determine the factors that are present within a given HUC-12, and to what degree, not necessarily to determine the relative importance of each factor in determining flood risk. Therefore, no weight has been applied to emphasize one factor over another at this time.

Areas That Need Mitigation, Study Need, or Data Gap

These polygon layers were populated by community responses to the data collection survey. These responses were combined into one polygon layer for this task. The scoring for this category gives points to any HUC-12 intersecting these polygons, according to the scoring in Table 4-2.

Inadequate Inundation Mapping

This analysis is completed using the ExFldHazard layer. This layer contains both flood quilt and Cursory Fathom data for the 1% annual chance storm event flood risk. The flood quilt includes the source of the

floodplain data. Based on the definitions of the source data from TWDB[23], the sources that represent adequate inundation mapping data are

- NFHL Preliminary Data (zones AE, AH, OH, and VE); and
- NFHL Effective Data (zones AE, AH, OH, and VE).

The effective floodplain data does not generally account Atlas 14 rainfall depths. The Atlas 14 study provided minimal differences in previous rainfall statistics for Region 7 and therefore all the NFHL Effective data was considered adequate. The following flood quilt data sources are considered inadequate-approximate inundation mapping data for this assessment:

- BLE,
- NFHL Zone A,
- FAFDS, and
- Cursory Fathom Data.

The total amount of floodplain area (from all sources in the flood quilt) and the amount of inadequate floodplain data in each HUC-12 were calculated. This computation produced a percentage of the HUC-12 floodplain data that is considered inadequate for the purposes of this assessment. All inadequate data sources represent approximate methods to estimate flood risk. These percentages were scored based on the following metrics outlined in Table 4-2 below.

TABLE 4-2 SCORING CRITERIA FOR FLOOD RISK KNOWLEDGE GAPS

Score (points)	0 points	1 point	2 points	3 points	4 points	5 points
# of Responses	0	1	2	3	4	5+
% Inadequate	0%	0.01-20%	21-50%	51-75%	76-90%	90%+

Known Flood Risk

The following section gives a brief description of the data categories included and how each HUC-12 watershed was scored related to known flood risk. Note that the objective of the Task 4A process is to determine the factors that are present within a given HUC-12, and to what degree, not necessarily to determine the relative importance of each factor in determining flood risk. Therefore, no weight has been applied to emphasize one factor over another at this time.

Areas Most Prone to Flooding that Threatens Life and Property

Each category related to areas most prone to flooding is described below. The delegation of points for each metric is summarized in Table 4-3**.**

[23] TWDB. 2021. Floodplain Quilt Prioritization: https://twdb-flood-planning-resources-twdb.hub.arcgis.com/pages/flood-quilt-pri

Buildings in the 1% Annual Chance Event Floodplain

This dataset was divided into point values based on the total number of buildings in the 1% annual chance storm event floodplain within each HUC-12. The buildings dataset was provided by the TWDB on the Data Hub. The count ranged widely for each HUC-12. Some rural HUC-12s have zero (0) buildings in the floodplain, while urban areas may have over 8,000 buildings in the floodplain.

Low Water Crossings

Low Water Crossings (LWCs) were identified in Tasks 1 and 2 and were downloaded from the TWDB Data Hub. LWCs were added or removed based on feedback from the data collection survey in Task 2. This category is scored based on the quantity of low water crossings occurring in a HUC-12. Urban areas typically have more roadways and documented low water crossings; therefore, the urban HUC-12s will tend to score higher than rural HUC-12s in this category.

Locations Where the Road Floods

Miles of roadway inundated by the 1% annual chance event floodplain within each HUC-12 were calculated. Roadway flooding can be difficult to quantify in west Texas. For many communities, the roadways are the main conveyance of runoff to a natural drainage feature like a playa or stream. HUC-12s located on the caprock tended to score higher in this category due to local these engineering practices.

Agricultural Areas at Risk of Flooding

Agricultural areas have been defined for this task as a land use of either farming or ranching. For this category, impacted agricultural areas were analyzed in each HUC-12. The impacted agricultural area is the farming and ranching land use parcel area located within the 1% annual chance event floodplain (as defined by the flood quilt data).

Existing Critical Facilities

Critical facilities for this assessment include hospitals, schools, fire stations, shelters, electric and gas lines among other features. Existing critical facilities were identified in Task 1 from the TWDB Data Hub. The survey responders were able to update the existing critical facilities by adding or removing facilities in the survey from Task 2. This category is scored based on the total number of critical facilities identified within the 1% annual chance event floodplain. The number of critical facilities within a HUC-12 is primarily a function of population density.

TABLE 4-3 SCORING CRITERIA FOR AREAS MOST PRONE TO FLOODING

Score (points)	0 points	1 point	2 points	3 points	4 points	5 points
Number of Buildings	0	1-50	51-250	251-500	501-750	751+
Number of LWC	0	1-5	6-10	11-15	16-20	21+
Road Flooding (mi.)	0	0-5	5-15	15-50	50-100	100+
Agricultural Area (sq. mi.)	0	0.01-0.35	0.36-2	2.01-3	3.01-5.5	5.51+
Number of Critical Facilities	0	1-5	6-10	11-25	26-50	51+

Historical Flooding

Each category related to historical flooding is described below. The delegation of points for each metric is summarized in Table 4-4.

Areas With a History of Flooding

The communities entered datapoints into the survey performed in Task 1 to mark areas in their communities that repetitively flood. This dataset is limited to locations identified by survey responders; it does not include additional information regarding high water rescues, injuries, or deaths.

FEMA Claims

This dataset compiles all the FEMA flood claims within the Upper Brazos watershed as of June 2021. The geospatial data assigned to the claims was highly redacted. Therefore, the consultant team decided to use the cities to which the flood claims were assigned. Each city was divided into the HUC-12s that intersected the city limits. Each city's flood claims were divided proportionally among the HUC-12s, based on the area intersecting the respective city. Most of the claims recorded in this dataset occurred in Lubbock, Taylor, and Haskell counties.

Historic Storm Events

The occurrence of historic storms was evaluated using the NOAA National Centers for Environmental Information Storm Events Database[24]. This database compiles historic storms from January 1950 to March 2022, the date of the flood mitigation needs analysis. The dataset is an official NOAA publication that documents

1. The occurrence of storms and other significant weather phenomena having sufficient intensity to cause loss of life, injuries, significant property damage, and/or disruption to commerce;
2. Rare, unusual weather phenomena that generate media attention; and/or
3. Other significant meteorological events, such as record maximum or minimum temperatures or precipitation that occur in connection with another event.

Storm events are subdivided into 48 categories, which include flood related events as well as other natural hazards. Three primary categories were selected for this assessment: floods, flash floods, and heavy rain. A total of 1,064 storm events were reported for Region 7 between 1950 and 2021, consisting of 213 floods, 748 flash floods, and 103 heavy rain events. Each event includes the source of data and narrative describing the details of the event. Storm events were then narrowed down to those which had reported property damage, crop damage, injuries, or deaths. This refinement left 257 storm events, consisting of 78 floods, 167 flash floods, and 12 heavy rain events.

The number of historic storms on record occurring within each HUC-12 was tabulated and scored accordingly.

[24] NOAA. 2022. Storm Events Database: https://www.ncdc.noaa.gov/stormevents/details.jsp

Damages from Historic Storms

In addition to the frequency of historic storms, the severity of these storms was also considered in the analysis. The Historic Storms dataset included information on reported damages, injuries, and deaths associated with each storm. Severity was scored from zero (0) to five (5) points based on reported property damages. One (1) additional point was added if injuries were reported, and two (2) additional points were added if deaths were reported.

TABLE 4-4 SCORING CRITERIA FOR AREAS WITH HISTORICAL FLOODING

Score (points)	0 points	1 point	2 points	3 points	4 points	5 points
Number of Areas with History of Flooding	0	1	2	3	4	5+
Number of FEMA Claims	0	1-5	6-10	11-30	31-50	51+
Number of Historical Storms	0	1-2	3-4	5-6	7-8	9+
Damages from Historical Storms	$0	$1-10,000	$10,001-30,000	$30,001-100,000	$100,001-500,000	$500,000+

Other Factors

Additional factors related to known flood risk are described in this section. These factors are a proxy for a region's resiliency to a flood event and preparedness. The delegation of points for each metric is summarized in Table 4-5**.**

Emergency Need

Limited data was provided to the Regional Flood Planning group on emergency needs from damaged or failing infrastructure. For this initial cycle, emergency need had limited impact on identifying Flood Mitigation Actions.

Communities Not Participating in the NFIP

Participation in the NFIP was considered as a proxy for flood awareness in each community. Residents of a community not participating in the NFIP are less likely to be aware of their flood risk. The NFIP participation status for entities in Region 7 can be found in Chapter 3. Non-participating communities are also not eligible for flood insurance under the NFIP. Furthermore, if a presidentially declared disaster occurs as a result of flooding, no federal financial assistance can be provided to non-participating communities for repairing or reconstructing insurable buildings in SFHAs. Therefore, this analysis considered non-NFIP communities as being more vulnerable to flooding risks. If most of the HUC-12 (>= 50%) intersected a non-NFIP community it was assigned 5 points. Otherwise, no points were allocated. The majority of the basin participating in the NFIP is located around the urban areas of Lubbock and Abilene including the counties of Hale, Lubbock, Jones, and Taylor. The delegation of points for this metric is shown in Table 4-5**.**

Social Vulnerability Index (SVI)

SVI can be used as a proxy for a community's resiliency to a flood event. SVI values for the State of Texas were downloaded from the CDC Agency for Toxic Substances and Disease Registry website[25]. The most recent SVI values published on the website (2018) were used in this assessment. SVI values are assigned per census tract, which needed to be converted to SVI per HUC-12. SVI values were assigned to each HUC-12 based on an area-weighted average. The percentage of a census tract that intersects a HUC-12 was multiplied by the SVI for the census tract. This procedure is followed for all census tracts intersecting a HUC-12 boundary, and those weighted SVI values are added together to produce one SVI value for each HUC-12. The SVI ratings vary between 0-1 and were scored according to Table 4-5. The higher the SVI, the higher the vulnerability of a community; the lower the SVI, the higher the resilience.

TABLE 4-5 ADDITIONAL SCORING CRITERIA FOR KNOWN FLOOD RISK

Score (points)	0 points	1 point	2 points	3 points	4 points	5 points
Community Flood Awareness	NFIP					Non-NFIP
SVI Rating	0	0.01-0.16	0.17-0.33	0.34-0.50	0.51-0.67	0.67+

Needs Analysis Results

The process and scoring methodology described above was implemented across the entire Upper Brazos Region. As previously discussed, this assessment was performed to address the two goals of Task 4A. The first goal is to identify the areas where the greatest flood risk knowledge gaps exist. The categories of inadequate inundation mapping, reported flood concerns, and areas without hydrologic & hydraulic models were selected as the basis for identifying these areas. Based on the data utilized in this preliminary assessment, approximately, 90% of the Upper Brazos watershed is considered inadequately mapped (as indicated by the red HUC-12s in Figure 4-1**)**.

The second goal is to determine the areas of greatest known flood risk and flood mitigation needs. For each HUC-12 in Region 7, the scores from each of the categories were added together to obtain a total score. All categories have an equal representation in the total score. This analysis also included the inadequate inundation mapping category because uncertainty itself is a risk. Based on the distribution of the final scores in this preliminary assessment, the top 10% were colored red to highlight the areas with the greatest known flood risks. Note that if a HUC-12 achieved a low score, it does not necessarily mean that there is no flood risk in the area, only that this known risk is relatively low compared to others.

The maps resulting from the Task 4A assessment will serve as a guide to the RFPG's subsequent efforts in Task 4B. The red and orange HUC-12s in Figure 4-1 highlight the areas in the Upper Brazos watershed where potentially feasible FMEs should be considered as part of Task 4B. The red and orange HUC-12s in Figure 4-2 emphasize watersheds where the RFPG should strive to identify and implement FMSs and FMPs as part of Task 4B to reduce the known flood risks within those areas.

[25] ASTDR. 2022. CDC/ATSDR Social Vulnerability Index: https://www.atsdr.cdc.gov/placeandhealth/svi/index.html

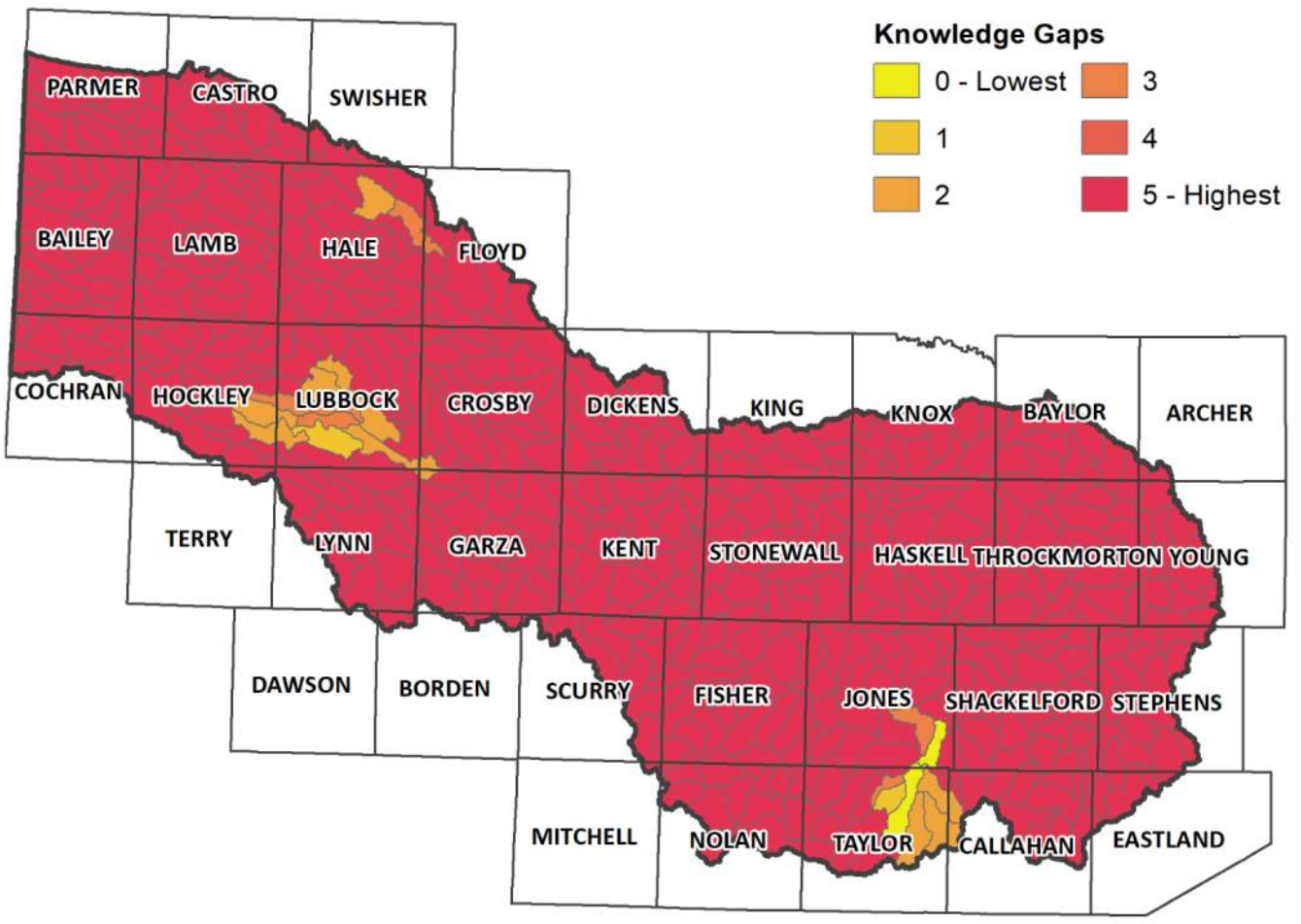


FIGURE 4-1 FLOOD RISK KNOWLEDGE GAPS

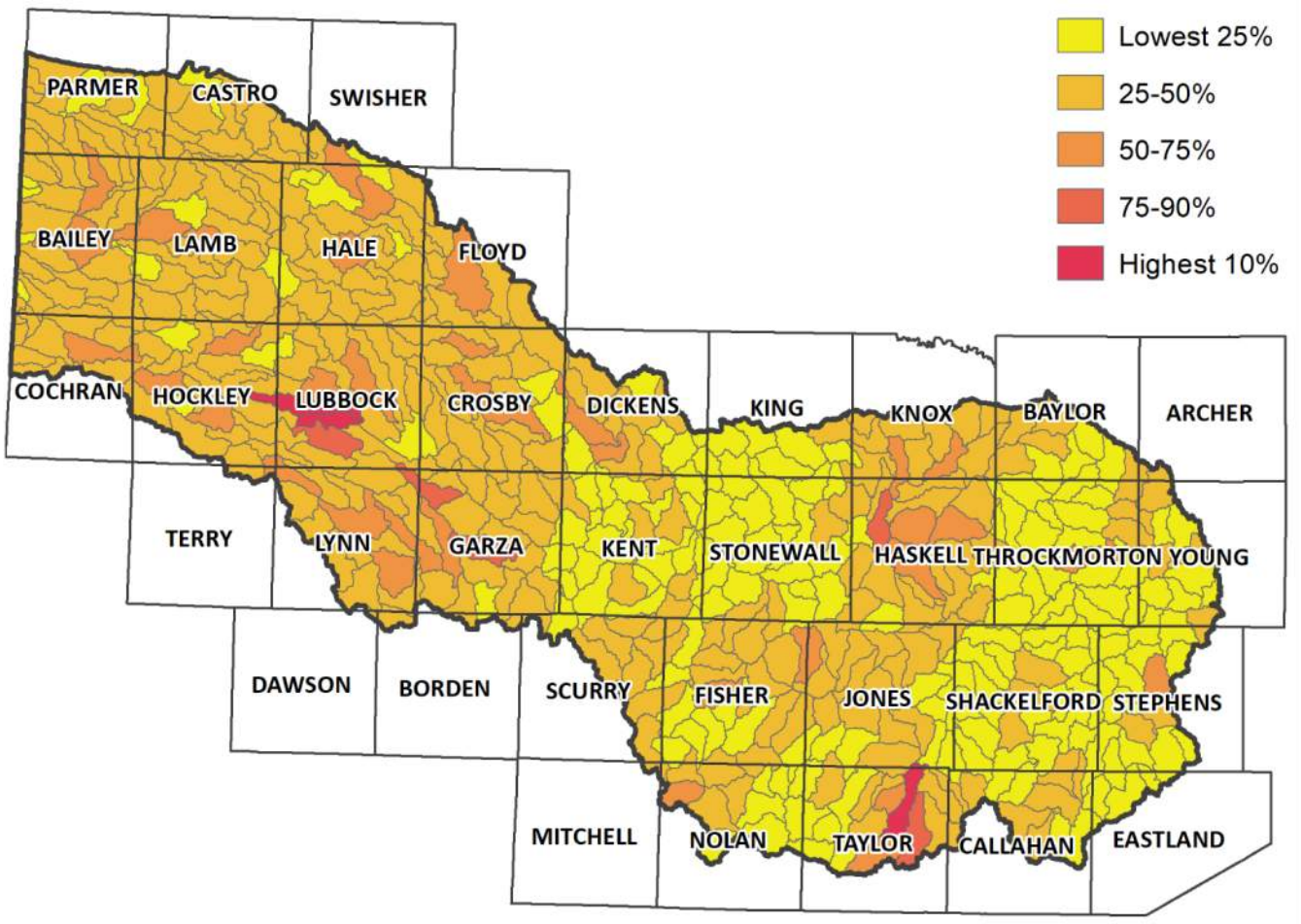


FIGURE 4-2 AREAS OF GREATEST KNOWN FLOOD RISK

Task 4B. Potential Flood Management Actions

Process to Identify FMEs, FMPs, and FMSs

The goal of Task 4B is to identify and evaluate a wide range of potential actions to define and mitigate flood risk across the basin. These actions have been broadly categorized into three distinct types, as defined below.

- **Flood Management Evaluation (FME)**: A proposed flood study of a specific, flood prone area that is needed in order to assess flood risk and/or determine whether there are potentially feasible FMSs or FMPs.
- **Flood Mitigation Project (FMP)**: A proposed project, either structural or non-structural, that has non-zero capital costs or other non-recurring costs and, when implemented, will reduce flood risk or mitigate flood hazards to life or property.
- **Flood Management Strategy** (**FMS**): A proposed plan to reduce flood risk or mitigate flood hazards to life or property.

Identification of potential FMEs and potentially feasible FMPs and FMSs begins with the execution of the Flood Mitigation Needs Analysis to identify the areas with the greatest gaps in flood risk knowledge and the areas of greatest known flood risk. This process and its outputs have been described in Section 4A. Based on the results of this analysis, several sources of data were used to develop a list of potential flood risk reduction actions that may address the basin's needs. The data includes information compiled under previous tasks, such as

- Existing flood infrastructure, flood mitigation projects currently in progress, and known flood mitigation needs (Task 1);
- Existing and future flood risk exposure and vulnerability (Tasks 2A and 2B);
- Floodplain management and flood protection goals and strategies developed by the RFPG for the Region (Tasks 3A and 3B); and
- Community input.

These actions were identified and evaluated through initial screening and data gathering under this task. As part of Task 5, FMEs, FMPs, and FMSs were further evaluated in order to compile the necessary technical data for the RFPG to decide whether or not to recommend these actions, or a subset of these actions.

This first RFP cycle relies primarily on compiling readily available information to determine appropriate flood mitigation actions to recommend for inclusion in the Draft Plan, rather than performing technical analysis to identify new actions. The list of potential FMEs and potentially feasible FMPs and FMSs for the Draft RFP were compiled based on contributions from the RFPG and other regional entities. Potentially feasible actions were acquired from previous flood studies, drainage master plans, flood protection studies, and capital improvement studies, among others. The specific list of previous flood studies and models relevant to flood plan development for Region 7 are provided in the following tables.

TABLE 4-6 MUNICIPAL PLANNING STUDIES

Report Title	Study Area	Sponsor Entity	Date
Abilene Master Drainage Plan	City of Abilene	City of Abilene	2020
Lubbock Master Drainage Plan	City of Lubbock	City of Lubbock	1997
Lubbock MDP - Update	City of Lubbock	City of Lubbock	2010
Lubbock MDP – 5-Year CIP	City of Lubbock	City of Lubbock	2018
Lubbock MDP – Supplement	City of Lubbock	City of Lubbock	2018-2020
Lubbock System C	City of Lubbock	City of Lubbock	2019
Lubbock System B, D (NWLDIP Phase 3)	City of Lubbock	City of Lubbock	2021
McAlister LOMR	Playa System E4A, E4B, and E9	City of Lubbock	2020

TABLE 4-7 HAZARD MITIGATION ACTION PLANS (HMAP)

Report Title	Study Area	Sponsor Entity	Date
Archer County HMAP	Archer County	Nortex Regional Planning Commission	2020
Baylor County HMAP	Baylor County	Nortex Regional Planning Commission	2020
Lubbock County HMAP	Lubbock County	Lubbock County	2015
Young County HMAP	Young County	Nortex Regional Planning Commission	2020
WCTCOG HMAP Planning Area 1	Taylor County	WCTCOG	2020
WCTCOG HMAP Planning Area 2	Callahan and Shackelford County	WCTCOG	2020
WCTCOG HMAP Planning Area 3	Fisher, Mitchell, Nolan, and Scurry County	WCTCOG	2020
WCTCOG HMAP Planning Area 4	Haskell, Kent, Stonewall, and Throckmorton County	WCTCOG	2020
WCTCOG HMAP Planning Area 5	Stephens County	WCTCOG	2020

TABLE 4-8 RELEVANT MODELS COLLECTED FOR THE RFP

Model Title	Software	Study Area	Sponsor Entity	Date
Abilene MDP	HEC-RAS	City of Abilene	City of Abilene	2020
Upper Clear Fork Brazos Watershed BLE	HEC-RAS	Upper Clear Fork Brazos HUC-8	FEMA	2017
Lubbock MDP Models	ICPR	City of Lubbock	City of Lubbock	2018- 2020
System C Models	ICPR	Playa System C Watershed	City of Lubbock	2019
System B, D (NWLDIP Phase 3)	ICPR	City of Lubbock	City of Lubbock	2021
McAlister LOMR	ICPR	System E4A, E4B, and E9	City of Lubbock	2020

TABLE 4-9 FEMA FLOOD INSURANCE STUDIES (FIS)

Model Title	Study Area	Sponsor Entity	Date
Archer County FIS	Archer County	FEMA	2021
City of Albany FIS	City of Albany	FEMA	1986
City of Levelland FIS	City of Levelland	FEMA	1990
City of Muleshoe FIS	City of Muleshoe	FEMA	1989
City of Roscoe FIS	City of Roscoe	FEMA	1988
City of Snyder FIS	City of Snyder	FEMA	1980
City of Sweetwater FIS	City of Sweetwater	FEMA	1989
City of Throckmorton FIS	City of Throckmorton	FEMA	1976
Dawson County FIS	Dawson County	FEMA	2011
Eastland County FIS	Eastland County	FEMA	1997
Fisher County FIS	Fisher County	FEMA	2011
Hale County FIS	Hale County	FEMA	2011
Haskell County FIS	Haskell County	FEMA	1987
Jones County FIS	Jones County	FEMA	2011
Lubbock County FIS	Lubbock County	FEMA	2017
Nolan County FIS	Nolan County	FEMA	1990
Stephens County FIS	Stephens County	FEMA	2019
Taylor County FIS	Taylor County	FEMA	2012
Young County FIS	Young County	FEMA	2019

Classification of Potential FMEs and Potentially Feasible FMPs and FMSs

The *Technical Guidelines* included a summary of different general action types, listed below in Table 4-10. Once potential flood risk reduction actions were preliminarily identified using this list, a high-level screening process was used to confirm that potential actions had been sorted into their appropriate categorization. The screening process is shown in Figure 4-3.

TABLE 4-10 FLOOD RISK REDUCTION PROJECT TYPES

Project Category	Action Types
FME	1. Watershed Planning a. H&H Modeling b. Flood Mapping c. Regional Watershed Studies 2. Engineering Project Planning a. Feasibility Assessments b. Floodproofing 3. Preliminary Engineering (alternative analysis and up to 30% design) 4. Property or Easement Acquisition 5. Regulatory Requirements for Reduction of Flood Risk 6. Studies on Flood Preparedness
FMP	**Structural** 1. Low Water Crossings or Bridge Improvements 2. Infrastructure (channels, ditches, ponds, stormwater pipes, etc.) 3. Regional Detention 4. Regional Channel Improvements 5. Storm Drain Improvements 6. Reservoirs 7. Dam Improvements, Maintenance, and Repair 8. Flood Walls/Levees 9. Nature Based Projects – living levees, increasing storage, increasing channel roughness, increasing losses, de-synchronizing peak flows, dune management, river restoration, riparian restoration, run-off pathway management, wetland restoration, low impact development, green infrastructure, playas improvements 10. Comprehensive Regional Project – includes a combination of projects intended to work together **Non-Structural** 1. Property or Easement Acquisition 2. Elevation of Individual Structures 3. Flood Readiness and Resilience 4. Flood Early Warning Systems, including stream gauges and monitoring stations 5. Floodproofing 6. Regulatory Requirements for Reduction of Flood Risk
FMS	None specified; at a minimum, RFPGs should include as FMSs any proposed action that the group would like to identify, evaluate, and recommend that does not qualify as either a FME or FMP.

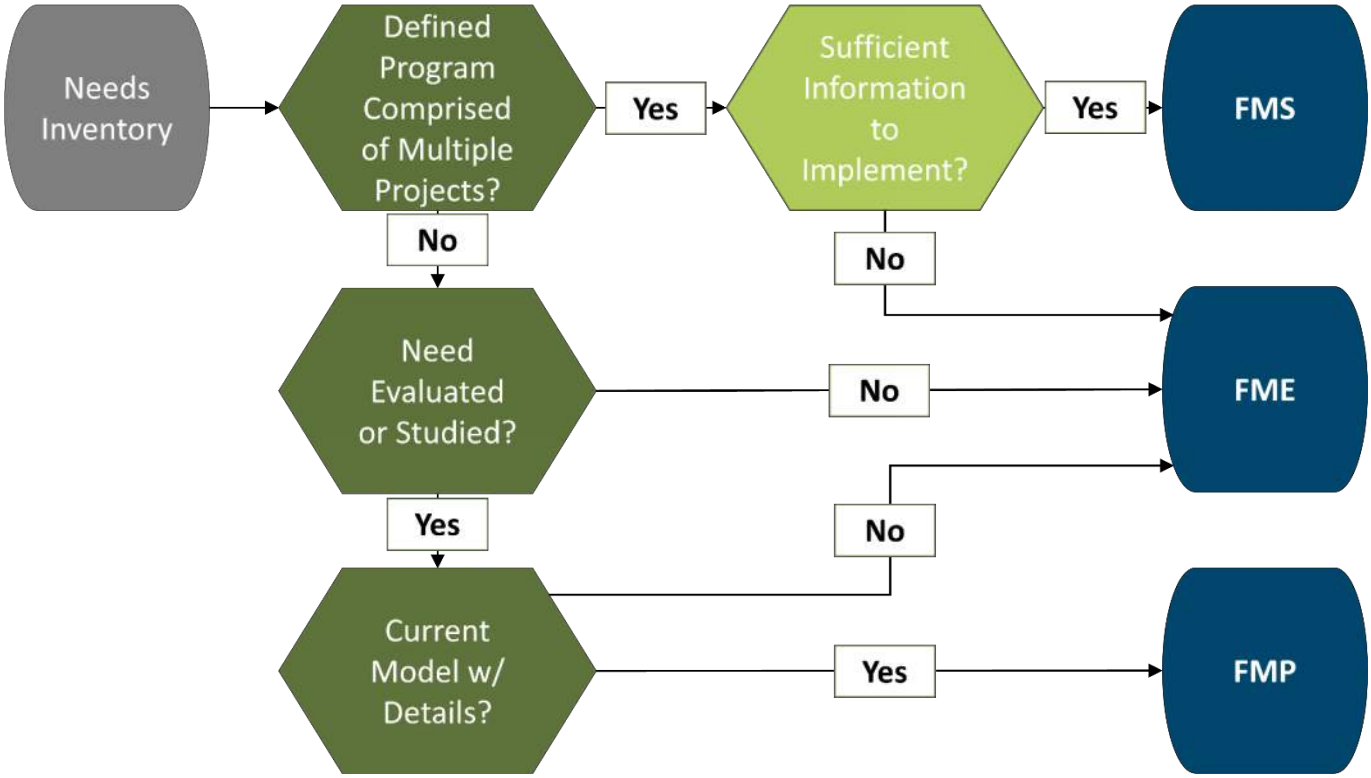


FIGURE 4-3 POTENTIAL FLOOD RISK REDUCTION ACTION SCREENING PROCESS

Generally, an action was considered an FME if it required a study to quantify flood risk in an area, define potential FMPs and FMSs to address the risk, or assess downstream impacts. Potential actions that could be considered FMPs and FMSs were screened to determine if they have been developed in enough detail and include sufficient data to meet the technical requirements for these action types. Actions that were initially considered for FMSs and FMPs that did not meet these requirements were adapted and repurposed as FMEs.

FMSs were also identified for other strategies the RFPG wishes to pursue. One example of a potential FMS is identifying repetitive loss properties and establishing a community-wide program of voluntary acquisitions to be implemented over several years. Another example would be a program to enhance public education and awareness about flooding throughout the region, which does not include a construction cost.

Evaluation of Potential FMEs

Several actions were identified as potential FMEs to address gaps in available flood risk data associated with the first planning cycle. The following sources of data were used to identify FMEs across the basin.

- Hazard Mitigation Action Plans
- Drainage Master Plans
- Previous flood studies
- Direct input from the RFPG and Community Representatives

The evaluation of FMEs relied on the compilation of planning level data to gauge alignment with regional strategies and flood planning guidance, the potential flood risk in the area, and the funding need and availability. This data included the following.

- Type of study and location
- Availability of existing modeling and mapping data
- Regional flood mitigation and floodplain management goals addressed by the FME, and whether the FME meets an emergency need
- Flood risk information, including flood risk type, number and location of structures, population, roadways, and agricultural areas at risk
- Sponsor entity and other entities with oversight
- Cost information, including study cost and potential funding sources

FME Types

The definition of an FME allows for a variety of study types to help assess flood risk and potentially define future FMPs and FMSs. A general list of study types was previously summarized in Table 4-11. The following section describes these project types in more detail and provides a summary of the different potential FMEs identified in Region 7.

Watershed Planning

FMEs classified as Watershed Planning typically involve efforts associated with H&H modeling to help define flood risk or identify flood prone areas at a watershed scale. The goal of Watershed Planning is to distribute resources equitably throughout the watershed to implement plans, programs, and projects that maintain watershed function and prevent adverse flood effects. A wide variety of project types fit under the umbrella of Watershed Planning, and the subcategories defined in Region 7 include the following.

Flood Risk Mapping – Flood mapping data helps communities quantify and manage their flood risk. It also provides communities a pathway to access flood insurance administered through the NFIP. Flood Mapping FMEs were identified for 29 out of the 36 counties within the Upper Brazos Basin. The FMEs included both the development of regulatory maps where none currently exist and updating existing, outdated maps to account for revised rainfall data, recent development conditions, and advances in floodplain modeling and mapping methodologies.

Drainage Master Plans – DMPs support the development and analysis of H&H models to evaluate flood risk within a given jurisdiction, evaluate potential alternatives to mitigate flood risk, and develop CIPs.

Engineering Project Planning

FMEs classified as Engineering Project Planning include studies to evaluate potential structural mitigation projects. These evaluations include feasibility assessments, preliminary alternatives analysis, and preliminary engineering design. The scope of the flood planning process defines a 30% design level as the cut-off between the study phase associated with an FME and the design implementation phase associated with an FMP.

A total of 10 potential FMPs were moved to FME Project Planning to develop these projects to meet the TWDB criteria for FMPs. Additional actions included in engineering project planning include studies to flood proof or relocate critical facilities. These needs were identified in communities HMAP but need additional analysis to identify specific project locations. A total of 14 projects requested were related to floodproofing or relocating critical facilities in Region 7.

Other FMEs

FMEs classified as "Other" are associated with studies to develop and support property acquisition programs or Drainage Criteria Manuals (DCMs). DCMs focus on generating stormwater criteria for infrastructure and floodplain ordinances to avoid new exposure to flood hazards. Higher standards programs promote more resilient practices than the NFIP for new construction. Higher standards can include regulations such as increasing freeboard requirements for structures in the SFHA, adopting a 'no-rise' in the base flood elevation (BFE) in the 1% annual chance event floodplain, and updating local flood ordinances to prohibit granting of variances in the SFHA.

FME Classification Summary

An overall summary of the identified FMEs is provided in Table 4-11. All potential FMEs that were identified are listed with their supporting technical information in Appendix B Required Table 12. In total, 226 potential FMEs were identified and evaluated. The geographic distribution of the identified FMEs is shown in Figure 4-4. Color gradations in Figure 4-4 reflect the number of FMEs that overlap for the same area; the darker the color, the greater the number of FMEs.

TABLE 4-11 FME TYPES AND GENERAL DESCRIPTION

FME Type	General Description	Identified
Watershed Planning – Drainage Master Plan	Supports the development and analysis of H&H models to define flood risk or identify flood prone areas OR large-scale studies that are likely to benefit multiple jurisdictions.	53
Watershed Planning – Flood Risk Mapping	Promotes the development and/or refinement of detailed flood risk maps to address data gaps and inadequate mapping. Create FEMA mapping in previously unmapped areas and update existing FEMA maps as needed.	30
Engineering Project Planning	Evaluation of a proposed project to determine whether implementation would be feasible OR initial engineering assessment including conceptual design, alternative analysis, and up to 30% engineering design.	66
Other	Other projects not classified above. All FMEs classified as "Other" are associated with studies to support criteria and ordinance updates including property acquisition programs (including high-risk and repetitive loss properties and acquiring and preserving open space adjacent to floodplains).	76
Total		**226**

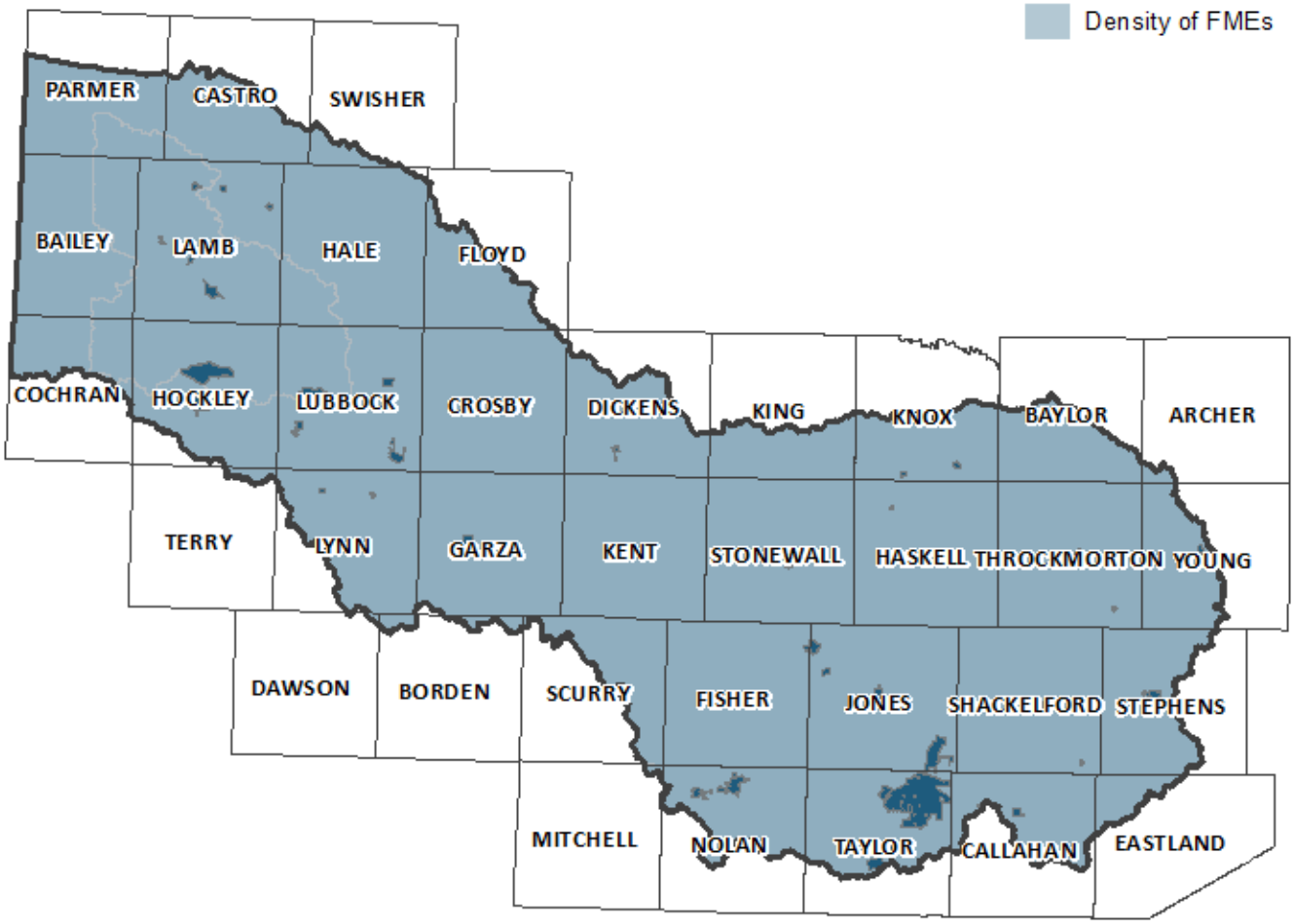


FIGURE 4-4 GEOGRAPHICAL DISTRIBUTION OF POTENTIAL FMES

Planning Level Cost Estimates

A planning level cost estimate was developed for each FME in accordance with the *Technical Guidelines*. The process to produce these cost estimates for each FME project type is outlined in the following sections. Cost estimates presented in this section are for planning purposes only and are not supported by detailed scopes of work or labor-hour estimates. It is anticipated that scopes of work and cost estimates will be refined prior to any future funding application through TWDB or other sources. All planning cost estimates in the 2023 Regional Flood Plan are presented in year 2020 dollars.

Watershed Planning – Drainage Master Plans

The objective of Drainage Master Plan FMEs is to evaluate and define flood risk, identify flood prone areas, and evaluate alternatives for mitigating such risks. Planning level cost estimates were developed for these types of FMEs assuming a typical scope of work that includes management, data collection, topographic survey, hydrologic analysis, hydraulic analysis, alternatives evaluation, and final deliverables. Experience from previous studies was used to identify the study effort and estimate the level of detail associated with the H&H analyses that are required for these studies. Values were estimated for small communities ($250,000) and large communities ($500,000) drainage master plans.

Each cost estimate also includes standard budget items based on the total project cost. These include a markup of 2% to account for quality assurance and quality control and 15% for project management, survey data capture, and technical reporting. Finally, a 30% contingency was applied to account for uncertainties associated with planning level estimates.

Watershed Planning – FEMA Mapping

Flood risk mapping data helps communities quantify and manage their flood risks. It also provides communities a pathway to access flood insurance administered through the NFIP. FEMA Mapping FMEs were identified for all counties within Region 7. The FMEs included both projects to develop regulatory maps where none exist and to update existing maps to account for revised rainfall data, recent development or topographic changes, and advances in floodplain modeling and mapping methodologies.

A spreadsheet was generated to produce planning level cost estimates for mapping studies utilizing relevant line items from the FEMA guidance document *Estimating the Value of Partner Contributions to Flood Mapping Projects* ("Blue Book") version 4.1. Costs pertaining to management, discovery data capture, hydrologic data capture, hydraulic data capture, floodplain mapping data capture, and final deliverables were included as part of the overall cost.

The FME study area was defined as the portion of the county boundary that is within the Upper Brazos River basin. A range of unit costs were developed to generate estimates based on the square mileage of the study areas and the total length of stream miles for which hydraulic modeling would be performed. It was estimated that the stream miles to be included would be 50% of the total stream miles classified as FEMA Zone A or unmapped within a given study area.

Experience with previous mapping projects was used to estimate the level of detail associated with the hydrologic and hydraulic analyses that are required for these studies. The level of detail needed to perform a regulatory study reflects differences in the physical characteristics of the basins and their levels of urban development. In terms of hydrologic analysis, it was estimated that 80% of the total project area could be analyzed using low-detail methods, while 20% would require more detailed rainfall-runoff analyses. For the hydraulic analysis, it was estimated that 70% of the included streams could be properly modeled with a low-detail hydraulic model, 20% with a medium-detail model, and the remaining 10% would require highly detailed models. Unit costs were applied to reflect these different levels of detail.

Each cost estimate also includes standard budget items based on the total project cost. These include a markup of 2% to account for quality assurance and quality control and 15% for project management, survey data capture, and technical reporting. Finally, a 30% contingency was applied to account for uncertainties associated with planning level estimates.

Engineering Project Planning

Engineering project planning considers two important components: (1) the evaluation of a proposed project to determine whether implementation would be feasible, and (2) an initial engineering

assessment including conceptual design, alternative analysis, and up to 30% engineering design. Each evaluation area is project-specific and varies greatly due to the wide range of improvements in channels, low water crossings, roads and bridges, storm drain systems, and levee systems. HMAPs were used, when available, for the respective entity in determining planning level cost estimates. It was assumed that each evaluation would be 10% of the total construction cost reported in the HMAP. In instances where no HMAP was available, additional research was conducted to gather supplemental information from FME sponsors or from similar studies to develop a scope of work and planning level cost estimate.

Other

FMEs classified as "Other" are associated with studies to develop and support property acquisition programs or DCMs. The scope and scale of property acquisition programs can vary widely, and there is great uncertainty in terms of the number of properties/parcels that could potentially be acquired, and their fluctuating market values. Therefore, rather than scaling each FME individually, a standard project cost of $100,000 was assigned to each FME.

It is assumed that this placeholder budget would provide sufficient funds to perform an initial assessment to identify potential areas for acquisition, prioritize areas/properties, perform market research, and define a scope of work for specific acquisition projects. This scope of work could include H&H studies, deed studies, property appraisals, inquiries about voluntary participation, identifying potential funding sources, and identifying supplementary work such as stream restoration and other flood risk reduction projects. This placeholder budget is not intended for acquiring properties. Further funding will be required in the future to implement the acquisition programs developed under these FMEs.

Process to Determine Flood Risk Indicators

Flood risk indicators were quantified to define the existing flood hazard, flood risk, and flood vulnerability within each FME project area. GIS processes were performed to combine and summarize this information by clipping the flood risk information generated for the basin as part of Task 2A to the individual project boundaries associated with each FME. The resulting flood risk indicator information was used to populate the associated fields in the FME feature class. These values are summarized in Appendix B Required Table 12.

Comparison and Assessment of FMEs

Due to the lack of available detailed studies in the regions, FMEs are the most numerous flood mitigation actions in the RFP. The inclusion of FMPs and some FMSs in this plan was hampered by the lack of detailed hydrologic and hydraulic modeling needed to assess them to meet the TWDB's technical requirements. Over 86% of Region 7 has no FIRM maps. Other than the City of Lubbock, the rest of the maps or models available in the region are more than a couple of decades old and likely do not reflect current conditions. Thirty new FIS studies with associated floodplain maps and models are recommended to ensure that appropriate regulation of the floodplains can occur, flood damages can be mitigated, and a solid basis for future assessment of riverine flooding issues and solutions is available.

Ten potential FMPs, or collections of FMPs, were submitted by communities within Region 7, but they did not have adequate modeling to meet TWDB requirements. These potential FMPs have been included as FMEs to support preparation of the needed studies and verify that the projects would meet TWDB requirements.

Determination of Emergency Need

For the purposes of this evaluation, an action was considered to meet an emergency need if it addresses an issue related to infrastructure in immediate need for repair or construction, particularly following a natural disaster or other destructive event. While flooding can occur at any time of year with any magnitude and often without warning, studies and evaluations on flooding generally do not meet these criteria because of the time it takes to complete a study and develop actionable alternatives. In Region 7, the lack of available models severely limits the ability to identify Flood Mitigation Projects and for communities to participate in floodplain management practices.

Evaluation of Potentially Feasible FMSs and FMPs

Potentially feasible FMPs were identified based on responses to the data collection survey, reviews of previous studies, and direct coordination with entities. FMSs and FMPs are required to be developed in a sufficient level of detail to be included in the RFP and recommended for state funding. In most cases, this level includes having recent H&H modeling data in order to assess the impacts of the project and an associated project cost to develop the project's benefit cost ratio (BCR). The development and use of technical information to evaluate potentially feasible actions is described in the subsections that follow.

Potentially Feasible FMPs

Three potentially feasible FMPs, located within the City of Lubbock, City of Bovina, and the City of Abilene were found to meet the TWDB requirements for a FMP. These potential FMPs consist of playa excavation and open channel improvements, buyouts, and early warning systems. None have been classified as meeting an emergency need. A summary listing of FMP types is provided in Table 4-12.

Further details are provided for the recommended FMPs in Task 5. The geographic distribution of each identified FMP is shown in Figure 4-5 with technical information for each FMP summarized in Appendix B Required Table 13.

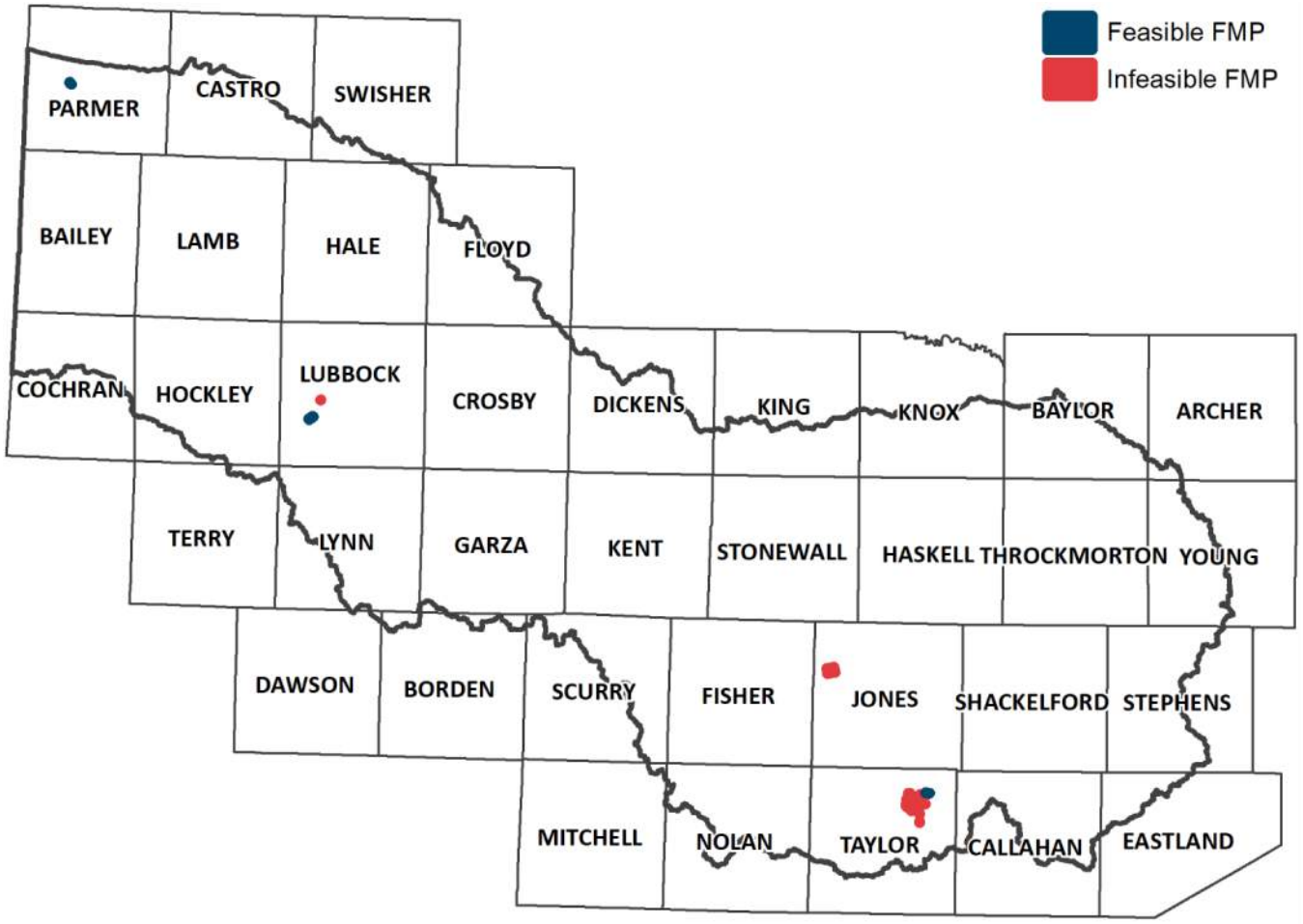


FIGURE 4-5 GEOGRAPHIC DISTRIBUTION OF IDENTIFIED FMPS

TABLE 4-12 FMP TYPES AND GENERAL DESCRIPTION

FMP Type	Name	General Description
Non-Structural: Early Warning System	City of Abilene Downtown Underpasses Flood Warning	Installation of sensors at three railroad underpasses
Structural: Regional Channel Improvements	City of Lubbock: Santa Fe Drive Improvements	Playa excavation, open channel construction for playa overflow and culvert improvements.
Non-Structural: Property Acquisition	Bovina Buyout Program	Voluntary buyout of 5 residential properties adjacent to playa to green space.

Additional potentially feasible FMPs may be identified through continued outreach with regional entities under Task 11 and through the execution of identified FMEs, either as FMEs are approved by the RFPG to be performed under Task 12, or as other funding sources are acquired by individual communities.

Table 4-13 includes a list of FMPs that were identified but determined by to be infeasible, including the primary reason for it being infeasible.

TABLE 4-13 INFEASIBLE FMPS

Infeasible FMP	Reason	Revised Action
City of Abilene Buttonwillow Creek Crossing	Does not meet TWDB FMP requirements	Moved to FME Project Planning
City of Abilene Buttonwillow Upstream Detention	Does not meet TWDB FMP requirements	Moved to FME Project Planning
City of Abilene Catclaw Creek From S. 11th to S. 7th	Does not meet TWDB FMP requirements	Moved to FME Project Planning
City of Abilene Elm Creek Detention below Southwest Dr	Does not meet TWDB FMP requirements	Moved to FME Project Planning
City of Abilene Elm Creek Diversion	Does not meet TWDB FMP requirements	Moved to FME Project Planning
City of Abilene Improve Curry Lane Detention Pond	Does not meet TWDB FMP requirements	Moved to FME Project Planning
City of Abilene Little Elm Creek at S. 7th Street	Does not meet TWDB FMP requirements	Moved to FME Project Planning
City of Abilene Treadway and S. 27th Street	Does not meet TWDB FMP requirements	Moved to FME Project Planning
City of Lubbock 4th St & Elkhart Ave CIP	Alternative is no longer feasible	Moved to FME Project Planning
Hamlin Dam Improvements	Does not meet TWDB FMP requirements	Moved to FME Project Planning
Hamlin South Lake Dam Diversion	Does not meet TWDB FMP requirements	Moved to FME Project Planning

Potentially Feasible FMSs

The RFPG identified 63 potentially feasible FMSs for Region 7. The geographic distribution of each FMS is shown in Figure 4-6 with technical information for each FMS summarized in Table 4-14. Color gradations in Figure 4-6 reflect the number of FMSs that overlap for the same area; the darker the color, the greater the number of FMSs.

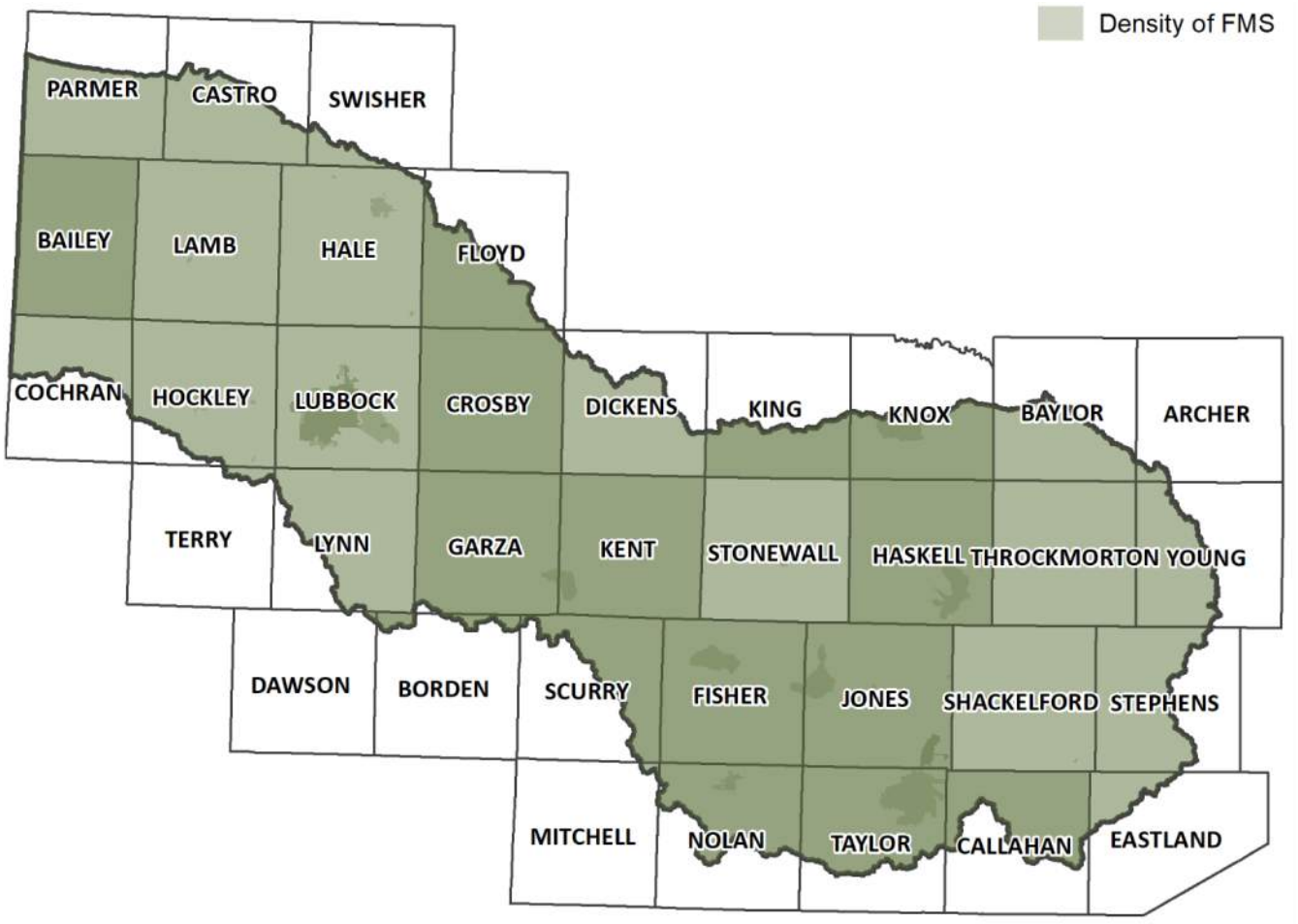


FIGURE 4-6 GEOGRAPHIC DISTRIBUTION OF IDENTIFIED FMSS

A variety of FMS types were identified. Some strategies encourage and support communities and municipalities to actively participate within the NFIP. Other FMSs recommend the establishment and implementation of public awareness and educational programs to better inform communities of the risks associated with flood waters. Additional FMSs promote preventive maintenance programs to optimize the efficiency of existing stormwater management infrastructure, recommend the development of a stormwater management manual to encourage best management practices, or promote the establishment of community-wide flood warning systems. None have been classified as meeting an emergency need. A summary listing of FMS types is provided in Table 4-14.

TABLE 4-14 FMS TYPES AND GENERAL DESCRIPTION

FMS Type	General Description	Identified
Education and Outreach	Develop a coordinated education, outreach, and training program to train staff and to inform and educate the public about the dangers of flooding and how to prevent flood damages to property.	10
Flood Measurement and Warning Systems	Develop program to install gauges, sensors, and precipitation measuring sites to monitor streams and waterways for potential flooding and support emergency response.	5
Infrastructure Projects	Develop program for improvements including reinforcement of slopes, spillway expansion, dam repairs and upgrades.	11
Regulatory and Guidance	Application to join NFIP or adoption of equivalent standards.	36
Other	Consider tax incentive programs for development of low-hazard land parcels.	1
Total		**63**

Comparison and Assessment of FMSs and FMPs

Potentially Feasible FMS and FMP Comparison and Assessment

A total of 14 potential FMPs were originally collected for the Region; however, only three met the recommendation requirements to be considered for inclusion as an FMP. All three of the FMPs are categorized into three distinct categories: an early warning system, regional channel improvements, and a property buyout program. The FMPs present proposed design and construction projects that will improve each sponsor's stormwater infrastructure in order to reduce flooding in high flood risk areas. The cost estimates range from $550,000 to $4,500,000.

A total of 63 potential FMSs were generated or requested by communities. Regulatory and Guidance was the largest category with 36 potential FMSs. These strategies included adding communities to the NFIP, developing and adopting stormwater management criteria, and floodplain management staff acquisition and training. Developing minimum NFIP or higher floodplain regulatory standards for new development near a floodplain preserves the natural capacity of the flooding source and limits upstream and downstream negative impacts. Minimum FEMA NFIP floodplain regulations can be found in 44 Code of Federal Regulations (CRF) Parts 59, 60, 65, and 70. TFMA has developed a Guide for Higher Standards for Floodplain Management (2018), which can serve as an example for higher floodplain development standards for the referenced FMSs. At a total of $1,725,000, these FMSs can have the greatest impact as they help prevent future flooding through better understanding of flood risks, preventing development in the floodplain, and improving drainage design and development standards.

Thirteen sponsors requested flood awareness and safety education support. These FMSs range from implementing the a "Turn Around, Don't Drown" campaign to general education about the NFIP. Of the

sponsors requesting education and outreach support, the City of Abilene demonstrated the highest flood risk to habitable structures and road crossings. An additional five outreach programs were developed from the RFPG goals.

Five sponsors expressed interest in flood measuring, monitoring, and warning systems. These systems include local warning notifications, monitoring/measuring gages, highwater detection systems, sirens, warning lights, signage, and automated gates.

Effects on Neighboring Areas of FMS or FMP

Each potentially feasible FMP and FMS must demonstrate that there would be no negative flood impacts on a neighboring area due to its implementation. No negative impact means that a project will not increase flood risk to surrounding properties. The analysis must be based on best available data and be sufficiently robust to demonstrate that the post-project flood hazard is no more than the existing flood hazard.

Some communities in Region 7 have established no negative flood impact policies for proposed development, but communities have different thresholds for defining what level of impact is considered adverse and require the analysis to be performed for different flood event scenarios. The *Technical Guidelines* governing state flood planning require the impacts analysis to be performed for the 1% ACE. Additionally, the *Technical Guidelines* require the following criteria to be met, as applicable, to establish no negative flood impact.

1. Stormwater does not increase inundation in areas beyond the public ROW, project property, or easement.
2. Stormwater does not increase inundation of storm drainage networks, channels, and roadways beyond design capacity.
3. Maximum increase of 1D water surface elevation (WSE) must round to 0.0 feet (< 0.05ft) measured along the hydraulic cross-section.
4. Maximum increase of 2D WSEs must round to 0.3 feet (< 0.35ft) measured at each computational cell.
5. Maximum increase in hydrologic peak discharge must be < 0.5% measured at computational nodes (sub-basins, junctions, reaches, reservoirs, etc.). This discharge restriction does not apply to a 2D overland analysis.

If negative impacts are identified, mitigation measures may be utilized to alleviate such impacts. Projects with design level mitigation measures already identified may be included in the RFP and could be finalized at a later stage to conform to the “No Negative Impact” requirements prior to funding or execution of a project.

A comparative assessment of pre- and post-project conditions for the 1% annual chance event was performed for each potentially feasible FMP based on their associated H&H models. The floodplain boundary extents, resulting WSEs, and peak discharge values were compared at pertinent locations to determine if the FMP conforms to the no negative impacts requirements. This comparative assessment

was performed for the entire zone of influence of the FMP. Further details pertaining to the no negative impact determination for each potentially feasible FMP are provided in the Task 5 narrative.

Estimated Benefits of FMS or FMP

To be recommended, each FMP or FMS must align with a regional floodplain management goal established under Task 3 and demonstrate a flood risk reduction benefit. To quantify the flood risk reduction benefit of each FMP or FMS, the anticipated impact after project implementation was evaluated with the following criteria.

- Reduction in habitable, equivalent living units flood risk
- Reduction in residential population flood risk
- Reduction in critical facilities flood risk
- Reduction in road closure occurrences
- Reduction in acres of active farmland and ranchland flood risk
- Estimated reduction in fatalities, when available
- Estimated reduction in injuries, when available
- Reduction in expected annual damages from residential, commercial, and public property
- Other benefits as deemed relevant by the RFPG including environmental benefits and other public benefits

These estimated benefits were produced from geospatial data by analyzing the existing 1% and 0.2% annual chance event floodplain boundaries with the proposed post-project floodplain boundaries. These proposed flood risk conditions were compared to the existing conditions flood risk indicators for a given area to quantify the reduction of flood risk achieved by implementation of an FMP or FMS. The results of the analysis are shown for each FMP or FMS in Appendix B Required Table 13 and Table 14, respectively.

Potential Impacts and Benefits from the FMS or FMP to other resources

Potential impacts and benefits from FMS or FMP are explored for Region 7 from the standpoint of environment, agriculture, recreation, navigation, water quality, erosion, and sedimentation. Factors unique to the region were reviewed, and an assessment of how these factors might interact with a potential FMS or FMP is discussed below.

Environmental

SB3 was designed to establish environmental flow standards for all major river basins and bay systems in Texas through a scientific, community-driven, and consensus-based process. The key questions addressed by the SB3 process as defined by TWDB are the following.

1. What is the quantity of water required by the state's rivers/estuaries to sustain a sound ecological environment?
2. How can this water be protected?
3. What is the appropriate balance between water needed to sustain a sound ecological environment and water needed for human or other uses?

FMSs or FMPs in the region should consider potential impacts as they relate to the ecological flows established under the directive of SB3. Four of the proposed FMSs or FMPs involved local detention or retention, therefore, there would be minimal or no impact to base or environmental flows.

Agricultural

Flood waters have the potential to destroy standing crops, create water-logged conditions that delay planting or harvesting, wash away productive topsoil, and damage farm equipment and infrastructure. FMSs or FMPs potentially reduce extremely high flows in rivers and streams thereby preventing flood waters from inundating areas outside of the floodway including agricultural areas. Structural FMSs or FMPs, like small flood control ponds, also have the potential to assist in agricultural production by serving a dual purpose of flood mitigation and water supply. Non-structural FMSs or FMPs have similar impacts on flood peak flow reduction and flooding including agricultural conservation practices such as conservation tillage, residue management, cover crops, and furrow dikes. These practices not only reduce downstream flooding by reducing surface runoff and increasing infiltration on agricultural lands but also reduce sediment and nutrient losses thereby improving downstream water quality.

The Regulatory and Guidance FMSs and Watershed Planning FMEs have the potential to benefit agricultural operations by improving their understanding of flood risks, making insurance available for structures, and preventing construction of regulated structures within the floodplain.

Recreational Resources

There are ten major lakes and reservoirs in Region 7. Recreational opportunities associated with these lakes and reservoirs have the potential to be impacted when they are being operated to mitigate flood risk. Flood control reservoirs hold water in their flood pools during peak runoff periods until the impounded water can be safely released downstream. During these periods, recreational use of adjacent parks and playgrounds may be vastly reduced. No new flood control reservoirs or other reservoirs of any kind are being proposed in the RFP. Eight FMSs are related to dams and reservoirs.

Navigation

None of the major rivers within Region 7 are used for commercial navigation.

Water Quality, Erosion, and Sedimentation

Water quality, erosion, and sedimentation are complex and interrelated issues. Water quality usually relates to nutrient and bacterial loading, but also includes turbidity, which relates to sediment load.

In this region, playa sedimentation is a concern, especially in urbanized areas. Playas are a volume-dependent drainage system. Over time, sedimentation in the playas gradually reduces the natural flood protection. Limited studies, however, have focused on the impacts of playa sedimentation. Through the Texas Playa Conservation Initiative[26], Texas Parks & Wildlife has an existing program focused on increasing the understanding of the behavior of playas and the restoration of these features to aid in

[26] TxPCI. 2022. Playas Work for Texas: https://playasworkfortexans.com/

groundwater infiltration and recharge and water quality protection. In water bodies such as the City of Lubbock's Canyon Lakes, entities have identified an FMS to dredge this sedimentation and restore flood storage.

Most of the other actions considered in this plan will improve understanding of the floodplains and allow for better understanding of any future project impacts. None of the proposed actions are expected to have adverse impacts to water quality, erosion, or sedimentation, but these potential impacts will need to be considered as future FMPs are developed.

Estimated Capital Cost of FMPs and FMSs

Cost estimates for each FMP were acquired from the engineering report that was used to generate the FMP. Cost estimates were adjusted as needed to account for inflation and other changes in price of labor and commodities that had taken place since the publication date of the original reports. The cost estimates listed in Appendix B Required Table 13 and Table 14 are expressed in 2020 USD.

Cost estimates for each FMS were acquired from the HMAPs that were used to generate the FMS. Cost assumptions from Table 4-15 were used if the HMAPs did not have associated costs or if the reported costs were lower than the cost assumptions. The cost assumptions are expressed in 2020 dollars and were developed based on engineering experience and other similar projects.

TABLE 4-15 FMS COST ASSUMPTIONS

FMS Type	Cost Estimate	Scope and Assumptions
Public Awareness and Educational Programs	$50,000 to $100,000	• Region-Wide Public Education on Flooding: Assume $100,000 based on other similar educational programs. • Community Public Education on Flooding: Assume $50,000 based on smaller scope.
Flood Warning Systems	$50,000 to $375,000	• Early Alert System/Gauge Notification: Costs estimated from HMAP
Infrastructure Projects	$50,000 to $500,000	• Varied programs estimated from HMAP and similar programs.
Regulatory and Guidance	$50,000	• Assume $50,000 to cover engineering consultant fees and support communities in their implementation process.
Other	$25,000	• Assume $25,000 to consider tax incentive program for development of low-hazard land parcels.

Benefit-Cost Ratio for FMPs

Benefit cost analysis (BCA) is the method by which the future benefits of a hazard mitigation project are determined and compared to its costs. The end result is a BCR, which is calculated by dividing the project's total benefits, quantified as a dollar amount, by its total costs. The BCR is a numerical

expression of the relative "cost-effectiveness" of a project. A project is generally considered to be cost effective when the BCR is 1.0 or greater, indicating the benefits of a prospective hazard mitigation project are sufficient to justify the costs (FEMA, 2009). However, a BCR equal to or greater than 1.0 is not a requirement for inclusion in the RFP. The RFPG can decide to recommend a project with a lower BCR with appropriate justification.

When a BCR had been previously calculated in an engineering report or study that was used to create an FMP, the previously calculated BCR value was utilized for the FMP analysis. For any FMP that did not already have a calculated BCR value, the TWDB BCA Input Spreadsheet was utilized in conjunction with the FEMA BCA Toolkit 6.0 to generate BCR values. The BCR value for each FMP is listed in Appendix B Required Table 13.

Residual, Post-Project, and Future-Risks of FMPs

It is expected that the implementation of recommended FMPs will reduce current and future levels of flood risk in the region. However, it is not possible to protect against all potential flood risks and there is potential for future increases in flood risk due to lack of maintenance or even a catastrophic failure. In general, residual and future risks for FMPs could be characterized as follows.

1. Flood events may exceed the level of service for which infrastructure is designed.
2. Potential failure or overtopping of dams and levees.
3. Communities depend on future funding and program priorities to maintain, repair, and replace flood protection assets. Routine maintenance of infrastructure is required to maintain its design capacity. Maintenance is sometimes overlooked due to budget, staff, and time constraints.
4. In our representative government, policy changes that adversely impact budgets, prior plans, assets, and standards are always a possibility.

Human behavior is unpredictable, people may choose to ignore flood warning systems or cross over flooded roadways for a variety of reasons.

The engineering studies that provide the supporting data for the potential Region 7 FMPs were reviewed to identify the residual, post-project and future risks associated with each FMP.

This review revealed that there is a significant residual risk for the City of Abilene Downtown Railroad Sensor project, as it does not reduce the flood risk. Rather, it will communicate the risk to the community. Additionally, the Bovina Buyout Program would consist of a voluntary property acquisition, so any property owner that does not choose to participate will continue to be at flood risk. For any structural project, regular maintenance of the infrastructure is required to maintain its design capacity as any debris or structural deterioration can hinder its performance.

Implementation Issues of FMPs

Implementation issues that could be identified include conflicts pertaining to ROW, permitting, acquisitions, utility or transportation relocations, as well as other issues that might be encountered before an FMP is able to be fully implemented.

The terms “buyout” and “acquisition” are often utilized interchangeably, but in the context of flood protection, both refer generally to the purchase of private property by the government for public use. After properties are purchased through a buyout program, the land is converted to open space. In the case of flood acquisitions, the process involves the purchase of a property in a floodplain in order to reduce the damage of future flooding on the site and/or for properties adjacent to the one being acquired. Any buyout program included in the RFP are voluntary acquisition programs.

One unique issue to this region is how to classify playas in accordance with Waters of the United States. The federal government regulates construction activities that take place within areas designated as Waters of the United States. As stated in 33 CFR 3.28.3(a)(3), playas are considered Waters of the United States, as are wetlands adjacent to Waters of the United States. However, communication with USACE on previous projects indicates that this may not apply to all playas. Therefore, close coordination with USACE on any playa project is a necessity. Additionally, playas were favored by prehistoric groups because they provided a more consistent source of water, wild game, and other resources. Therefore, coordination with the State Historic Preservation Officer and the THC as described by the National Historic Preservation Act and Antiquities Code of Texas regulations could be required for some projects.

Potential Funding Sources

A wide variety of funding opportunities could be utilized to fund the identified actions. Traditionally, stormwater and flood mitigation project funding sources have either been locally sourced user fees, general taxes, or funded externally by state and federal grants. While low-interest loan programs do provide for additional funding, few local entities chose this path due to the lack of a dedicated funding source sufficient to cover debt service. Therefore, many communities adopted a “pay-as-you-go” method of funding stormwater projects or - in the event of a disaster - applied for state and federal disaster recovery grants. Today, communities have a broader range of funding sources and programs that include the above as well as recently created mitigation grant and loan programs such as the Building Resilient Infrastructure and Communities and the TWDB FIF. The potential funding sources for the identified FMEs, FMPs and FMSs are listed in Appendix B Required Tables 12, 13 and 14, respectively. Further details on funding opportunities and the anticipated funding sources for the recommended actions are included in the Task 9 narrative.

Task 5. Evaluation and Recommendation of Flood Management Actions

The objective of Task 5 is for RFPGs to use the information developed under Task 4 to recommend flood mitigation actions (FMEs, FMSs, and FMPs) for inclusion in the Regional Flood Plan. While Task 4B discusses the technical evaluations of the potential FMEs, and potentially feasible FMSs and FMPs identified by the RFPG, Task 5 focuses on how the RFPG used this data to make a recommendation for a given flood mitigation action. Generally, this chapter summarizes and documents the process undertaken by the RFPG to make final recommendations on the given flood mitigation action types and potential FMEs and potentially feasible FMSs and FMPs identified and evaluated under Task 4B and whether these actions are recommended by the RFPG.

While there is abundant need across the Region and the State for better, recent, and more widely available data on flood risk, it is evident that not every conceivable flood mitigation action can be recommended in the Regional Flood Plan or included in the State Flood Plan. The RFPG evaluated the identified potential flood mitigation actions and, based on the significant needs in the region, recommended those that met TWDB requirements. The RFPG understands that not all recommendations may be performed in the same planning cycle as they are identified. Finally, all recommendations considered alignment with RFPG-adopted flood mitigation and floodplain management goals.

RFPG Evaluation and Recommendation Process

The Upper Brazos RFPG considered the potentially feasible flood management and flood mitigation actions developed in Task 4. Unless a potential Sponsor requested an action be removed from its list of potentially feasible solutions, all the potentially feasible FMEs were recommended in the flood plan. The FMPs and FMSs that made it through the evaluation process and were not specifically requested by the potential sponsor to be removed from its list of action were also recommended.

Sponsor Outreach

The RFPG contacted potential sponsors for all identified FMEs, FMPs, and FMSs to obtain clarification regarding potentially feasible flood management or flood mitigation actions, such as locations or project descriptions. In some instances, these conversations produced additional insight as to the potential sponsor's preferred action compared to other potential solutions previously considered in Task 4. In other cases, the potential sponsors contacted the RFPG expressing interest in specific actions being considered for potential inclusion in the plan. Additional information on outreach can be found in the Task 10 narrative.

The RFPG decided that a potential sponsor did not have to affirm its willingness to sponsor a given action as a prerequisite for inclusion in the plan. As a result, all potential actions were considered for inclusion unless an entity had specifically stated that a particular action was not of interest to the entity. This approach provides the following concepts.

1. A conservative estimate of the flood mitigation needs in the region.
2. Does not obligate an entity to sponsor or pursue an action; it simply allows an entity to be eligible for funding if interest in and capacity to sponsor an action becomes evident before the next regional flood plan is adopted.

As part of the Task 9 effort, the RFPG sent surveys to all sponsors associated with recommended actions to communicate that they had been identified as a sponsor and to inquire about potential funding sources for the actions listed in the plan. This survey effort is detailed in Task 9.

Flood Management Evaluations (FMEs)

Summary of Approach in Recommending FMEs

FMEs were recommended according to TWDB *Technical Guidelines* in which those actions are most likely to result in the identification of potentially feasible FMPs and FMSs. Recommended FMEs are intended to account for the 1% annual chance flood event and support one or more flood mitigation or floodplain management goals.

Description and Summary of Recommended FMEs

A total of 225 potential FMEs were identified and evaluated by the RFPG. Of these projects, 225 were recommended, representing a combined total of approximately $83M of flood management evaluation needs across the region. Figure 5-1 shows the distribution of the recommended FMEs within the region. Appendix A Map 19 includes a detailed view of recommended FMEs. A one-page summary sheet for each recommended FME is included in Appendix C.

TABLE 5-1 SUMMARY OF RECOMMENDED FMES

FME Type	General Description	Total	Cost
Watershed Planning – Drainage Master Plans	Supports the development and analysis of H&H models to define flood risk or identify flood prone areas OR large-scale studies that are likely to benefit multiple jurisdictions.	53	$19M
Watershed Planning – Flood Risk Mapping	Promotes the development and/or refinement of detailed flood risk maps to address data gaps and inadequate mapping. Create FEMA mapping in previously unmapped areas and update existing FEMA maps as needed.	30	$26M
Engineering Project Planning	Evaluation of a proposed project to determine whether implementation would be feasible OR initial engineering assessment including conceptual design, alternative analysis, and up to 30% engineering design.	66	$30M
Other	FMEs associated with studies to support criteria and ordinance updates including property acquisition programs (including high-risk and repetitive loss properties and acquiring and preserving open space adjacent to floodplain areas).	76	$8M
Region 7 FMEs	**Total**	**225**	**$84M**

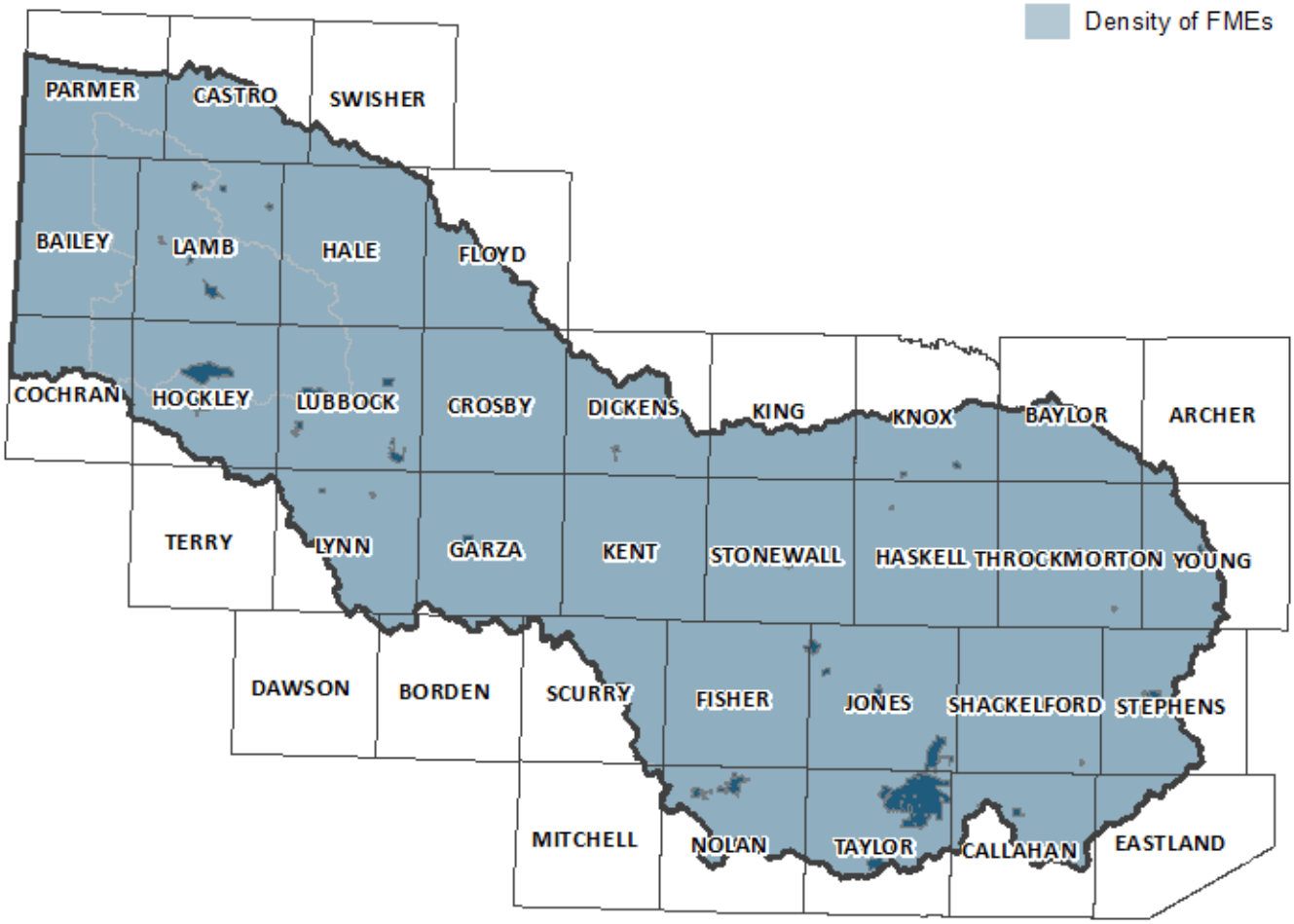


FIGURE 5-1 GEOGRAPHIC DISTRIBUTION OF RECOMMENDED FMES

Flood Mitigation Projects (FMPs)

Summary of Approach in Recommending FMPs

For consideration as an FMP, a project must be defined in a sufficient level of detail to meet the technical requirements of the regional flood planning project *Scope of Work* and the associated *Technical Guidelines* developed by the TWDB. In summary, the RFPG must be able to demonstrate that each recommended FMP meets the following TWDB requirements.

1. Supports at least one regional floodplain management or flood mitigation goal.
2. Provides mitigation. (Response and recovery projects are not eligible for inclusion in the RFP.)
3. Consists of a discrete project (not an entire capital program or drainage master plan).
4. Results in
    - Quantifiable flood risk reduction benefits
    - No negative impacts to adjacent or downstream properties (A No Negative Impact Certification is required.)
    - No negative impacts to an entity's water supply

- No overallocation of a water source based on the water availability allocations in the most recently adopted State Water Plan.

In addition, the TWDB recommends that, at a minimum, FMPs should mitigate flood events associated with the 1% annual chance event flood (100-year level of service). In the event a 100-year level of service is not feasible, the RFPG can recommend an FMP with a lower level of service with appropriate justification for the level of service that can be achieved.

Updated opinion of probable costs and estimated project benefits must also be determined to establish a BCR for each recommended FMP. The TWDB recommends that proposed projects have BCRs greater than 1, but the RFPG may recommend FMPs with a BCR lower than 1 with proper justification.

All potentially feasible FMPs that had the necessary data and detailed H&H modeling results available to populate these technical requirements were considered for recommendation by the RFPG. Pertinent details about the FMP evaluation are provided in the following section.

FMP Evaluation

Initial Evaluation

Each FMP was evaluated to ensure that it would support at least one of the regional floodplain management or flood mitigation goals established in Task 3. The goals associated with each FMP are included in Appendix B Required Table 11. Based on a review of the supporting studies and hydrologic and hydraulic models, the RFPG determined that each FMP should be primarily for mitigation (rather than a response or recovery project), should be a discrete project, and should not have any anticipated impacts on water supply or water availability allocations as established in the most recently adopted State Water Plan.

No Negative Impacts Determination

Each identified FMP must demonstrate that no negative impacts on a neighboring area would result from its implementation. No negative impact means that a project will not increase flood risk to surrounding properties. Using best available data, the increase in flood risk is measured by the 1% annual chance event WSEL and peak discharge. According to TWDB *Technical Guidelines* it is recommended that no rise in WSEL or discharge should be permissible, and that the analysis extent must be sufficient to prove proposed project conditions are equal to or an improvement on the existing conditions. These conditions were evaluated for each potentially feasible FMP based on currently available regional planning level data. However, the local sponsor will be ultimately responsible for proving the final project design has no negative flood impact prior to initiating construction.

For the purposes of this flood planning effort, a determination of no negative impact can be established if stormwater does not increase inundation of infrastructure such as residential and commercial buildings and structures. Additionally, the following requirements, per TWDB *Technical Guidelines*, should be met to establish no negative impact, as applicable.

1. Stormwater does not increase inundation in areas beyond the public ROW, project property, or easement.
2. Stormwater does not increase inundation of storm drainage networks, channels, and roadways beyond design capacity.
3. The maximum increase of 1D WSEL must round to 0.0 feet (<0.05 ft) measured along the hydraulic cross-section.
4. The maximum increase of 2D WSEL must round to 0.3 feet (<0.35 ft) measured at each computation cell.
5. Maximum increase in hydrologic peak discharge must be less than 0.5 percent (<0.5%) measured at computation nodes (sub-basins, junctions, reaches, reservoirs, etc.). This discharge restriction does not apply to a 2D overland analysis.

If negative impacts are identified, mitigation measures may be utilized to alleviate such impacts. Projects with design level mitigation measures already identified may be included in the RFP and could be finalized at a later stage to conform to the "No Negative Impact" requirements prior to funding or execution of a project. TWDB-Required Table 13 includes a column to indicate the presence of mitigation measures within the project design.

Furthermore, the RFPG has flexibility to consider and accept additional "negative impact" for requirements 1 through 5 based on engineer's professional judgment and analysis given any affected entities are informed and accept the impacts. This should be well-documented and consistent across the entire region. However, flexibility regarding negative impact remains subject to TWDB review.

Benefit Cost Analysis

BCA is the method by which the future benefits of a hazard mitigation project are determined and compared to the project costs. The end result is a BCR, which is calculated by dividing the project's total benefits (in dollars) by its total costs. The BCR is a numerical expression of the relative "cost-effectiveness" of a project. A project is generally considered to be cost effective when the BCR is 1.0 or greater, indicating the benefits of a prospective hazard mitigation project are sufficient to justify the costs (FEMA, 2009).

However, a BCR greater than 1.0 is not a requirement for inclusion in the RFP. The RFPG can recommend a project with a lower BCR with appropriate justification. When a BCR had been previously calculated in an engineering report or study that was used to create an FMP, the previously calculated BCR value was utilized for the FMP analysis. For any FMP that did not already have a calculated BCR value, the TWDB BCA Input Spreadsheet was utilized in conjunction with the FEMA BCA Toolkit 6.0 to generate BCR values. BCR calculations are included in Appendix C.

Description and Summary of Recommended FMPs

Due to the level of detail required for consideration as an FMP, only 3 out of 14 potentially feasible FMPs were determined to have enough details available for evaluation and recommendation for inclusion in the RFP. Based on the FMP evaluation described above, the RFPG has determined that three FMPs comply with all the TWDB requirements and recommended them for inclusion in the RFP. The

remaining 11 potential FMPs may still be considered for recommendation as part of the Amended RFP when data becomes available or if, at the submittal of the Draft RFP, they have been reclassified as FMEs to evaluate additional study information needed.

The RFPG recommendations also considered the level of service and BCR of each FMP as discretionary evaluation criteria. Some FMPs do not provide a 100-year level of service and/or their BCR is less than 1. Figure 5-2 shows the locations of the recommended FMPs throughout the region. Appendix A Map 20 includes a detailed view of recommended FMPs.

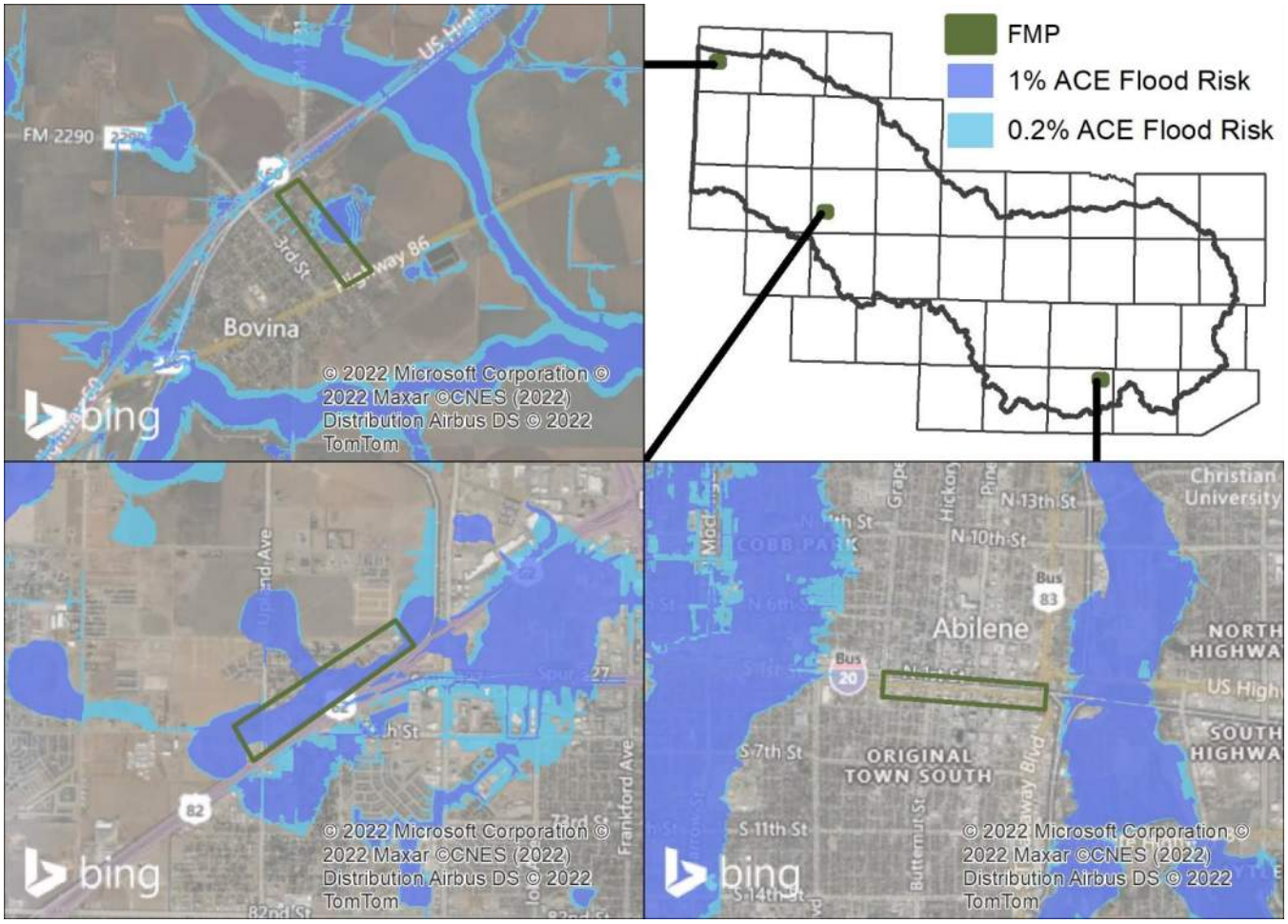


FIGURE 5-2 GEOGRAPHIC DISTRIBUTION OF RECOMMENDED FMPS

City of Abilene Downtown Underpasses Flood Warning

This project was identified in the City of Abilene 2020 Master Drainage Plan. This project includes the installation of sensors at three railroad underpasses to monitor water levels for a total cost of $636,000. While this project will not reduce the water surface during flood events, it aligns with the overarching flood planning goal to protect against loss of life by communicating hazards flooding situations. The underpasses at Butternut, Cedar, and Pine Streets are the most frequent road closures in Abilene.

The project was determined to have no negative impacts because there will be no change to the floodplain. This evaluation did not require a model to show no negative impact.

City of Lubbock: Santa Fe Drive Improvements

This project includes playa excavation and open channel construction for playa overflow and culvert improvements. This project is part of the Northwest Lubbock Drainage Improvements Plan completed by Freese & Nichols. The hydraulic modeling was completed in ICPR v4 and includes existing and proposed conditions. The total project cost is $4,500,000 and reduces flood risk for 60 structures. This project has a BCR of 0.7 and provides a 100-year level of service.

The project was determined to have no negative impacts through review of the Northwest Lubbock hydraulic model.

Bovina Buyout Program

This project was identified by the 2018 Parmer County Hazard Mitigation Action Plan. This project includes buy out of five properties, pending owners' voluntary agreement, along East Street, that are directly across from the playa lake. This area would be converted into open green space. TPWD encourages the use of nature-based solutions, such as the Bovina Buyout Program and the use the use of playas to assist with flood mitigation. The estimated cost of this project is $550,000. This project reduces flood risk for five structures for a BCR 1.9. This project was deferred previously due to lack of funding and political support.

The project was determined to have no negative impacts because the only change to the floodplain includes removing structures at risk. This evaluation did not require a model to show no negative impact.

Summary of Recommended FMPs

Table 5-2 provides a summary of the recommended FMPs. A no negative impact determination summary table has been included in Appendix C. A one-page summary sheet for each recommended FMP is also included in Appendix C.

TABLE 5-2 SUMMARY OF RECOMMENDED FMPS

FMP	Description	Estimated Cost
City of Abilene Downtown Underpasses Flood Warning	Installation of sensors at 3 railroad underpasses to monitor water levels.	$636,000
City of Lubbock: Santa Fe Drive Improvements	Playa excavation and open channel construction for playa overflow and culvert improvements.	$4,500,000
Bovina Buyout Program	Buy out 5 properties, pending owners' voluntary agreement, along East Street, that are directly across from the playa lake and to make the area into open green space.	$550,000
Region 7 FMPs	**Total**	**$5,686,000**

Flood Management Strategies (FMSs)

Summary of Approach in Recommending FMSs

The approach for recommending FMSs adheres to similar requirements as the FMP process. However, due to the flexibility and varying nature of RFPG's potential utilization of FMSs, some of these requirements may not be applicable to certain types of FMSs. In general, the RFPG must demonstrate that each recommended FMS meets the following TWDB requirements as applicable.

1. Supports at least one regional floodplain management or flood mitigation goal.
2. Provides mitigation. (Response and recovery projects are not eligible for inclusion in the RFP).
3. Results in
    - Quantifiable flood risk reduction benefits.
    - No negative impacts to adjacent or downstream properties.
    - No negative impacts to an entity's water supply.
    - No overallocation of a water source based on the water availability allocations in the most recently adopted State Water Plan.

In addition, the TWDB recommends that, at a minimum, FMSs should mitigate flood events associated with the 1% annual chance event (100-year level of service). However, if a 100-year level of service is not feasible, the RFPG may recommend an FMS with a lower level of service and an explanation for the recommendation.

Description and Summary of Recommended FMSs

A variety of FMS types were identified and evaluated for Region 7. A total of 63 potentially feasible FMSs were considered by the RFPG, and all 63 were recommended for inclusion in the RFP. Generally, these FMSs recommend city-wide and county-wide strategies and initiatives that represent a combined total cost of approximately $13M. These FMSs support several of the regional floodplain management or flood mitigation goals established in Task 3.

The number and types of projects recommended by the RFPG are summarized in Table 5-3. Figure 5-3 shows the locations of the recommended FMSs across the region. Appendix A Required Map 21 includes a detailed view of recommended FMSs. A one-page summary sheet for each recommended FMS is included in Appendix C.

TABLE 5-3 SUMMARY OF RECOMMENDED FMSS

FMS Type	General Description	Total	Cost
Education and Outreach	Develop an education, outreach, and training program to train staff and to educate the public about the dangers of flooding and how to prevent flood damages to property.	10	$750,000
Flood Measurement and Warning Systems	Develop program to install gauges, sensors, and precipitation measuring sites to monitor streams and waterways for potential flooding and support emergency response.	5	$800,000
Infrastructure Projects	Develop program for improvements including reinforcement of slopes, spillway expansion, dam repairs and upgrades.	11	$9,883,000
Regulatory and Guidance	Application to join NFIP or adoption of equivalent standards.	36	$1,725,000
Other	Consider incentives program.	1	$25,000
Region 7 FMSs	**Total**	**63**	**$13.2M**

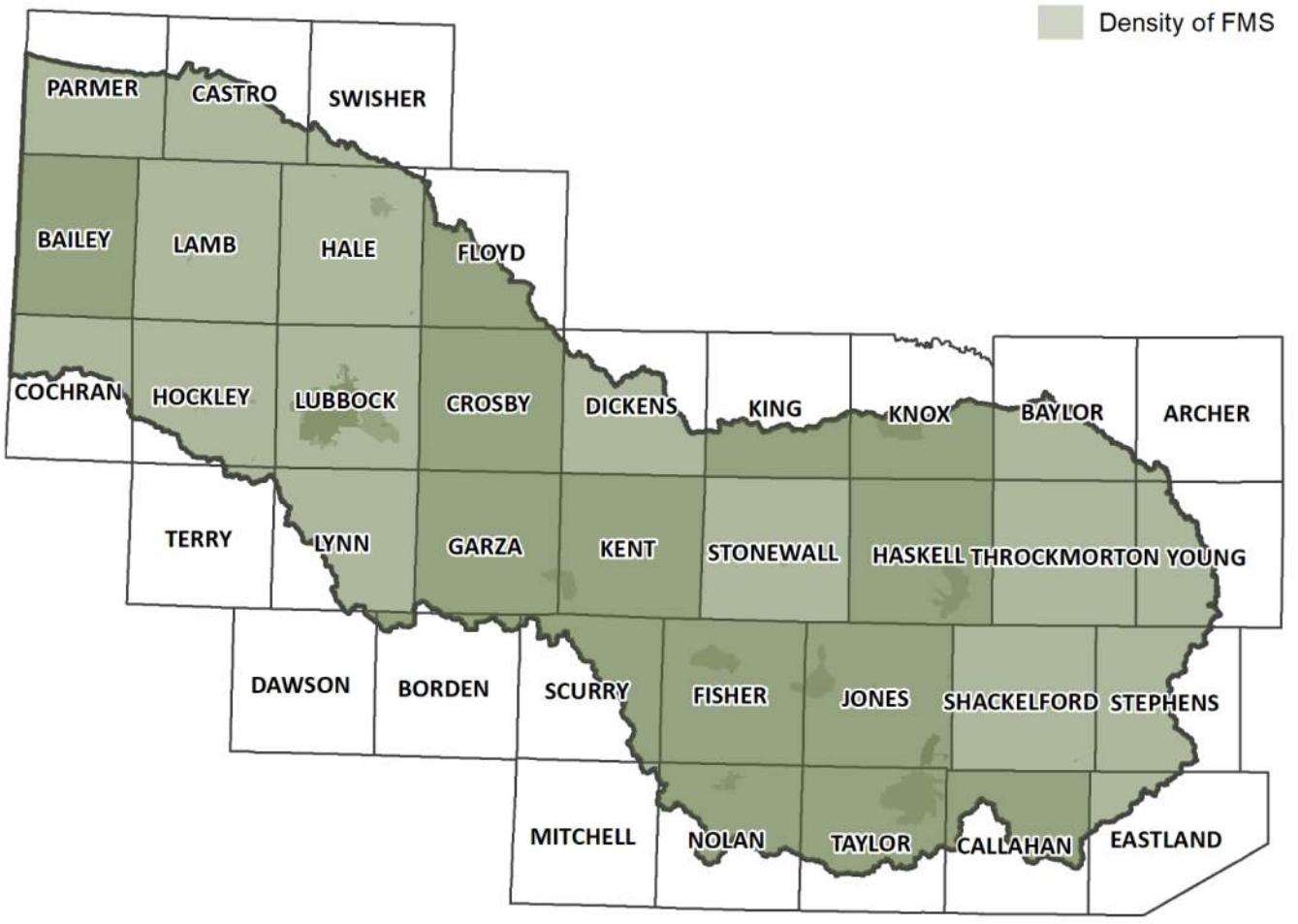


FIGURE 5-3 GEOGRAPHIC DISTRIBUTION OF RECOMMENDED FMSS

Task 6. Impact and Contribution of the Regional Flood Plan

The objective of Task 6 is for the RFPG to use the information from Tasks 4 and 5 to summarize the impacts and contributions the regional flood plan is expected to have if the plan is implemented as recommended. The following sections describe the impacts and contributions of this plan to various aspects of water resources. Implementation of the plan as recommended assumes that all FMPs, FMSs, and FMEs are fully funded and completed.

This Regional Flood Plan when implemented, will not negatively affect neighboring areas located within or outside of the flood planning region.

Task 6A. Impacts of Regional Flood Plan

The overall impacts of the RFP include potential impacts to areas at risk of flooding that include structures and populations in the floodplain, low water crossings, water supply, and impacts on the environment, agriculture, recreational resources, water quality, erosion, sedimentation, and navigation. This chapter describes the processes undertaken by the RFPG to achieve these tasks and summarizes the outcomes of this effort.

The impact of the plan also includes how future flood risk will be avoided through implementation of recommended improvements to the region's floodplain management policies. These details are provided to highlight the importance of stakeholder involvement and support in maximizing the plan's effectiveness during amendment periods and future cycles.

Relative Reduction in Flood Risk

The impacts of the plan on existing conditions were determined based on a before-and-after (regional flood plan implementation) comparison of the same type of information provided under the Task 2 Existing Flood Risk Analysis. The quantitative comparison of 1% and 0.2% annual chance event data with and without the plan illustrates how much the region's existing flood risk will be reduced through implementation of the plan as recommended by the RFPG.

Reduction in Flood Risk Identification Needs

In Task 2, 99% of the region area was identified as needing flood risk identification or updates to existing flood risk information. After the completion of recommended flood management evaluations (FME), 0% of the region area will need flood risk identification, a reduction of 1847 square miles (99%).

Reduction in Flood Risk Exposure

The RFPG recommended three FMPs for implementation. These projects include emergency preparedness improvements, channel conveyance improvements, and property acquisition. When implemented, FMPs will positively impact flood risk exposure by removing or reducing population and property from flood risk. Table 6-1 summarizes the estimated reduction in flood risk exposure to

residential structures and population in 1% and 0.2% annual chance event floodplains if the regional flood plan is implemented as recommended. Some potential FMPs did not have quantified benefits due to the current level of study detail available. These projects were recommended as FMEs for further evaluations and may be included as an FMP in a future plan once benefits and impacts can be quantified.

TABLE 6-1 REDUCTION IN 1% ACE FLOOD RISK EXPOSURE DUE TO RECOMMENDED FMPS

Flood Exposure Region-Wide	Existing Conditions At Risk	Remaining After Implementation	With Reduction in Exposure
Residential Structures	88	40	65
Population	338	239	159
Critical Facilities	0	0	0
Low Water Crossings	3	3	0
Road Closures	37	37	0
Length of Roads (miles)	1.39	1.39	0
Farm & Ranch Land (acres)	0	0	0

No Adverse Impact

As proposed, the recommended FMPs, when implemented, will not negatively affect neighboring areas located within or outside of the flood planning region. The comparative assessment to determine "no negative flood impact" on upstream or downstream areas or neighboring regions was performed based on currently available regional planning level data. The local sponsor will ultimately be responsible for ensuring the final project design has no negative flood impact prior to initiating construction.

Avoidance of Future Flood Risk

The following sections illustrate how future flood risk (that might otherwise arise if no changes were made to floodplain policies etc.) will be avoided through implementation of the regional flood plan. Impacts of the plan on existing flood risk that also impact future flood risk are not included in the discussion. The future flood risk in Region 7 as identified in Chapter 2 is shown in Table 6-2.

TABLE 6-2 SUMMARY OF EXISTING AND FUTURE FLOOD RISKS

Assets	Existing 1% ACE	Existing 0.2% ACE	Future 1% ACE	Future 0.2% ACE
Total Area (sq. mi.)	3,634	5,028	4,063	5,028
Total Number of Structures	28,532	54,087	35,954	54,087
Residential Structures	19,838	37,008	24,645	37,008
Population	60,299	109,284	72,040	109,284
Roadway Stream Crossings	4,299	4,694	4,632	4,694
Roadway Segments (mi.)	1,811	2,908	1,963	2,908
Area of Agriculture (sq. mi.)	126	200	140	200
Critical Facilities	81	147	100	147

Floodplain management recommendations and goals were established by the RFPG in Chapter 3. The goals in Chapter 3 establish a long-term vision for reduction of flood risk in the region. The potential flood risk of new assets identified in Table 6-2 can be reduced, and resiliency could be increased for many of these assets by communities adopting higher floodplain management criteria and standards. Regulation of development, implementation of higher standards, and use of best available data are all recommended strategies for avoiding potential increases in flood exposure over time. The avoidance of future flood risk will be realized through implementation of the goals established by the RFPG and execution of the FMPs and FMSs recommended in this plan and in future planning cycles.

Other Impacts

The sections below describe the anticipated impacts of the plan on each of the following categories: environment, agriculture, recreational resources, water quality, erosion, sedimentation, and navigation.

Socioeconomic Impacts

Watershed planning can contribute to the region's ability to prepare for, respond to, and recover from flood events. Reducing socioeconomic disparities through the implementation of measures to create equity can be initiated through planning. This reduction is done by ensuring that vulnerable populations have the same access to resources and social infrastructure as those unaffected by flooding.

Recreational Impacts

There are ten major lakes and reservoirs in Region 7. Recreational opportunities associated with these lakes and reservoirs have the potential to be impacted when they are being operated to mitigate flood risk. Flood control reservoirs hold water in their flood pools during peak runoff periods until the impounded water can be safely released downstream. During these periods, recreation use potential of adjacent parks and playgrounds may be vastly reduced. No new flood control reservoirs, or other reservoirs of any kind, are being proposed in the RFP. A total of eight FMSs are related to dams and reservoirs.

Environmental Impacts

Senate Bill 3 (SB3) was designed to establish environmental flow standards for all major river basins and bay systems in Texas through a scientific, stakeholder-driven, and consensus-based process. Three key questions are addressed by the SB3 process as defined by TWDB. –

1. What is the quantity of water required by the state's rivers/estuaries to sustain a sound ecological environment?
2. How can this water be protected?
3. What is the appropriate balance between water needed to sustain a sound ecological environment and water needed for human or other uses?

FMSs or FMPs in the Region should consider potential impacts related to the ecological flows established under the directive of SB3. Four of the proposed FMSs or FMPs involve local detention or retention, therefore, there would be minimal or no impact to base or environmental flows.

Agricultural Impacts

Flood waters have the potential to destroy standing crops, create water-logged conditions that delay planting or harvesting, wash away productive topsoil, and damage farm equipment and infrastructure. FMSs or FMPs potentially reduce extremely high flows in rivers and streams, thereby preventing flood waters from inundating areas outside of the floodway including agricultural areas. Structural FMSs or FMPs like small flood control ponds or functional playas also have the potential to assist in agricultural production by serving dual purpose of flood mitigation and water supply. Non-structural FMSs or FMPs have similar impacts on flood peak flow reduction and flooding including agricultural conservation practices such as such as conservation tillage, residue management, cover crops, and furrow dikes. These practices reduce both downstream flooding by reducing surface runoff and increasing infiltration on agricultural lands and also sediment and nutrient losses, thereby improving downstream water quality.

The Regulatory and Guidance FMSs and Watershed Planning FMEs have the potential to benefit agricultural operations by improving their understanding of flood risks, making insurance available for structures, and preventing construction of regulated structures within the floodplain.

Water Quality, Erosion, and Sedimentation Impacts

Water quality, erosion, and sedimentation are complex and interrelated issues. Water quality usually relates to nutrient and bacterial loading, but also includes turbidity, which relates to sediment load.

In this region, playa sedimentation is a concern, especially in urbanized areas. Playas are a volume-dependent drainage system and sedimentation over time gradually reduces the natural flood protection and infiltration. Limited studies, however, have been focused on the impacts of playa sedimentation. Through the Texas Playa Conservation Initiative[27], Texas Parks & Wildlife has an existing program focused on increasing the understanding of the behavior of playas and the restoration of these features to aid in groundwater infiltration and recharge and water quality protection. In water bodies such as the City of Lubbock's Canyon Lakes, stakeholders have identified an FMS to dredge this sedimentation and restore flood storage.

Navigation Impacts

None of the major rivers within Region 7 are used for commercial navigation.

Task 6B. Contributions and Impacts on Water Supply and the State Water Plan

The goal of Task 6B is to evaluate potential impacts of the RFP on water supply development and the State Water Plan. This chapter describes the processes undertaken by the RFPG to achieve these tasks and summarizes the outcomes of this effort.

[27] TxPCI. 2022. Playas Work for Texas: https://playasworkfortexans.com/

This effort included

1. A region-wide summary and description of the contribution that the Regional Flood Plan would have on water supply development including a list of specific FMSs and FMPs that would measurably impact water supply.
2. A description of any anticipated impacts that the Regional Flood Plan FMSs and FMPs may have on water supply, water availability, or projects in the State Water Plan.

Contributions on Water Supply Development

RFPGs must list recommended FMSs or FMPs that, if implemented, would measurably contribute to water supply with the following considerations.

1. Involves directly increasing water supply volume available during drought of record through both increased availability and direct supply to specific water user group(s)
2. Directly benefits water availability
3. Indirectly benefits water availability
4. Has no anticipated impact on water supply

Examples of FMSs and FMPs that could measurably contribute to water supply include the following:

1. Directly and/or indirectly recharging aquifers,
2. Modifying large detention structures to include a water supply component for irrigation and/or other needs, and
3. The implementation of stormwater management ordinances that manage flooding while simultaneously including a water supply aspect of beneficial reuse for irrigation purposes.

Moreover, green infrastructure, natural channel design, stormwater detention, low impact development, and other measures can help mitigate flood flows and protect water quality without impacting local water supply. This can help manage downstream water treatment costs and benefit rate payers across the region.

Additionally, RFPGs must also list recommended FMSs or FMPs that, if implemented, would negatively impact and/or measurably reduce

1. Water availability volumes that are the basis for the most recently adopted State Water Plan, and
2. Water supply volumes.

An example of an FMS or FMP that could measurably reduce water availability involves reallocating a portion of reservoir storage that is currently designated for water supply purposes to be used for flood storage instead. There are no such recommended actions related to reservoirs for Region 7. Furthermore, land use changes over time could potentially reduce groundwater availability due to less naturally occurring aquifer recharge, or an FMS that preserves open space or limits additional impervious cover could help maintain aquifer recharge.

As noted in Appendix B Required Table 13 and Table 14, it was determined that there were no recommended FMSs or FMPs that would measurably contribute or have a negative impact and/or measurably reduce water supply.

FMSs

There are no nature-based FMSs in this plan, but there are eleven infrastructure strategies that could eventually implement green infrastructure, low impact development, and other nature-based components. Utilizing these measures could aid in mitigating flood risk by slowing and reducing stormwater discharges while simultaneously improving water quality. Other FMS project types, such as education and outreach strategies, regulatory and guidance, and flood measurement and warning strategies, do not apply to water supply development.

FMPs

One of the three FMPs could indirectly be relevant to water supply. The Boniva voluntary buyouts entails property acquisition directly across a playa lake and eventually turning that space into an open green space. Nature-based FMPs could help mitigate flood risk by slowing and reducing stormwater discharges while improving water quality. Additionally, property acquisition and/or preservation of open spaces could limit impervious cover and help maintain aquifer recharge. Ultimately, it was determined that no projects would have a measurable impact on water supply.

Anticipated Impacts to the State Water Plan

In response to the 1950's drought, the TWDB was established in 1957 to prepare a comprehensive, long-term plan for the development, conservation, and management of the state's water resources. The 2022 State Water Plan (SWP)[28] was produced by the TWDB and based on approved RWPs in accordance with Senate Bill 1 enacted in 1997 by the 75th Texas Legislature. As stated in SB1 Section 16.053.a, the purpose of the regional water planning effort is to

> "…provide for the orderly development, management, and conservation of water resources and preparation for and response to drought conditions in order that sufficient water will be available at a reasonable cost to ensure public health, safety, and welfare; further economic development; and protect the agricultural and natural resources of that particular region."

The TWDB established 16 regional water planning areas (RWPAs) and appointed members who represent 12 key public interests to the regional water planning groups (RWPG). This grassroots approach allows planning groups to evaluate region-specific risks, uncertainties, and potential water management strategies from the local water providers. Region 7 primarily covers Region O (Llano Estacado) and Region G (Brazos G) RWPAs as shown in Figure 6-1. Additionally, a small portion of Region 7 (less than 6%) falls within Region B and Region F RWPAs. The total overlapping area(s) of each water planning region is provided in Table 6-3 below.

[28] TWDB. 2022. 2022 State Water Plan: https://www.twdb.texas.gov/waterplanning/swp/2022/index.asp

TABLE 6-3 REGIONAL WATER PLANNING AREAS WITHIN FLOOD REGION 7

Regional Water Planning Groups	Approximate Overlapping Area within Region 7 (sq. mi.)	Percent of Overlapping Area within Region 7 (%)
Region O	9,400	47%
Region B	9,400	47%
Region G	800	4%
Region F	500	2%
TOTAL	**20,100**	**100%**

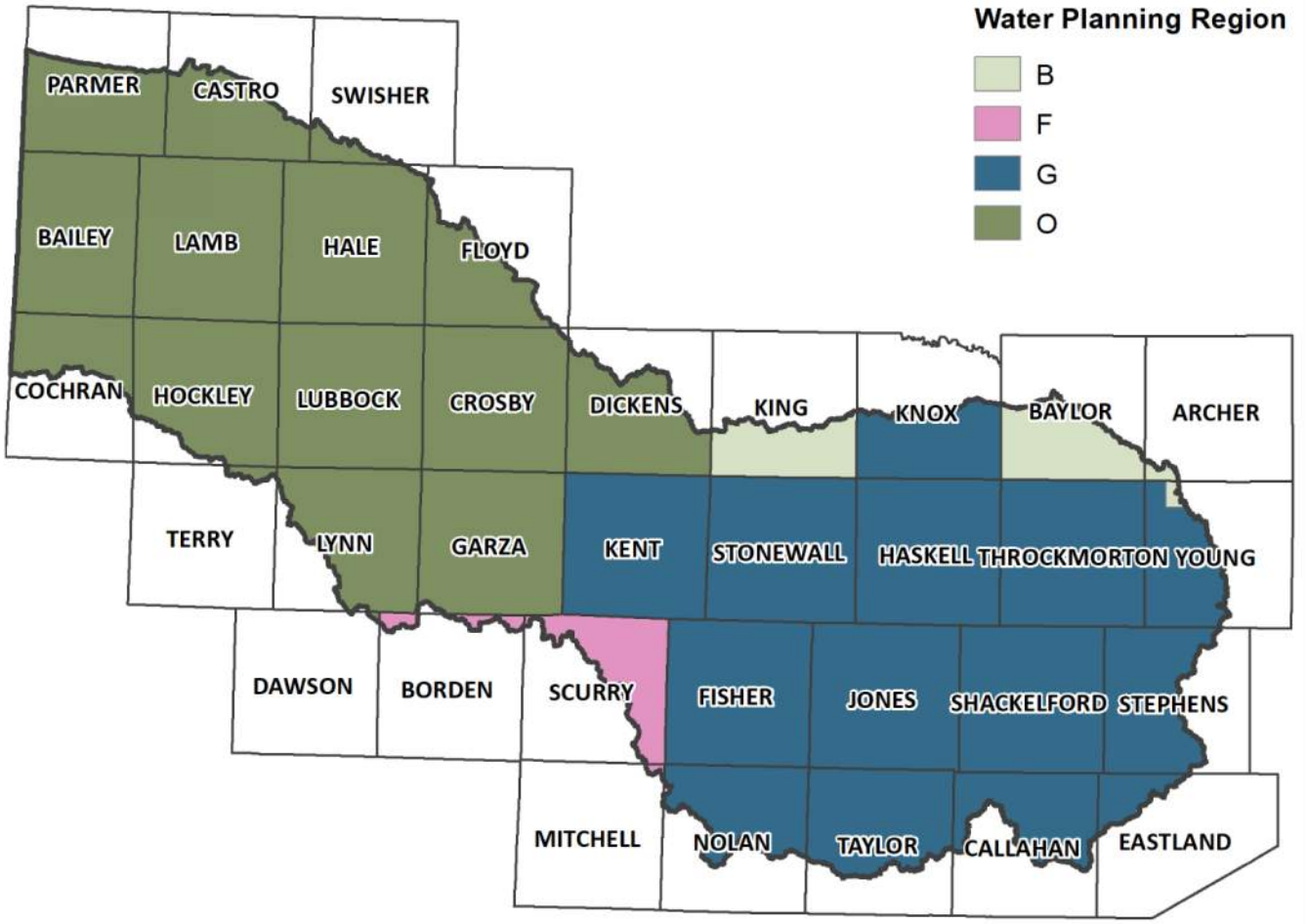


FIGURE 6-1 REGION 7 ASSOCIATED REGIONAL WATER PLANNING GROUPS

Region O

There are 16 counties from Region O that fall fully or partially within flood Region 7. Region O is approximately 20,294 square miles and is located in the South Plains of Texas. Of that 20,294, approximately 9,400 square miles falls within Region 7. This RWPG includes up to 20 voting members who represent 14 different key interest groups. Groundwater is the region's primary source of water as there is very little surface water and low stream flow. There is one major (High Plains Aquifer System)

and two minor aquifers (Seymour and Dockum) that supply water to the region. The High Plains Aquifer System is a significant resource as it is the main source of drinking water for the region and provides water for municipal, mining, and manufacturing needs. Even though the High Plains Aquifer System is used to meet a variety of needs, approximately 95% of water obtained is used for irrigation, while the remaining 5% is used for municipal, livestock, steam electric, mining, and manufacturing demands. Although there is low streamflow, there are four major existing reservoirs located in the region. These reservoirs have various uses such as water supply, irrigation, and recreational purposes. There are no recommended FMSs or FMPs that impact the proposed operation of these existing reservoirs. Further details for the aquifers and reservoirs in Region O in Region 7 are listed in Table 6-4.

TABLE 6-4 WATER RESOURCES IN REGION O ASSOCIATED WITH REGION 7

Water Source Type	Water Source Name	Counties
Aquifer	High Plains Aquifer System: Ogallala	Bailey, Borden, Castro, Cochran, Crosby, Dawson, Dickens, Floyd, Garza, Hale, Hockley, Lamb, Lubbock, Lynn, Parmer, Swisher, Terry
Aquifer	High Plains Aquifer System: Edwards-Trinity	Bailey, Borden, Cochran, Crosby, Dawson, Floyd, Garza, Hale, Hockley, Lamb, Lubbock, Lynn, Terry
Aquifer	Dockum	Bailey, Borden, Castro, Cochran, Crosby, Dawson, Dickens, Floyd, Garza, Hale, Hockley, Kent, King, Lamb, Lubbock, Lynn, Parmer, Scurry, Swisher, Terry
Reservoir	Alan Henry Reservoir	Garza, Kent
Reservoir	White River Lake	Crosby

Region G

The eastern portion of Region 7 covers the northwestern part of the Region G water planning area. Region G is approximately 31,600 square miles, most of which is comprised of central Texas. Region G consists of 23 voting members who represent 12 interest groups.

1. the public,
2. counties,
3. municipalities,
4. industries,
5. agriculture,
6. the environment,
7. small businesses,
8. electric-generating utilities,
9. river authorities,
10. water districts,
11. groundwater districts,
12. water utilities

There are 14 counties from Region G that fall fully or partially within Region 7. The water demand for Region G can be compiled into six (6) distinct categories of water use. Approximately 36% of water demand is for municipal purposes; 32% for irrigation; 21% for steam-electric; and the remaining 11% is allotted for mining, livestock, and manufacturing. The planning area depends slightly more on surface water than groundwater. Nonetheless, there are six major and eleven minor aquifers in Region G. The Seymour Aquifer is highly developed and is the most significant in terms of usage, as most of its water is used for irrigation. The Trinity Aquifer is a significant groundwater source for eastern counties such as

Callahan and Eastland. All major and minor existing aquifers and reservoirs in Region G that intersect with the Upper Brazos regional boundary are listed below in Table 6-5.

TABLE 6-5 WATER RESOURCES IN REGION G ASSOCIATED WITH REGION 7

Water Source Type	Water Source Name	Counties
Aquifer	Seymour	Knox, Kent, Stonewall, Haskell, Fisher, Jones
Aquifer	Edwards – Trinity Plateau (outcrop)	Nolan, Taylor
Aquifer	Trinity (outcrop)	Callahan, Eastland
Aquifer	Cross Timbers	Haskell, Throckmorton, Young, Jones, Shackelford, Stephens, Taylor, Callahan, Eastland
Aquifer	Blaine (outcrop)	Knox, Stonewall, Fisher
Aquifer	Blaine (subcrop)	Stonewall, Fisher
Aquifer	Dockum (outcrop)	Fisher, Kent, Nolan
Reservoir	Millers Creek	Baylor, Throckmorton
Reservoir	Lake Sweetwater	Nolan
Reservoir	Lake Stamford	Haskell
Reservoir	Lake Kirby	Taylor
Reservoir	Lake Fort Phantom Hill	Jones
Reservoir	Lake Davis	Knox
Reservoir	Lake Daniel	Stephens
Reservoir	Lake Cisco	Eastland
Reservoir	Lake Abilene	Taylor
Reservoir	Hubbard Creek Reservoir	Stephens, Shackelford
Reservoir	Lake Alan Henry	Garza, Kent

Region B

The northeastern portion of Region 7 covers a part of the southern counties in Region B. There are only four (4) counties – King, Baylor, Archer, and Young – that fall fully or partially within Region 7. Approximately 9% of Region B (800 square miles) lay within Region 7's boundaries. The RWPG consists of 19 members that represent 11 different interests across all of Region B's counties.

Approximately 62% of water use is designated to irrigation, 21% for municipal use, and the remaining 17% is designated to industrial purposes, power cooling, livestock, and mining. Most of the water used in Region B is surface water, but groundwater still provides a valuable resource to parts of the region. There are two major aquifers and two minor aquifers within the Region B planning area. Of the four total aquifers, only 2 – Seymour (major) and Cross Timbers (minor) – fall within Region 7's regional boundary. There are no recommended FMSs or FMPs that impact the proposed operation of these existing reservoirs. Aquifers and reservoirs in Region B that intersect flood Region 7 are listed in Table 6-6.

TABLE 6-6 WATER RESOURCES IN REGION B ASSOCIATED WITH REGION 7

Water Source Type	Water Source Name	Counties
Aquifer	Seymour	Archer, Baylor, Cottle,
Aquifer	Blaine	King
Aquifer	Cross Timbers (Canyon, Cisco, and Wichita Albany Groups)	Archer, Baylor, Young
Reservoir	Kemp Lake	Baylor
Reservoir	Diversion Lake	Archer, Baylor
Reservoir	Little Wichita River System	Archer
Reservoir	Lake Arrowhead	Clay
Reservoir	Lake Olney and Cooper	Archer
Reservoir	Miller's Creek Reservoir	Baylor

Region F

The northeastern portion of Region F covers very small parts of two south-central counties in Region 7. These two counties are Borden and Scurry. Only 4% of Region 7 falls within the Region F boundary. It is estimated that roughly 60% of the water used is supplied by groundwater. More than 60% of the region's water use is for irrigation – majority of which is provided from groundwater. There are 4 major and 10 minor aquifers throughout the region, but only 1 major aquifer and 2 minor aquifers are relevant to Region 7. Furthermore, there are 17 major water supply reservoirs in Region F. Only one, Lake J. B. Thomas, falls within the Upper Brazos Flood planning regional boundary, which is listed in Table 6-7.

TABLE 6-7 WATER RESOURCES IN REGION F ASSOCIATED WITH REGION 7

Water Source Type	Water Source Name	Counties
Aquifer	Ogallala	Borden
Aquifer	Edward-Trinity (High Plains)	Borden
Aquifer	Dockum (outcrop)	Scurry
Reservoir	Lake J. B. Thomas	Borden, Scurry

Summary of Impacts to Water Supply

The recommended FMSs and FMPs are not anticipated to have any measurable impact on water supply, water availability, or projects in the State Water plan as presented in Table 6-8.

TABLE 6-8 SUMMARY OF FMS AND FMP IMPACTS TO WATER SUPPLY

FMS or FMP Negatively Impacting Water Supply	FMS or FMPs Contributing to Water Supply
None	None

Task 7. Flood Response Information and Activities

The following chapter summarizes the flood emergency management practices using demographic, historical, projected, and statistical data from the previous chapters, and by implementing data from the survey responses. The TWDB specifically stated that the RFPG "shall not perform analyses or other activities related to planning for disaster response or recovery activities." The focus of this chapter is summarizing the information obtained and providing general recommendations regarding flood response activities.

Types of Flooding in the Upper Brazos Region

Across the state, there are five different types of floods: flash floods, coastal floods, urban floods, river floods, and pluvial floods. The most common types of flooding in the Upper Brazos region are river and pluvial floods. River flooding tends to be more widespread, encompassing huge swaths of land while pluvial floods tend to be more locally dangerous, impacting mobility and emergency access. Stormwater in the Upper Brazos region is typically conveyed through streets and the natural drainage features which makes the region susceptible to flash flooding. The Upper Brazos region is prone to different types of flooding depending on the part of the region.

Flash floods are floods caused by heavy rainfall over a short time period. The flood water can occur quickly and be very powerful making it extremely dangerous.

Pluvial floods happen when there is flooding due to extreme rainfall in the local area. In Region 7, the most common example of this is flooding around playas.

Riverine floods occur when excess rainfall moves downstream causing an overtopping of the riverbank. This overtopping then spills the water onto the nearby floodplain.

Urban floods are flooding that is caused by excess runoff water in developed areas when the constructed drainage features are overwhelmed and the water does not have anywhere else to go.

When such flood events occur, it is imperative that plans are in place to combat the effects of the flooding.

The Nature and Types of Flood Response Preparations

There are four phases to emergency management.

Flood Mitigation: The implementation of actions, including both structural and non-structural solutions, to reduce flood risk to protect against the loss of life and property.

Flood Preparedness: Actions, aside from mitigation, which are taken before flood events to prepare for flood response activities.

Flood Response: Actions taken during and in the immediate aftermath of a flood event.

Flood Recovery: Actions taken after a flood event involving repairs or other actions necessary to return to pre-event conditions.

For example, when a severe rain event is projected to occur, steps are taken for preparedness: disaster preparedness plans are in place, drills and exercises are performed, an essential supply list is created, and potential vulnerabilities are assessed. During the response phase, disaster plans are implemented, search and rescues may occur, low water crossing signs may be erected. In the recovery phase, evaluation of flood damage, rebuilding damaged structures, and removing debris occur. The most important step of the four phases of emergency management is mitigation.

Hazard mitigation is defined as any sustained action taken to reduce or eliminate the lasting risk to life and property from hazard events. It is an on-going process that occurs before, during, and after disasters and seeks to break the cycle of damage and restoration in hazardous areas.

Flood mitigation is the primary focus of the regional flood planning process and plan development efforts through identifying and recommending FMEs, FMSs and FMPs by the RFPG. The plan may also include flood preparedness FMEs, FMSs and FMPs.

Examples of mitigation actions include planning and zoning, floodplain protection, property acquisition and relocation, or public outreach projects. Examples of preparedness actions include installing disaster

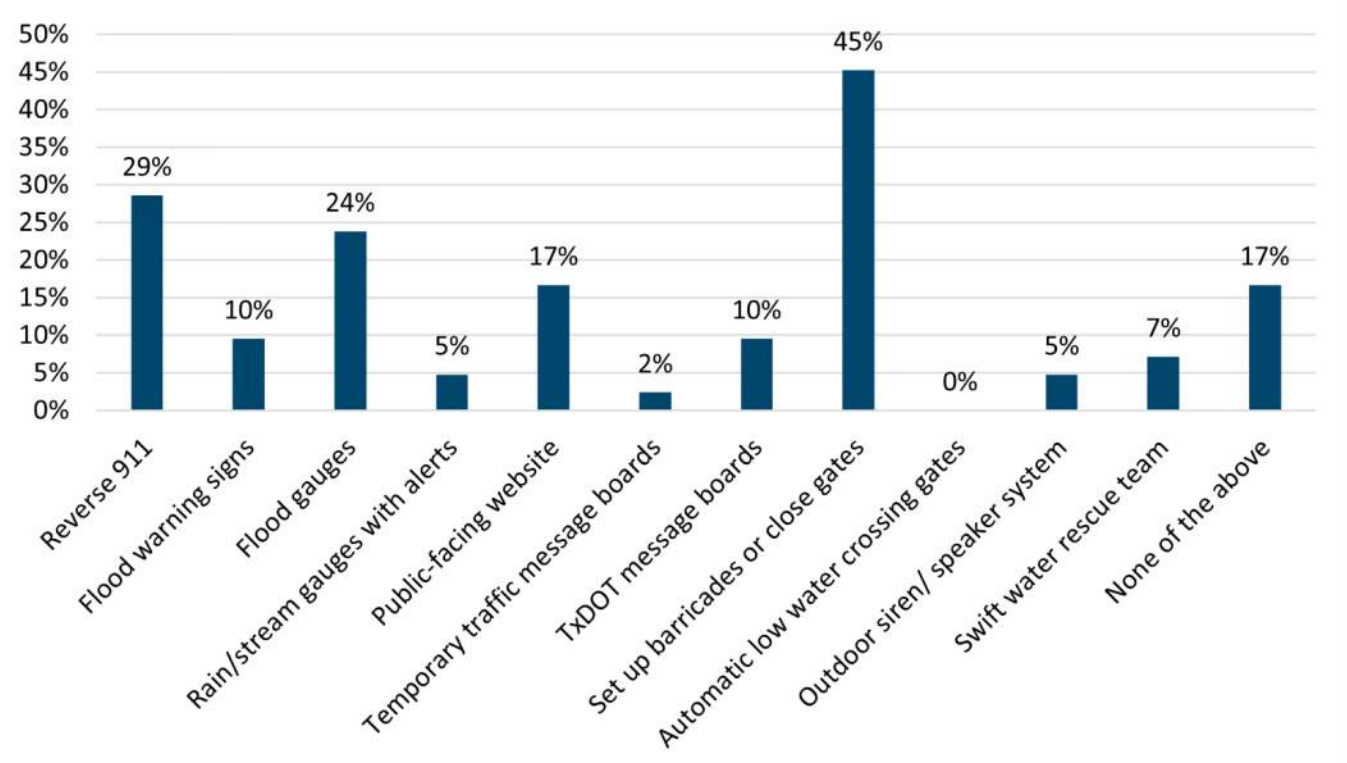
warning systems, purchasing radio communications equipment, or conducting emergency response training.

Actions and Preparations

A total of nine HMAPs were collected from Region 7. These plans were reviewed, and the following mitigation actions were identified by communities in the Upper Brazos region

- Buyout/Acquisition/Elevation projects
- Drainage Control & Maintenance
- Education & Awareness for Citizens
- Equipment Procurement for Response
- Erosion Control Measures
- Flood Insurance Education
- Flood Study/Assessment
- Infrastructure Improvement
- Installation/Procurement of Generators
- Natural Planning Improvement
- Outreach and Community Engagement
- Technology Improvement
- Urban Planning and Maintenance

In May 2021, a web-based survey was sent out to each regulatory entity in the region to gather additional information including information related to flood response. The survey indicated that several of the types of floodplain management activities were in place including reactive maintenance following complaints or damages after a storm, utilizing Emergency Alert Systems, and ordinance enforcement. Figure 7-1 shows the flood response activities in practice in Region 7.



Source: Region 7 Data Collection Tool and Interactive web map as of September 2021

FIGURE 7-1 FLOOD RESPONSE ACTIVITY FROM WEB SURVEY

Many of the mitigation and preparatory actions are done in conjunction with the relevant entities who put these actions into practice. Figure 7-2 shows the survey responders' reliance upon various entities before, during, and after a flood emergency, which corresponds to preparedness, response, and recovery. The following section takes a more detailed look at the entities in the Region and their role in flood emergency management.

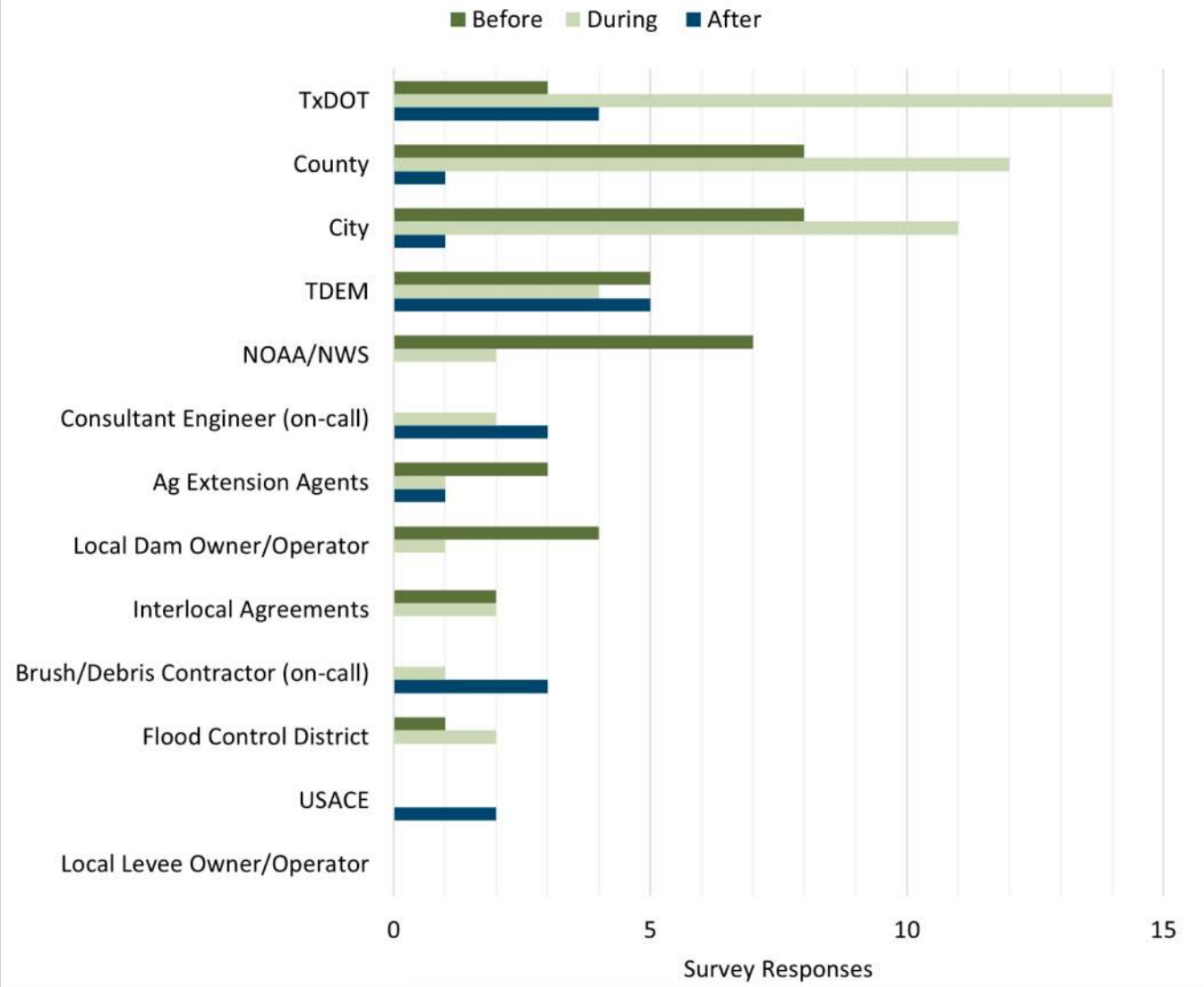


FIGURE 7-2 ENTITIES INVOLVED WITH FLOOD EMERGENCY MANAGEMENT FROM WEB SURVEY

Relevant Entities in the Region

The purpose of flood risk management is to help prevent or reduce flood risk by using either structural or non-structural means or a combination of the two. Responsibility for flood risk management is shared between Federal, State, and local government agencies; private-sector stakeholders; and the general public. There are a total of 140 political subdivisions in Region 7 with flood related authority. Table 1-5 includes a list of all the political subdivisions in Region 7 with flood related authority.

TABLE 7-1 POLITICAL SUBDIVISIONS IN REGION 7 WITH FLOOD RELATED AUTHORITY

Counties					
Archer	Cochran	Floyd	Kent	Mitchell	Stonewall
Bailey	Crosby	Garza	King	Nolan	Swisher
Baylor	Dawson	Hale	Knox	Parmer	Taylor
Borden	Dickens	Haskell	Lamb	Scurry	Terry
Callahan	Eastland	Hockley	Lubbock	Shackelford	Throckmorton
Castro	Fisher	Jones	Lynn	Stephens	Young

Municipalities					
Abernathy	Clyde	Idalou	Muleshoe	Ransom Canyon	Stamford
Abilene	Crosbyton	Impact	Munday	Roby	Sudan
Albany	Dickens	Jayton	New Deal	Rochester	Sweetwater
Amherst	Dimmitt	Knox City	New Home	Ropesville	Tahoka
Anson	Earth	Levelland	Newcastle	Roscoe	Throckmorton
Anton	Edmonson	Littlefield	O'Brien	Rotan	Trent
Aspermont	Farwell	Lockney	Olton	Rule	Tuscola
Baird	Floydada	Lorenzo	Opdyke West	Seymour	Tye
Benjamin	Goree	Lubbock	Petersburg	Shallowater	Weinert
Bovina	Hale Center	Lueders	Plainview	Slaton	Whiteface
Breckenridge	Hamlin	Megargel	Post	Smyer	Wilson
Buffalo Gap	Hart	Merkel	Putnam	Springlake	Wolfforth
Buffalo Springs	Haskell	Moran	Ralls	Spur	Woodson
Cisco	Hawley	Morton			

Other	
Brazos River Authority	Nortex Regional Planning Commission
Canadian River Municipal Water Authority	Panhandle Regional Planning Commission
Dickens County WCID 1	Permian Basin Regional Planning Commission
Fort Griffin Special Utility District	Red River Authority of Texas
Haskell County Water Supply District 1	Rotan Municipal Water Authority
Knox County Drainage District 1	Salt Fork Water Quality District
Knox County WCID 1	South Plains Association of Governments
Lake Alan Henry Water District	Stonewall County WCID 1
Lower Colorado River Authority	Tuscola - Taylor County WCID 1
Lubbock County WCID 1	West Central Texas Council of Governments
Lytle Lake WCID	West Central Texas Municipal Water District
North Central Texas Municipal Water Authority	White River Municipal Water District

In Task 1, the various stakeholders that were contacted to provide data via the survey were listed: Agriculture, Cities, Counties, Councils of Governments, Districts such as Municipal/Special Utility Districts, and State and Federal Agencies. Listed below are the various contributing entities and partners with descriptions of their roles related to flooding.

Ag Extension Agents are employed by land-grant universities and serve the citizens of that state by serving as an expert or teacher on the topic of Agriculture. Ag extension agents can provide valuable information on preparation and recovery from flood events specific to agricultural entities. The Upper Brazos region has a significant agricultural footprint making working closely with Ag Extension Agents crucial to prevent losses.

Cities, or Municipalities, generally take responsibility for parks and recreation services, police and fire departments, housing services, emergency medical services, municipal courts, transportation services (including public transportation), and public works (streets, sewers, snow removal, signage, and so forth). There are 81 municipalities within Region 7.

The major responsibilities of the 36 **County** governments in Region 7 include providing public safety and justice, holding elections at every level of government, maintaining Texans' most important records, building and maintaining roads, bridges. and county airports, providing emergency management services, providing health and safety services, collecting property taxes for the county and sometimes for other taxing entities, issuing vehicle registration and transfers, and registering voters.

There are two COGs that cover Region 7, SPAG and WCTCOG. **COGs** are voluntary associations that represent member local governments, mainly cities and counties, which seek to provide cooperative planning, coordination, and technical assistance on issues of mutual concern that cross jurisdictional lines. COGs can serve a resource for flood data, flood planning, and flood management.

The mission of the **TWDB** is to lead the state's efforts in ensuring a secure water future for Texas and its citizens. TWDB provides water planning, data collection and dissemination, financial assistance, and technical assistance services to the citizens of Texas.

FEMA is an agency of DHS, initially created under President Jimmy Carter. While on-the-ground support of disaster recovery efforts is a major part of FEMA's charter, the agency provides state and local governments with experts in specialized fields, funding for rebuilding efforts, and relief funds for infrastructure by directing individuals to access low-interest loans, in conjunction with the Small Business Administration. FEMA also provides funds for training of response personnel throughout the United States and its territories as part of the agency's preparedness effort.

A **Flood Control District** is a special purpose district created by the Texas Legislature and governed by County Commissioners Courts. It is a government agency established to reduce the effects of flooding. There are currently no flood control districts in Region 7.

Dams and Levees are owned and operated by individuals, private and public organizations, and the government. The responsibility for maintaining a safe dam rests with the owner. A dam

failure resulting in an uncontrolled release of the reservoir can have a devastating effect on persons and property downstream. It is critical that the owners are part of the flood planning process to ensure collaborative and cohesive flood planning.

NOAA is an American scientific and regulatory agency within the United States Department of Commerce that forecasts weather, monitors oceanic and atmospheric conditions, charts the seas, conducts deep sea exploration, and manages fishing and protection of marine mammals and endangered species in the U.S. exclusive economic zone. NOAA provides historical data that can help communities determine their future probability of flood events and is key in the planning and mitigation process.

The National Weather Service (NWS) is a section of NOAA. The **NWS** mission is to provide weather and climate data, forecasts, warnings, and impact-based decision support services for the protection of life and property and enhancement of the national economy. NWS provides flash flood indicators through watches, warnings, and emergency notices.

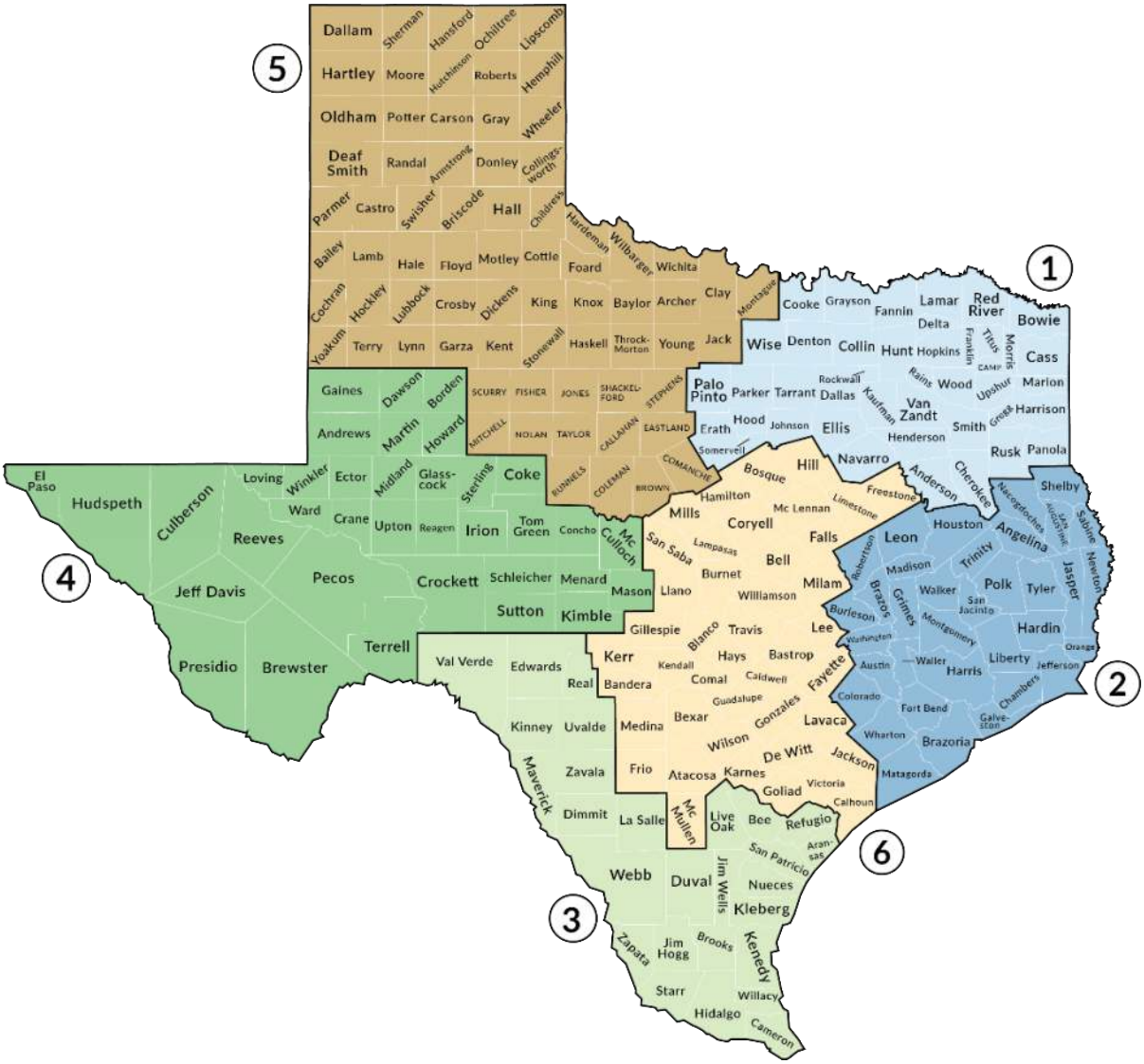
- A Flash Flood WATCH is issued when conditions look favorable for flash flooding. A watch usually encompasses several counties. This notice indicates the time to start thinking about your plan of action and where you would go if water begins to rise.
- A Flash Flood WARNING is issued when dangerous flash flooding is happening or will happen soon. A warning is usually a smaller, more specific area. This notice can be issued due to excessive heavy rain or a dam/levee failure. This warning is when you must act quickly as flash floods are an imminent threat to you and your family. You may only have seconds to move to higher ground.
- A Flash Flood EMERGENCY is issued for the exceedingly rare situations when extremely heavy rain is leading to a severe threat to human life and catastrophic damage from a flash flood is happening or will happen soon. Typically, emergency officials are reporting life threatening water rises resulting in water rescues/evacuations.

River Authorities or Districts in the state of Texas are public agencies established by the state legislature and given authority to develop and manage the waters of the state. Upper Brazos has several River Authorities within its region that each have the power to conserve, store, control, preserve, utilize, and distribute the waters of a designated geographic region for the benefit of the public.

Daily river forecasts are issued by the thirteen River Forecast Centers, **RFCs,** using hydrologic models based on rainfall, soil characteristics, precipitation forecasts, and several other variables. Some RFCs, especially those in mountainous regions, also provide seasonal snowpack and peak flow forecasts. These forecasts are used by a wide range of users, including those in agriculture, hydroelectric dam operation, and water supply resources. The forecasts can provide essential information on the river levels and conditions.

Texas Division of Emergency Management **(TDEM)**, a division of the Texas DPS, is charged with coordinating state and local responses to natural disasters and other emergencies in Texas.

TDEM is intended to ensure the state and its local governments respond to and recover from emergencies and disasters and implement plans and programs to help prevent or lessen the impact of emergencies and disasters. There are six TDEM regions within Texas, and in those regions are Assistant Chiefs and District Coordinators. They serve as the Division's field response personnel stationed throughout the State. They have a dual role as they carry out emergency preparedness activities and coordinate emergency response operations. In their preparedness role, they assist local officials in carrying out emergency planning, training, and exercises, and developing emergency teams and facilities. They also teach a wide variety of emergency management training courses. In their response role, they deploy to incident sites to assess damages, identify urgent needs, advise local officials regarding state assistance, and coordinate deployment of state emergency resources to assist local emergency responders. The Upper Brazos region is mostly in region 5 with some counties extending into region 4.



Source: Texas Department of Emergency Management

FIGURE 7-3 TDEM REGIONS

TxDOT is a government agency in the state of Texas. Though the public face of the agency is generally associated with the construction and maintenance of the state's immense state highway system, the agency is also responsible for overseeing aviation, rail, and public transportation systems in the state. TxDOT can provide real time road closure and low water crossing information during and after a flood event. Users can access this data through TxDOT's Drive Texas website: https://drivetexas.org.

USACE is an important part of the nation's military. The agency is responsible for a wide range of efforts in the United States including addressing safety issues related to waterways, dams, and canals but also environmental protection, emergency relief, hydroelectric power, and much more. USACE is composed of several districts. Region 7 is represented in the Albuquerque and the Fort Worth Districts. The USACE Flood Risk Management Program works across the agency to focus the policies, programs, and expertise of USACE toward reducing overall flood risk. This program includes the appropriate use and resiliency of structures such as levees and floodwalls, as well as promoting alternatives when other approaches (e.g., land acquisition, flood proofing, etc.) reduce the risk of loss of life, reduce long-term economic damages to the public and private sector, and improve the natural environment.

Emergency Information

There are various means by which data can be collected and disseminated in a flood event. These include gauges to measure the current flood risk and communication systems to alert the public.

Two types of gauges used are rain gauges and stream gauges. A rain gauge is a meteorological instrument to measure the precipitating rain depth in a given amount of time. Stream gauging is a technique used to measure the discharge, or the volume of water moving through a channel per unit time, of a stream at a selected location. The elevation of the water surface in the stream channel, known as a stage or gauge height, can be used to determine the discharge in a stream.

In addition to the NWS, local news stations or radio stations are vital components in relaying real time information to local residents of inclement weather and flooding. They can also alert residents to low water crossing closings, dam or levee breaches, and other potential dangers. They can also issue flood watches, warnings, and emergency notifications.

An Emergency Alert System is software that provides alert messages during an emergency. Messages can interrupt radio and television to broadcast emergency alert information. Messages cover a large geographic footprint including about half of Region 7. Emergency message audio/text may be repeated twice, but Emergency Alert System activation interrupts programming only once, then regular programming continues.

A reverse 911 system allows an agency to pull up a map on a computer, define an area and send off a recorded phone message to each business or residence in that area. It can provide data to residents of flood dangers in their area.

School emergency alert systems allow schools to communicate quickly to staff, students, first responders, and others so that they can take appropriate action in the event of an emergency situation. Various versions this tool are used in schools through the region from daycares to K-12 grade, as well as colleges and universities.

Flood Recovery Activities

The most common flood recovery activity within the region is debris removal which, if not completed, compounds the next flood emergency. This activity is primarily conducted by cities, counties, and TxDOT. Entities in the region coordinate with FEMA and TDEM for funding of larger recovery activities and to advise local officials regarding assistance and resources.

In 2019, Knox County declared a local emergency due to damage to county roadways. They received funding from FEMA to repair a number of roads. According to local officials, major destruction to the roads was caused partially from waterways on private lands that have not been maintained due to lack of government assistance and personal funds. These waterways were designed years ago to help manage crop loss and erosion of farmland. Today many of these waterways are full of silt and debris that in turn limit their capabilities of handling large rain and runoff events.

In the 1981 Columbus Day flood, Stephens County was affected by flooding causing water and sewer facilities to be washed out and out of service. The city of Breckenridge did not have treated drinking water for almost two weeks, and water was supplied by Red Cross and National Guard. According to local officials, the FEMA flood map was designed from this flood event. In several flood events following, the 1981 FIRM was used to evacuate residents.

Plans to be Considered

State and Regional plans

The State Hazard Mitigation Plan is an effective instrument to reduce losses by reducing the impact of disasters upon people and property. Although mitigation efforts cannot completely eliminate impacts of disastrous events, the plan endeavors to reduce the impacts of hazardous events to the greatest extent possible. The plan evaluates, profiles, and ranks natural and human-caused hazards effecting the Texas as determined by frequency of event, economic impact, deaths, and injuries. The plan

- Assesses hazard risk,
- Reviews current state and local hazard mitigation and climate adaption capabilities, and
- Develops strategies and identifies state agency (and other entities) potential actions to address needs.

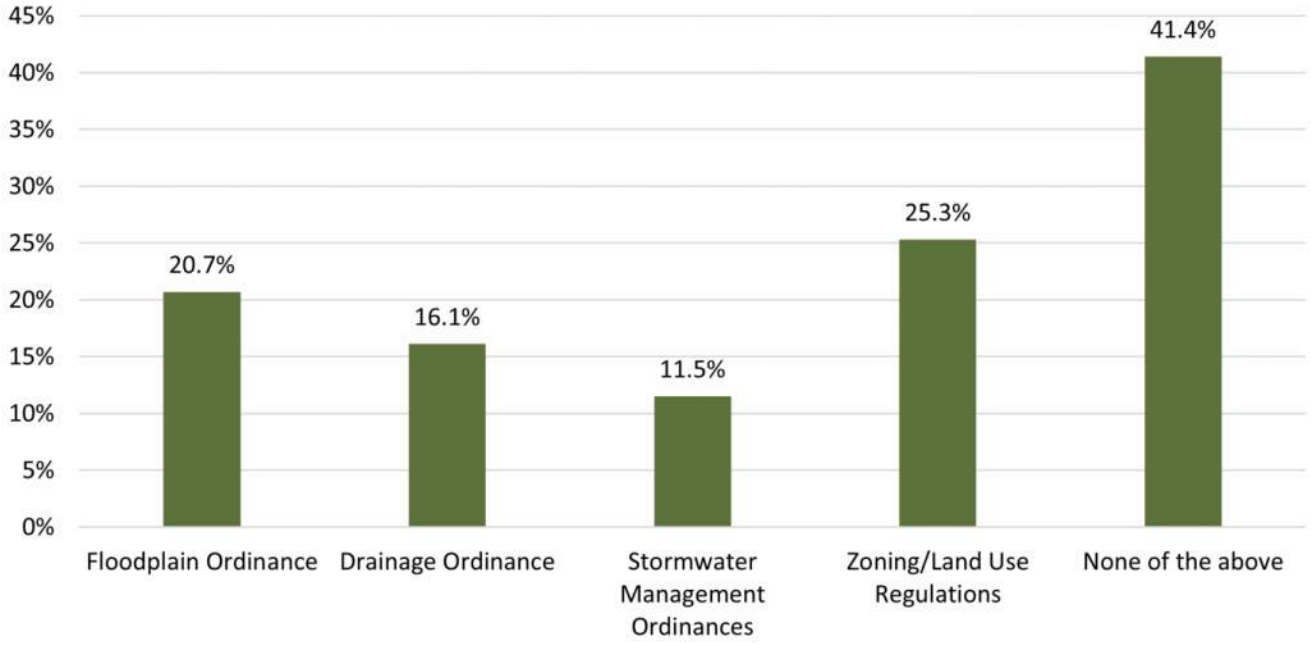
The Regional Emergency Preparedness Program is one of the largest and most effective programs of its kind nationwide. Bringing together urban, suburban, and rural jurisdictions, the program facilitates information sharing, collaboration, and cooperation between jurisdictions in a politically neutral and supportive environment. The Regional Preparedness Program accomplishes this connection through networking, standardization of policy and procedures, and coordination efforts with stakeholders.

Local Plans

In Region 7's data collection effort and survey in 2021, the RFPG requested local emergency management and emergency response plans that were publicly available. Some emergency plans are protected by law and are not available for public consumption. In addition to the plans provided by local entities, the region also obtained Emergency Management plans, Hazard Mitigation Plans, and other regional and local flood planning studies from County and local jurisdictions.

An emergency management plan is a course of action developed to mitigate the damage of potential events that could endanger an organization's ability to function. Such a plan should include measures that provide for the safety of personnel and, if possible, property and facilities.

Region 7 has several plans and regulations in place region wide that provide the framework that dictate a community's capabilities in implementing mitigation and preparedness actions. The following are flood plans and regulations indicated to be in place currently as collected from the data collection tool.



Source: Region 7 Data Collection Tool and Interactive web map as of September 2021

FIGURE 7-4 REGION 7 PLANS AND REGULATIONS

Other plans to consider include HMAPs, Emergency Action Plans (EAPs), as well as watershed management plans. An EAP provides the basis for the coordinated planning and management of types of emergencies and disaster events. Watershed management plans promote that all sectors of the community work together to create a flood hazard resilient community.

Hazard mitigation planning reduces loss of life and property by minimizing the impact of disasters. It begins with state, tribal, and local governments identifying natural disaster risks and vulnerabilities that are common in their area. After identifying these risks, they develop long-term strategies for protecting people and property from similar events. Mitigation plans are key to breaking the cycle of disaster

damage and reconstruction. While several of the counties are covered by a HMAP, only 27 plans are currently approved by FEMA, as they are to be updated on a 5-year cycle, however, some of the jurisdictions may be updating their HMAPs currently. Having an up to date HMAP is key in assessing risk and in developing mitigation actions. To check the status of your community's HMAP, go to FEMA Hazard Mitigation Plan Status (arcgis.com) .

TABLE 7-2 REGION 7 HAZARD MITIGATION PLANS

Jurisdiction	HMAP Status	Jurisdiction	HMAP Status
Archer County	Approved Plan	Kent County	Approved Plan
Bailey County	No Approved Plan	King County	No Approved Plan
Baylor County	Approved Plan	Knox County	Approved Plan
Borden County	No Approved Plan	Lamb County	Approved Plan
Callahan County	Approved Plan	Lubbock County	Plan In Progress
Castro County	Approved Plan	Lynn County	Approved Plan
Cochran County	Approved Plan	Mitchell County	Approved Plan
Crosby County	No Approved Plan	Nolan County	Approved Plan
Dawson County	No Approved Plan	Parmer County	Approved Plan
Dickens County	Approved Plan	Scurry County	Approved Plan
Eastland County	Approved Plan	Shackelford County	Approved Plan
Fisher County	Approved Plan	Stephens County	Approved Plan
Floyd County	No Approved Plan	Stonewall County	Approved Plan
Garza County	Approved Plan	Swisher County	Approved Plan
Hale County	No Approved Plan	Taylor County	Approved Plan
Haskell County	Approved Plan	Terry County	Approved Plan
Hockley County	No Approved Plan	Throckmorton County	Approved Plan
Jones County	Approved Plan	Young County	Approved Plan

In the private sector, an EAP is a document required by particular OSHA standards. The purpose of an EAP is to facilitate and organize employer and employee actions during workplace emergencies. They are an essential element in emergency management for critical facilities.

As part of the Dam Safety Program, owners of significant and high hazard dams are required to submit an EAP to TCEQ. Dam EAPs document responsibilities during flood response and identifies the flood inundation area. Table 7-3 below summarizes the state regulated dams in the Upper Brazos region as of September 2021.

TABLE 7-3 SUMMARY OF REGION 7 STATE REGULATED DAMS - 2021

State Regulated Dams	239
High Hazard Potential	23
Significant Hazard Potential	32
Low Hazard Potential	184

A watershed management plan helps in the understanding and address existing flooding, erosion, and water quality problems. It can be useful in preparing for future challenges. Watershed management plans inform recommendations, help educate the public and influence decision makers regarding land use changes, investment in capital projects and modifications to development regulations within the basin.

Region 7's ability to prepare, respond, recover, and mitigate disaster events is determined by several factors. With a clear understanding of the plans that determine a community's capabilities, a recognition of the entities with whom coordination is key, and knowledge of the actions sustained to promote resiliency, the region can be better equipped to implement sound measures for flood mitigation and preparedness.

Task 8. Administrative, Regulatory, and Legislative Recommendations

According to 31 Texas Administrative Code 362.3, the RFPG shall include legislative recommendations that are considered necessary and desirable to facilitate flood management planning and implementation to protect life and property. The RFPG discussed administrative, regulatory, and legislative issues during the Flood Planning effort. The RFPG considered regional input provided through a region wide survey shortly after the Region 7 planning efforts began.

As part of the Flood Planning efforts, recommendations can include alterations to the legislation associated with flood planning throughout the state, as well as regulatory or administrative features associated with flood-related activities. Recommendations may also be proposed to further the Flood Planning effort itself, such as desired support or data from the Texas Water Development Board or from other entities of the State. Where helpful, additional explanation is given for specific recommendations.

Administrative Recommendations

The Upper Brazos Regional Flood Planning Group recommends the Texas Water Development Board (TWDB) to consider the following administrative actions.

1) TWDB should develop model standards, ordinances, and processes.

a) Model ordinances for general law cities (e.g., building codes, subdivision regulations)

A general law city may only exercise those powers that are specifically granted or implied by statute. Providing these communities with model ordinances should increase the level of practice across the state.

b) Model floodplain management standards for varied levels of floodplain management practices to encourage increased levels. (e.g. low/medium/high)

This recommendation is for TWDB to develop model standards that have different levels of practice using the example levels low, medium, and high as defined by the Flood Planning process. This should facilitate communities to improve their floodplain management practices. This will particularly encourage communities with limited dedicated resources to flooding.

c) Model processes for participation in the FEMA National Flood Insurance and Community Rating System program. Develop state incentives for local governments to participate in each program.

Many communities do not understand the process to apply for the NFIP or CRS program, they also are unsure of the additional requirements that will come with these federal programs. If TWDB provided additional resources on the benefits and requirements for participation in these programs, communities may choose to increase their level of participation.

In the Upper Brazos region, only two communities participate in the CRS program. There are 21 communities that only participate in the NFIP in the emergency program and 13 communities that have no participation in FEMA's programs.

d) Model the process and clarify the investment required to take BLE data to 1) regulatory BLE information on a FIRM panel and 2) detailed study on a FIRM panel.

TWDB is investing in completing BLE data for the entire state. Providing a better understanding of how BLE data can assist local communities and the next steps for utilizing them will encourage the communities to leverage this investment.

2) TWDB should provide support to local floodplain administrators.

a) Provide ongoing training targeted to non-technical floodplain administrators.

This support would include the development of online resources including training modules, webinars, and print resources. An example of non-technical Floodplain Administrators would be county judges who serve as floodplain administrators. This work could be done under a partnership with the Texas Floodplain Managers Association (TFMA). This scope would also include guidance regarding their expected roles and regulatory authority.

b) Assist smaller jurisdictions in preparing funding applications or make the application process easier.

Most of the communities in Region 7 do not have resources to effectively pursue flood evaluations, flood mitigation projects, or apply for funding. TWDB could provide training for COGs to assist cities with funding process.

c) Use the project list in the State Flood Plan to help connect local communities to federal grant programs that are administered by state agencies (TWDB/TDEM), providing a "one stop" application process.

d) Provide training to state agencies, local governments, engineers, planners in the use of natural floodplain preservation/conservation.

e) Incentivize voluntary buy out programs, turning previously flooded properties/neighborhoods into green space and parkland as an alternative to large-scale construction projects.

3) TWDB should utilize a variety of flood mitigation criteria to evaluate projects for funding including alternatives to traditional methods.

a) Do not score or award funding for projects that benefit agricultural activities based on a traditional benefit-cost ratio; provide guidance on TWDB-preferred methodology to account for benefits to agricultural areas and activities and include consideration of agricultural benefits when ranking projects in the State Flood Plan. Methodology should consider temporary nature and ancillary benefits provided by occasional agricultural land flooding.

b) Do not score or award funding for projects that benefit energy activities based on a traditional benefit-cost ratio; provide guidance on TWDB-preferred methodology to account for benefits to energy activities and include consideration of energy benefits when ranking projects in the State Flood Plan.

c) Expand consideration and priority for FMEs that establish initial FEMA effective floodplains.

Establishing BFEs is a key first step for many communities to consider floodplain management practices and identify FMPs. In Region 7, communities have become more engaged in the regional flood planning process once flood risk data produced in the draft regional flood plan was made available for the first time.

d) Expand consideration for projects that do not provide 100-year level of service but can demonstrate substantial benefit during higher frequency events.

The 1% annual chance exceedance flood has traditionally been the focus for flood mitigation projects. Regional and state flood planning should acknowledge that for many communities localized flooding from more frequent events is the cause risk to life and property.

e) Consider alternate requirements to eliminate barriers that prevent jurisdictions from working together to provide regional flood mitigation solutions. For example, if primary sponsor meets all administrative requirements but additional jurisdictions do not, allow the regional solution to remain in contention for state funding.

4) TWDB should increase efforts to educate the public about flood-related issues.

a) Develop a statewide database and tracking system to document flood-related fatalities that is publicly available. This could be an addition to the Flood Plan Data Hub to capture existing data from TxDOT, NOAA, or others.

b) Partner with TFMA to promote public education and outreach about flood awareness and flood safety and provide outreach materials to communities. Partnership with Texas Association of Counties to include dedicated outreach to County Judges who often act as Floodplain Administrators without a technical flooding background.

c) Maintain a flood hazard area map on a public web map platform database, potentially integrated with the existing Water Data interactive site.

d) Develop a model-based future conditions flood hazard data layer using BLE data and provide it for use by RFPGs and the technical consulting teams during the next flood planning cycle.

In Region 7 there is very limited effective floodplain mapping and modeling available. The RFPG was not comfortable extrapolating approximate data to quantify future flood risk. With future flood planning cycles, model based future conditions flood hazard data should be utilized to quantify potential future flood risk.

Regulatory Recommendations

The Upper Brazos RFPG recommends various regulatory agencies to consider the following regulatory actions.

1) **The State should review and update TxDOT criteria.**
   a) Review TxDOT design criteria to identify opportunities to improve consideration for flood safety. Align with goals and objections of flood planning criteria. Develop funding mechanism for TxDOT to improve facilities flood safety.
   b) Update TxDOT design criteria to include no adverse impacts requirement for proposed road projects.
2) **The State should consider adopting current versions of International Building Code and International Residential Code as State building standards.**

   Adoption of these building standard statewide will Improve Texas' eligibility for federal funding under the Building Resilient Infrastructure and Communities (BRIC) program.
3) **The State should recommend (not adopt or require) an additional statewide building standard of a minimum floor elevation equal to the base flood elevation (BFE) plus freeboard to account for potential changes in future rainfall depths and flood elevations.**

   Additional building standards for freeboard may be appropriate for some areas of the state. The specific freeboard amount to account for future rainfall and flood elevations will vary widely and therefore a statewide value should not be adopted or required.
4) **The State should encourage FEMA to streamline the CRS application process to make it easier to obtain certification and implement at the local level.**
5) **The State should explore the use of current legislatively authorized entities to provide continuity and resources for communities related to flooding before creating new entities.**

   Many of the smaller communities are not funded or resourced to deal with the complexities of floodplain management. Exploration of existing entities should be considered to support Flood Mitigation Action implementation and provide communities support in implementing floodplain management practices.

Legislative Recommendations

The Upper Brazos Regional Flood Planning Group recommends the Texas Legislature to consider the following legislative actions.

1) **The Texas Legislature should provide recurring biennial appropriations to the Flood Infrastructure Fund for study, strategy, and project implementation.**

2) **The Texas Legislature should provide State incentives for establishment of dedicated drainage funding at a local level.**

3) **The Texas Legislature should provide guidance for use of public funds to improve private properties for flood risk reduction (e.g., elevation of structures in floodplains).**

   Communities are frequently approached by the public to make improvements to private property to reduce flood risk. Additional guidance from the Legislature will help communities navigate their legal liability and responsibilities.

4) **The Texas Legislature should provide counties with legislative authority to establish drainage utilities and assess drainage fees.**

   This recommendation is supported by the USACE and they provided the following comments. Although state legislation was passed in the early 2000's which gave counties the ability to regulate floodplains, interpretation of these regulations varies widely from county to county. The legislate bill lacks implementation guidance in the form of administrative rules. If development is occurring in unincorporated areas, this development can dynamically impact flood risk.

5) **The Texas Legislature should provide counties with expanded regulatory authority to manage new development to reduce future flood risk and benefit water supplies.**

6) **The Texas Legislature should provide clarity on roles and responsibilities within ETJ areas related to floodplain management activities.**

7) **The Texas Legislature should develop and allocate State funding to assist privately-owned dam owners and NRCS dams with the costs associated with repair and maintenance of dams. Priority should be given to NRCS dams with the highest risk to the public at large.**

8) **The Texas Legislature should allocate a percentage of funds appropriated for this overall program to assist rural or small entities to implement identified actions.**

Task 9. Flood Infrastructure Financing Analysis

The TWDB requires that each RFPG assess and report on how sponsors propose to finance recommended FME, FMS, and FMP. A primary aim of this survey effort is to understand the funding needs of local sponsors and propose what role the state should have in financing the recommended FMEs, FMSs, and FMPs.

Sources of Potential Funding for Flood Management Activities

Communities, counties, and entities with flood-related authority or responsibility across the state utilize a variety of funding sources for their flood management efforts, including local, state, and federal sources. This section discusses some of the most common avenues of generating local funding, as well as various state and federal financial assistance programs available to communities. Table 9-1 summarizes the local, state, and federal funding sources presented in this chapter, and characterizes each by the following three key parameters:

- Which state and federal agencies are involved, if applicable,
- Whether they offer grants, loans, or both, and
- Whether they are classified as regularly occurring opportunities or are only available after a disaster.

Local Funding

Through the RFPG's initial stakeholder outreach efforts, the RFPG sought to understand the landscape of local funding for flood efforts in Region 7. Many communities, particularly smaller and more rural communities, reported that they did not have any local funding sources for flood management activities. Those communities that did report having local funding indicated the following primary sources:

- Local taxes,
- Disaster/Emergency funds,
- Stormwater utility fees, and
- Local or grant funds.

This section primarily focuses on the funding mechanisms available to municipalities and counties, as a large majority of the FME, FMS, and FMP sponsors are these types of entities. Special purpose districts are briefly discussed as there may be opportunities to create more of these types of districts in the region. River authorities typically generate their own revenue from fees charged to users for selling water, electricity, wastewater treatment, and other services.

A community's (for cities or counties) general fund revenue stems from sales, property, and other taxes and is typically the primary fund used by a local governmental entity to support most departments and services such as police, fire, parks, trash collection, and local government administration. Due to the high demands on this fund for many local needs, the general fund often cannot provide a significant amount of funding for flood projects.

TABLE 9-1 COMMON SOURCES OF FLOOD FUNDING IN TEXAS

Source	Federal Agency	State Agency	Program Name	Grant (G)	Loan (L)	Post-Disaster (D)
Local	-	-	General fund			
Local	-	-	Bonds			
Local	-	-	Stormwater or drainage utility fee			
Local	-	-	Special-purpose district taxes and fees			
State	-	TSSWCB	Structural Dam Repair Grant Program	G		
State	-	TWDB	Flood Infrastructure Fund (FIF)	G	L	
State	-	TWDB	Texas Water Development Fund (Dfund)		L	
State	-	TSSWCB	Operation and Maintenance (O&M) Grant Program	G		
State	-	TSSWCB	Flood Control Dam Infrastructure Projects - Supplemental Funding	G		
Federal	FEMA	TWDB	Flood Mitigation Assistance (FMA)	G		
Federal	FEMA	TDEM	Building Resilient Infrastructure and Communities (BRIC)	G		
Federal	FEMA	TCEQ	Rehabilitation of High Hazard Potential Dam Grant Program (HHDP)	G		
Federal	FEMA	*TBD*	Safeguarding Tomorrow through Ongoing Risk Mitigation (STORM)		L	
Federal	FEMA	TDEM	Hazard Mitigation Grant Program (HMGP)	G		D
Federal	FEMA	TDEM	Public Assistance (PA)	G		D
Federal	FEMA		Cooperating Technical Partners (CTP)	G		
Federal	HUD	GLO	Community Development Block Grant – Mitigation (CDBG-MIT)	G		D
Federal	HUD	GLO	Community Development Block Grant Disaster Recovery Funds (CDBG-DR)	G		D
Federal	HUD	TDA	Community Development Block Grant (TxCDBG) Program for Rural Texas	G		
Federal	USACE	-	Partnerships with USACE, funded through Continuing Authorities Program (CAP), Water Resources Development Acts (WRDA), or other legislative vehicles[1]			
Federal	EPA	TWDB	Clean Water State Revolving Fund (CWSRF)	G[2]	L	

[1]Opportunities to partner with USACE are not considered grant or loan opportunities, but shared participation projects where USACE performs planning work and shares in the cost of construction.

[2]The CWSRF program offers principal forgiveness, which is similar to grant funding.

Dedicated stormwater or drainage fees are an increasingly popular tool for local flood-related funding. Municipalities can establish a stormwater utility (SWU), sometimes called a drainage utility, which is a legal mechanism used to generate revenue to finance a city's cost to provide and manage stormwater services. To provide these services, municipalities assess fees to users of the stormwater utility system. Impact fees, which are collected from developers to cover a portion of the expense to expand municipal storm water systems necessitated by the new development, can also be used as a source of local funding for flood-related efforts.

Another source for local funding to support flood management efforts includes special districts. A special district is a political subdivision established to provide a single public service (such as water supply, drainage, or sanitation) within a specific geographic area. Examples of these special districts include Water Control and Improvement Districts (WCID), Municipal Utility Districts (MUD), Drainage Districts (DD), and Flood Control Districts (FCD). Each of the different types of districts are governed by different state laws, which specify the authorities and process for creation of a district. Districts can be created by various entities, including the Texas Legislature, the Texas Commission on Environmental Quality, county commissioners' courts or city councils. Some types of districts may have the ability to raise revenue through taxes, fees, or bonds to fund flood and drainage-related improvements within a district's area.

Lastly, municipalities and counties have the option to issue debt through general obligation bonds, revenue bonds, or certificates of obligation, which are typically paid back using any of the previously mentioned local revenue raising mechanisms.

Overall, local governments have various options for raising revenue to support local flood-related efforts; however, each avenue presents its own unique challenges and considerations. It is important to note that municipalities have more authority to establish various revenue raising options in comparison to counties. Of the communities that do have access to local funding, the amount available is generally much lower than the total need, leading local communities to seek out state and federal financial assistance programs.

State Funding

Today, communities have a broader range of state and federal funding sources and programs available thanks to new grant and loan programs that did not exist even five years ago. Currently, two primary state agencies are involved in providing state funding for flood mitigation projects: the TWDB and the Texas State Soil and Water Conservation Board (TSSWCB). It is important to note that state and federal financial assistance programs discussed herein are not directly available to homeowners and the general public. Local governments may apply on behalf of their communities to receive and implement funding for flood mitigation projects within their jurisdiction.

The TWDB's Flood Infrastructure Fund (FIF) is a new funding program passed by the Texas Legislature and approved by Texas voters through a constitutional amendment in 2019. The program provides financial assistance in the form of low or no interest loans and grants (cost match varies) to eligible political subdivisions for flood control, flood mitigation, and drainage projects. FIF rules allow for a wide

range of flood management projects, including structural and nonstructural projects, planning studies, and preparedness efforts such as flood early warning systems. After the first State Flood Plan is adopted, only projects included in the most recently adopted state plan will be eligible for funding from the FIF. FMEs, FMSs, and FMPs recommended in this regional flood plan will be included in the overall State Flood Plan, and the sponsor for a particular recommended action will be eligible to apply for this funding source. The Flood Protection Planning Grant referenced in Table 9-1 has been replaced by the Flood Infrastructure Fund Category 1 planning grants.

The TWDB also manages the Texas Water Development Fund (Dfund) program, which is a state-funded, streamlined loan program that provides financing for several types of infrastructure projects to eligible political subdivisions. This program enables the TWDB to fund projects with multiple eligible components (water supply, wastewater, or flood control) in one loan at a low interest rate. Financial assistance for flood control may include structural and nonstructural projects, planning efforts, and flood warning systems.

The TSSWCB has three state-funded programs specifically for flood control dams:

- Operation and Maintenance (O&M) Grant Program,
- Flood Control Dam Infrastructure Projects – Supplemental Funding program, and
- Structural Repair Grant Program.

The O&M Grant Program provides grants for local soil and water conservation districts (SWCD) and certain co-sponsors of flood control dams. This program reimburses SWCDs 90% of the cost of an eligible operation and maintenance activity as defined by the program rules; the remaining 10% must be paid with non-state funding. The Flood Control Dam Infrastructure Projects - Supplemental Funding program was created and funded in 2019 by the Texas Legislature. Grants are provided to local sponsors of flood control dams, including SWCDs, to fund the repair and rehabilitation of the flood control structures, to ensure dams meet safety criteria to adequately protect lives downstream. The Structural Repair Grant Program provides state grant funds that cover up to 95% of the cost of allowable repair activities on dams constructed by the United States Department of Agriculture - Natural Resources Conservation Service (USDA-NRCS), including match funding for federal projects through the Dam Rehabilitation Program and the Emergency Watershed Protection (EWP) Program of the Texas NRCS.

Federal Funding

Federal funding currently accounts for a large share of total available funding for flood projects throughout the state and region, with federal funding programs having greater access and availability to large funding amounts from the federal government appropriated by Congress. Commonly utilized funding programs administered by seven different federal agencies are discussed in this section. The funding for these programs originates from the federal government. For many of the programs, a state agency partner plays a key role in the management of the program. Each funding program has its own unique eligible applicants, project types, requirements, and application and award timelines. More information regarding each program and these details can be found at the links below.

Federal Emergency Management Agency (FEMA)

Common FEMA-administered flood-related funding programs include

- Flood Mitigation Assistance (FMA),
- Building Resilient Infrastructure and Communities (BRIC),
- Rehabilitation of High Hazard Potential Dam (HHPD) Grant Program,
- Safeguarding Tomorrow through Ongoing Risk Mitigation (STORM),
- Hazard Mitigation Grant Program (HMGP),
- Public Assistance (PA) program, and
- Cooperating Technical Partners (CTP) Program.

Flood Mitigation Assistance (FMA) is a nationally competitive grant program that provides funding to states, local communities, federally recognized tribes, and territories. FMA is administered in Texas by the Texas Water Development Board (TWDB). Funds can be used for projects that reduce or eliminate the risk of repetitive flood damage to buildings insured by the NFIP. Funding is typically a 75% federal grant with a 25% local match. Projects mitigating Repetitive Loss and Severe Repetitive Loss properties may be funded through a 90% federal grant and 100% federal grant, respectively. FEMA's FMA program now includes a disaster initiative called Swift Current. The program was released as a pilot initiative in 2022 and explored ways to make flood mitigation assistance more readily available during disaster recovery. Similar to traditional FMA, the Swift Current program mitigates repetitive losses and substantially damaged buildings insured under the NFIP.

The Building Resilient Infrastructure and Communities (BRIC) is a new nationally competitive grant program implemented in 2020. The program supports states, local communities, tribes, and territories as they undertake hazard mitigation projects, reducing the risks they face from disasters and natural hazards. BRIC is administered in Texas by the Texas Division of Emergency Management (TDEM). Funding is typically a 75% federal grant with a 25% local match. Small, impoverished communities and U.S. Island territories may be funded through a 90% federal grant and 100% federal grant, respectively.

Safeguarding Tomorrow through Ongoing Risk Mitigation (STORM) is a new revolving loan program enacted through federal legislation in 2021 to provide needed and sustainable funding for hazard mitigation projects. The program is designed to provide capitalization grants to states to establish revolving loan funds for projects to reduce risks from disaster, natural hazards, and other related environmental harm. At the time of the publication of this plan, the program does not yet appear to be operational and has not yet been implemented in Texas.

FEMA's Rehabilitation of High Hazard Potential Dam (HHPD) Grant Program, administered in Texas by the TCEQ, provides technical, planning, design, and construction assistance in the form of grants for rehabilitation of eligible high hazard potential dams. The cost share requirement is typically no less than 35% state or local share.

Under the Hazard Mitigation Grant Program (HMGP), FEMA provides funding to state, local, tribal, and territorial governments so they can rebuild from a recent disaster in a way that reduces, or mitigates, future disaster losses in their communities. The program is administered in Texas by TDEM. Funding is

typically a 75% federal grant with a 25% local match. While the program is associated with Presidential Disaster Declarations, the HMGP is not a disaster relief program for individual disaster victims or a recovery program that funds repairs to public property damaged during a disaster. The key purpose of HMGP is to ensure that the opportunity to take critical mitigation measures to reduce the risk of loss of life and property from future disasters is not lost during the reconstruction process following a disaster.

FEMA's FEMA Public Assistance (PA) program provides supplemental grants to state, tribal, territorial, and local governments, and certain types of private non-profits following a declared disaster so communities can quickly respond to and recover from major disasters or emergencies through actions such as debris removal, life-saving emergency protective measures, and restoring public infrastructure to its pre-disaster condition. Funding cost share levels are determined for each disaster and are typically not less than 75% federal grant (25% local match) and typically not more than 90% federal grant (10% local match). In Texas, FEMA PA is administered by TDEM. In some situations, FEMA may fund mitigation measures as part of the repair of damaged infrastructure. Generally, mitigation measures are eligible if they directly reduce future hazard impacts on damaged infrastructure and are cost-effective. Funding is limited to eligible damaged facilities located within PA-declared counties.

The Cooperating Technical Partners (CTP) program is an effort launched by FEMA in 1999 to increase local involvement in developing and updating Flood Insurance Rate Maps (FIRMs), Flood Insurance Study reports, and associated geospatial data in support of FEMA's Risk Mapping, Assessment and Planning (Risk MAP) Program. To participate in the program, interested NFIP-participating communities, state or regional agencies, universities, territories, tribes, or nonprofits must complete training and execute a partnership agreement. Working with the FEMA regions, a program participant can develop business plans and apply for grants to perform eligible activities.

Housing and Urban Development (HUD)

HUD administers the following three federal funding programs:

- Community Development Block Grant – Disaster Recovery (CDBG-DR),
- Community Development Block Grant – Mitigation (CDBG-MIT), and
- Community Development Block Grant (TxCDBG) for Rural Texas.

Following a major disaster, Congress may appropriate funds to the Department of Housing and Urban Development (HUD) under the Community Development Block Grant – Disaster Recovery (CDBG-DR) program when there are significant unmet needs for long-term recovery. Appropriations for CDBG-DR are frequently very large, and the program provides 100% grants in most cases. The CDBG-DR is administered in Texas by the Texas General Land Office (GLO). The special appropriation provides funds to the most impacted and distressed areas for disaster relief, long term-recovery, restoration of infrastructure, housing, and economic revitalization.

The Community Development Block Grant – Mitigation (CDBG-MIT) is administered in Texas by the GLO. Eligible grantees can use CDBG Mitigation (CDBG-MIT) assistance in areas impacted by recent disasters to carry out strategic and high-impact activities to mitigate disaster risks. The primary feature differentiating CDBG-MIT from CDBG-DR is that unlike CDBG-DR, which funds recovery from a recent

disaster to restore damaged services, systems, and infrastructure, CDBG-MIT funds are intended to support mitigation efforts to rebuild in a way that will lessen the impact of future disasters.

The Community Development Block Grant (CDBG) program provides annual grants on a formula basis to small, rural cities and to counties to develop viable communities by providing decent housing and suitable living environments and expanding economic opportunities principally for persons of low- to moderate-income. Funds can be used for public facilities such as water and wastewater infrastructure, street and drainage improvements, and housing. In Texas, the CDBG program is administered by the Texas Department of Agriculture (TDA).

U.S. Army Corps of Engineers (USACE)

The USACE works with non-Federal partners (States, Tribes, counties, or local governments) throughout the country to investigate water resources and related land problems and opportunities and, if warranted, develop civil works projects that would otherwise be beyond the sole capability of the non-Federal partner(s). Partnerships are typically initiated or requested by the local community to their local USACE District office. Before any project or study can begin, USACE determines whether there is an existing authority under which the project could be considered, such as the US Army Corps of Engineers Continuing Authorities Program (CAP), or whether Congress must establish study or project authority and appropriate specific funding for the activity. New study or project authorizations are typically provided through periodic Water Resource Development Acts (WRDA) or via another legislative vehicle. Congress will not provide project authority until a completed study results in a recommendation to Congress of a water resources project, conveyed via a Report of the Chief of Engineers (Chief's Report) or Report of the Director of Civil Works (Director's Report). Opportunities to partner with USACE are not considered grant or loan opportunities, but shared participation projects where USACE performs planning work and shares in the cost of construction. USACE also has technical assistance opportunities, including Floodplain Management Services, Silver Jackets team, and the Planning Assistance to States program, available to local communities.

U.S. Environmental Protection Agency (EPA)

The Clean Water State Revolving Fund (CWSRF) provides financial assistance in the form of loans with subsidized interest rates and opportunities for partial principal forgiveness for planning, acquisition, design, and construction of wastewater, reuse, and stormwater mitigation infrastructure projects. Projects can be structural or non-structural. Low Impact Development (LID) projects are also eligible. The CWSRF is administered in Texas by the TWDB.

U.S. Department of Agriculture (USDA)

The USDA's Natural Resources Conservation Service (NRCS) provides technical and financial assistance to local government agencies through the following programs: Emergency Watershed Protection Program, Watershed Protection and Flood Prevention Program, Watershed Surveys and Planning, and Watershed Rehabilitation. The Emergency Watershed Protection (EWP) program, a federal emergency recovery program, helps local communities recover after a natural disaster by offering technical and financial assistance to relieve imminent threats to life and property caused by floods and other natural disasters

that impair a watershed. The Watershed Protection and Flood Prevention Program helps units of federal, state, local and tribal government to protect and restore watersheds; to prevent erosion, floodwater, and sediment damage; to further the conservation development, use and disposal of water; and to further the conservation and proper use of land in authorized watersheds. The focus of Watershed Surveys and Planning program is funding the development of watershed plans, river basin surveys and studies, flood hazard analyses, and floodplain management assistance aimed at identifying solutions that use land treatment and nonstructural measures to solve resource problems. Lastly, the Watershed Rehabilitation Program helps project sponsors rehabilitate aging dams that are reaching the end of their design lives. This rehabilitation addresses critical public health and safety concerns. The USDA also offers various Water and Environmental grant and loan funding programs, which can be used for water and waste facilities, including stormwater facilities, in rural communities.

Special Appropriations

On occasion and when the need is large enough, Congress may appropriate funds for special circumstances, such as natural disasters or pandemics (COVID-19). A few examples of recent special appropriations from the federal government that can be used to fund flood-related activities include

- American Rescue Plan Act (ARPA) and
- Infrastructure Investment and Jobs Act (IIJA)/ Bipartisan Infrastructure Law (BIL).

In 2021, the American Rescue Plan Act (ARPA) provided for a substantial infusion of resources to eligible state, local, territorial, and tribal governments to support their response to and recovery from the COVID-19 pandemic. Coronavirus State and Local Fiscal Recovery Funds (SLFRF), a part of ARPA, delivers $350 billion directly to state, local, and tribal governments across the country. Communities have significant flexibility to meet local needs within the eligible use categories, one of which includes improving stormwater facilities and infrastructure as an authorized use. Eligible entities may request their allocation of Coronavirus State and Local Fiscal Recovery Funds directly from the U.S. Department of Treasury.

Although not a direct appropriation to local governments like ARPA, the 2021 Infrastructure Investment and Jobs Act (IIJA), also called the Bipartisan Infrastructure Law (BIL), authorizes over $1 trillion for infrastructure spending across the U.S. and provides for a significant infusion of resources over the next several years into existing federal financial assistance programs, including several of the flood funding programs discussed herein, as well as creating new programs.

Barriers to Funding

Barriers to accessing or seeking funding sources for flood management activities include lack of knowledge of funding sources, lack of expertise to apply for funding, lack of resources to prepare funding applications, lack of expertise to manage funding awards when received, and lack of funds available for local match requirements. As opposed to some other types of infrastructure, flood projects do not typically generate revenue, and many communities do not have steady revenue streams to fund flood projects, as earlier discussed. Consequently, communities struggle to generate funds for local match requirements or loan repayment. Complex or burdensome application or program requirements,

as well as prolonged timelines also act as barriers to accessing state and local financial assistance programs. The high demand for state and federal funding, particularly for grant opportunities, means that the need exceeds available funds, leaving many local communities without the resources they need to address flood risks.

Flood Infrastructure Financing Outreach and Survey

Flood Infrastructure Financing Outreach and Survey Methodology

The RFPG performed a survey of the sponsors for the recommended FMEs, FMSs and FMPs. The RFPG primarily used in-person meetings and email surveys to survey the sponsors. As a last resort, the RFPG mailed surveys or used other means of collecting the required information. The primary aim of this survey effort was to understand the funding needs of local sponsors and obtain feedback regarding the role the state should have in financing the recommended FMEs, FMSs, and FMPs.

In-Person Meetings

The RFPG visited sponsors for the recommended FMEs, FMSs, and FMPs with capital costs identified for each. Since the RFPG could not visit every sponsor, in-person meetings were prioritized for:

- **Potential FMP Sponsors** – There is a desire through the Flood Planning process to identify and construct projects. The communities with Flood Mitigation Projects that meet the TWDB criteria were prioritized to confirm interest.
- **HMAP identified actions** – Communities that have previously expressed need through the Hazard Mitigation Action Plan process were also identified. These communities have existing flooding needs identified.
- **Flood Risk Knowledge Gaps** – FMEs were identified to fill the areas of greatest flood risk knowledge gaps. These communities are limited in their current floodplain management practices by a lack of flood risk data.

During these visits, the RFPG showed the sponsors their specific list of recommended FMEs, FMSs, and FMPs along with maps of the project areas and capital costs. Funding sources and amounts were then discussed for each individual FME, FMS, and FMP. Any sponsor feedback was incorporated such as FME, FMS, and/or FMP edits or additions.

Email Survey

A Flood Infrastructure Fund survey was emailed to sponsors who the RFPG was unable to meet with. When email addresses were unavailable, additional outreach such as phone calls were used to obtain emails. The RFPG collected information from sponsors by creating a survey through mail merge and sending it through email. Mail merge allowed the RFPG to automate a batch of emails that were personalized for each sponsor by linking a main template to a data source. The main template contained the text that was the same for each survey while the data source was a file containing all the information to be merged into the survey and the sponsor's email address. An example of the survey emailed out to sponsors is shown in Figure 9-1**.**

During the mail merge process, a personalized table of recommended FMEs, FMSs, and FMPs was generated for each sponsor. The table included the identification number, type, name, description, and total estimated cost for each FME, FMS, and FMP listed. Additionally, a link was provided to the Region 7 GIS Dashboard where sponsors could navigate to for more information about their FMEs, FMSs, and FMPs. After receiving the email, sponsors were asked to reply to the survey by selecting from the drop-down menu of possible answers under the financing columns. Sponsors could select a percentage between 0% to 100% (in 5% increments) under the 'Percent Funding to be Financed by Sponsor' and 'Other Funding Needed' columns for each FME, FMS, and/or FMP.

Drop-down menu options for 'Anticipated Source of Sponsor Funding' included

- Taxes,
- General Revenue,
- Dedicated Revenue Inclusion Fees,
- Entity Budget/Funds,
- Donations,
- Bonds/Other Financing,
- Other, and
- TBD.

Hello Sponsor,

We are reaching out to you because there are one or more actions for your community that will be listed in the Upper Brazos regional flood plan, and we need your help to identify how much state or federal funding you may need to implement these projects.

Please reply to this email and fill out the drop-down menu in the table below for each of your entities' Flood Mitigation Actions by July 10, 2022. Please note the percent funding financed by sponsor and other funding needed must equal 100%. For more information regarding your Flood Mitigation Actions, visit the following link: Region 7 - GIS Dashboard. If we do not receive a response, we will assume that 100% of the cost for that action will need other funding (including state, federal and/or other funding).

The Texas Water Development Board (TWDB) designated 15 regional flood planning areas each of which began with a designated regional flood planning group that will develop a regional flood plan for their region by January 2023. TWDB will bring the regional flood plans together to produce the first State Flood Plan by September 1, 2024. Entities must have their project listed in the State Flood Plan to receive state funding for a proposed flood project. As part of the regional flood planning process, RFPGs must indicate how sponsors will propose to finance recommended Flood Mitigation Actions included in the Flood Plan[1]. Flood Mitigation Actions include Flood Management Evaluation (FME), Flood Mitigation Strategy (FMS), and Flood Mitigation Project (FMP)[2].

There is no commitment associated with being a sponsor for an action in the plan, this is just a planning level study.

Flood Mitigation Action ID	Flood Mitigation Action Type[2]	Flood Mitigation Action Name	Flood Mitigation Action Description	Flood Mitigation Action Total Estimated Cost*	Sponsor Funding		Other Funding Needed** (including state, federal and/or other funding)
					Anticipated Source of Sponsor Funding	Percent Funding to be Financed by Sponsor**	
071000001	FME	Initial FEMA Mapping	Create FEMA Mapping in previously unmapped areas	$711,000	Taxes	0%	100%
071000085	FME	GIS Development	Develop a GIS inventory of stormwater infrastructure	$100,000	Choose an item.	Choose an item.	Choose an item.
071000121	FME	DCM	Consider stormwater criteria for infrastructure and floodplain ordinances to avoid new exposure to flood hazards.	$100,000	Choose an item.	Choose an item.	Choose an item.
072000001	FMS	NFIP Participation	Application to join NFIP or adoption of equivalent standards.	$50,000	Choose an item.	Choose an item.	Choose an item.

**Costs are based on high level engineering estimates and assumptions.*

***Percent funding financed by sponsor and other funding needed MUST equal 100%.*

FIGURE 9-1 FLOOD INFRASTRUCTURE FINANCING SURVEY EXAMPLE

Flood Infrastructure Financing Survey Results

The RFPG met with 43 sponsors and emailed the funding survey to 55 sponsors. The primary aim of this survey effort was to understand the funding needs of local sponsors and then propose what role the state should have in financing the recommended FMEs, FMSs, and FMPs. As of June 29, 2022, 39 responded through email or an in-person meeting, for a response rate of 40%. Appendix C presents the results of the survey for each FME, FMS, and FMP. With additional time provided in the second cycle of

regional flood planning, the RFPG anticipates that a greater response rate may be obtained through additional outreach efforts such as follow-up emails, phone calls, and meetings.

The RFPG assumed that those sponsors who did not respond to the survey would need 100% of the total project costs to be funded by state and/or federal sources. This assumption represents an average of 0% projected local investment in projects. A high percentage of outside need is supported by the initial outreach efforts discussed, which confirmed that many communities, particularly smaller and more rural communities, do not have any local funding available for flood management activities. Those communities that did report having local funding indicated relatively little local funding available in relation to overall need.

Overall, there is a total cost of $102.6M needed to implement the recommended FMEs, FMSs, and FMPs in this regional flood plan. From the total cost of $102.6M, it is projected that $98.6M in state and federal funding is needed. This number does not represent the amount of funding needed to mitigate all risks in the region and solve flooding problems in their totality. This number simply represents the funding needs for the specific, identified studies, strategies, and projects in this cycle of regional flood planning. It is estimated an additional $97M would be needed to construct additional projects that are not yet included as an FMP. Future cycles of regional flood planning will continue to identify more projects and studies needed to further flood mitigation efforts in Region 7.

TABLE 9-2 SUMMARY OF FUNDING SURVEY RESULTS

Action	Total Cost	Potential Funding Amount	Other Funding Needed
FME	$83,694,000	$1,298,300	$82,395,700
FMP	$5,686,000	$1,252,200	$4,433,800
FMS	$13,183,000	$1,425,800	$11,757,200
Future FMP Needs	$97,143,657	$0	$97,143,657
Total	**$199,706,657**	**$3,976,300**	**$195,730,357**

Task 10. Adoption of Plan and Public Participation

Upper Brazos RFPG Meetings

As required by 31 TAC §361, the RFPGs conducted all business in meetings posted and held in accordance with the Texas Open Meetings Act, Texas Government Code Chapter 551, with a copy of all materials presented or discussed available for public inspection prior to and following public meetings. Additional notice requirements referenced in 31 TAC §361.21 were followed when applicable.

Pre-Planning Meetings

The RFPG solicited public input regarding suggestions and recommendations as to issues, provisions, projects, and strategies that should be considered during the flood planning cycle and/or input on the development of the regional flood plan (as required per Texas Water Code §16.062(d) and 31 Texas Administrative Code §361.12(a)(4)).

Virtual pre-planning meetings were held on May 20, 2021 and May 25, 2021. The purpose of these meetings was to educate the public on the formation of the Regional Flood Planning Group and the planning process.

Monthly RFPG Meetings

The Upper Brazos RFPG held monthly meetings to obtain updates from the Technical Consultant Team, provide input on processes and methodologies, and provide approval for components of the Regional Flood Plan. These meetings were open to the public and were held in a hybrid format with opportunities to attend in person or through virtually through Zoom. Table 10-1 below provides a summary of the key items from each monthly meeting. Meeting materials and meeting minutes were made available on the Region's Flood Plan website, Region 7 Upper Brazos RFPG - Flood Planning Group Meeting (upperbrazosflood.org).

TABLE 10-1 OVERVIEW OF MONTHLY RFPG MEETINGS

Meeting Date	Discussion Topics	SOW Requirements
November 19, 2020	Administrative Meeting	-
December 17, 2020	Administrative Meeting	-
January 21, 2021	Administrative Meeting	-
March 18, 2021	Technical Consultant Selection	-
April 15, 2021	Intro to Data Collection Approach	-
May 20, 2021	Task 2: Flood Risk Approach	Pre-Planning Public Meeting
May 25, 2021	Special Meeting	Pre-Planning Public Meeting
June 17, 2021	Data Request Update	Flood Prone Areas Public Comment Meeting
July 15, 2021	Task 3: Floodplain Management Goals	Flood Prone Areas Public Comment Meeting

Meeting Date	Discussion Topics	SOW Requirements
August 19, 2021	Task 2: Flood Risk Analyses Approach Task 3: Goals Menti Poll Task 4A: Needs Analysis Introduction	-
September 16, 2021	Task 1: Data Collection update Task 2: Flood Risk update Task 3: Floodplain Management Goals Task 4: Needs Analysis update	-
October 28, 2021	Task 1: Data Collection Task 2: Flood Risk Analysis Task 3: Floodplain Management Goals Task 4: Needs Analysis and FMX ID	ACTION ITEM: Approval of: Recommended Standards & Goals RFPG to recommend and not adopt minimum standards
December 3, 2021	Task 4: FME, FMS, and FMP Process Task 4C: Interim Tech Memo Task 2: Flood Risk Analysis Update	ACTION ITEM: Approval of: FMX Process Interim Technical Memorandum
January 18, 2022	Task 2: Flood Risk Analysis	
February 17, 2022	Task 2b: Future Conditions Analysis Task 4c: Tech Memo Supplement	ACTION ITEM: Approval of: Tech Memo Supplement
March 17, 2022	Task 4: Flood Mitigation Actions Task 7: Flood Response Introduction	-
April 21, 2022	Task 4/5: Flood Mitigation Actions Task 7: Flood Response	-
May 19, 2022	Task 4/5: Flood Mitigation Actions Task 9: Flood Infrastructure Financing Task 11: Stakeholder Outreach Update	-
June 23, 2022	Task 6: Impacts of the Plan Task 11: Stakeholder Outreach Update	ACTION ITEM: Approval of: Recommended FMX
July 21, 2022	Task 6: Impacts of the RFP Future Work Plan	ACTION ITEM: Approval of: Draft Regional Flood Plan.
September 8, 2022	Draft Flood Plan Task 12: Perform FMEs	
November 17, 2022	Draft Flood Plan Comment Discussion Task 11: Additional Outreach Task 12: Perform FMEs	ACTION ITEM: Approval of Potential Task 12 FMEs
December 15, 2022	Final Regional Flood Plan	ACTION ITEM: Approval of: Final Regional Flood Plan.

Public Participation

At each RFPG meeting a public comment period was opened to receive feedback from the public. In addition to these opportunities, there were formal public meetings on various tasks and targeted stakeholder outreach summarized below.

Stakeholder Outreach

Data Collection Survey

The Region 7 RFPG created a public survey to solicit knowledge about the flood planning area and input on regional strategies and initiatives. The survey was made available on the RFPG webpage and also emailed directly to community officials and other key stakeholders in the region. These community officials were also contacted by the RFPG and technical consultant, either by phone or in person, and encouraged to participate in the survey.

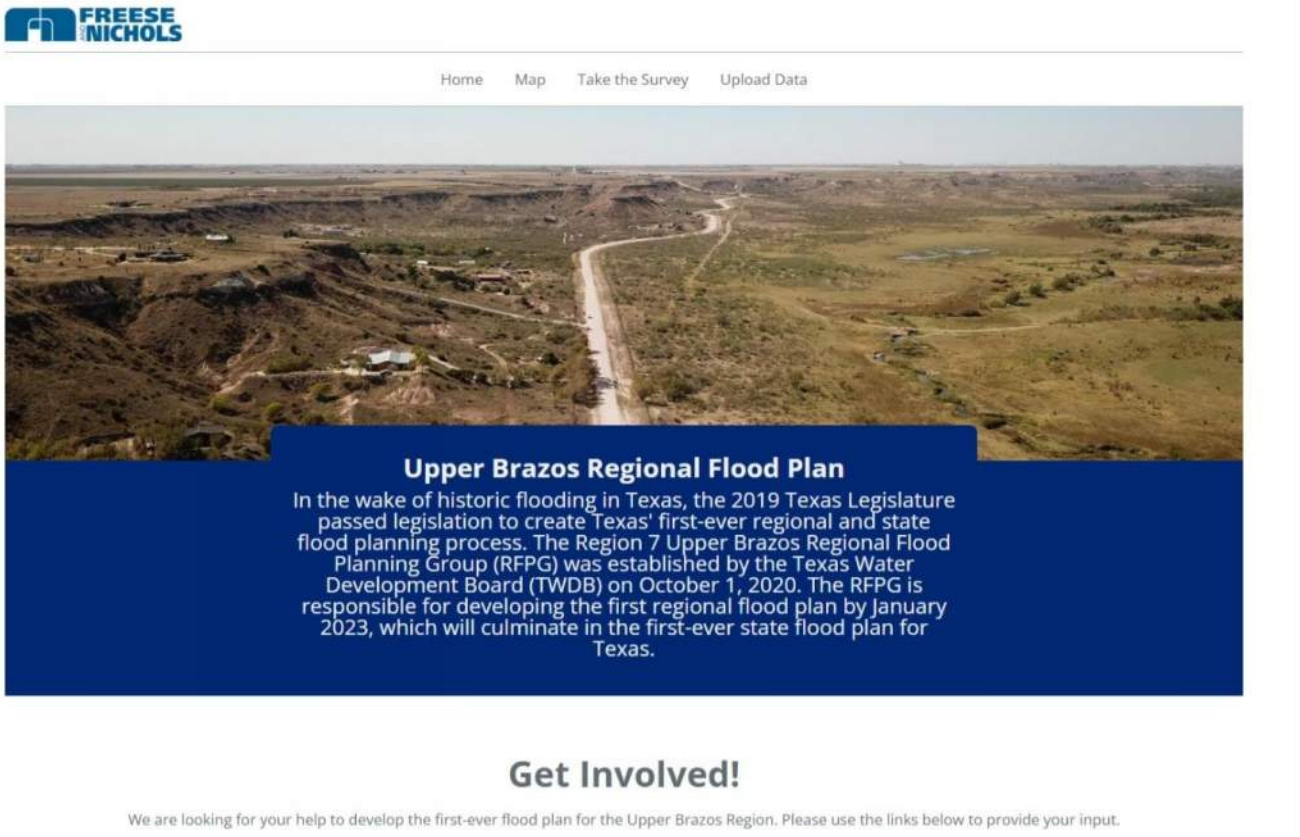


FIGURE 10-1 REGION 7 DATA COLLECTION SURVEY

In addition to the formal survey, the public also had access to an interactive web map to identify areas of flood risk, as well as existing flood mitigation project areas in the region. Finally, an online portal was provided for stakeholders to upload relevant data and information to contribute to the planning process.

Flood Management Action Outreach

The RFPG help in person outreach meetings with 43 Sponsors of identified FMEs, FMPs, and FMSs to obtain clarification regarding potentially feasible flood management or flood mitigation actions, such as locations or project descriptions. In some instances, these conversations produced additional insight as to the potential Sponsor's preferred action compared to other potential solutions previously considered in Task 4. In other cases, the potential Sponsors contacted the RFPG expressing interest in specific actions being considered for potential inclusion in the plan. Each outreach meeting followed the general agenda as shown below.

Outreach Agenda

Introduction to Flood Plan Process and Purpose
Review Maps

1. Tell us about the worst historical flood in your community
2. Are there any projects already in construction or completed as shown on the map?
3. Are there any high hazard or flood prone areas not shown on the map?
4. Are there any areas that you consider an emergency need?
5. Would you like the RFPG to study or evaluate this area of need?
6. Would you be willing to serve as a local sponsor of this project or study?
7. Would you be willing to be the local sponsor for the projects or studies shown on the map?
8. Are there any projects or studies not shown on the map?
9. Do you have H&H models for these studies or projects?
10. Do you have construction plans or an OPCC?
11. What funding do you have available for future and current planned projects?
    a. Regulations
12. How do you regulate floodplain areas?
13. Do you have ordinances to regulate floodplain areas?
14. How do you protect Playa Lakes? Do you allow modification of playas?
15. Do you have any wish list items that would help reduce flood risk in your community/county? And if so, would these wish list items need funding?
16. Would it help your community to have a regional flood authority to support the development, operation, and maintenance of floodplain management projects to reduce flood impacts?
17. Who is the best person within your organization to keep on our contact list?
18. Is there anyone else you know of we should speak to?
19. Would you be interested in collaborating with others on a county/regional level to develop projects that might benefit a larger area (such as an early flood warning system)?
    a. Conclusion
20. Would you like us to send over the region-wide floodplain management standards and the 5 and 10-year goals that the flood planning group has adopted? There is no requirement to

implement these, but there may be programs that could benefit your area and we'd like to gather your input.

Flood Risk Public Meeting

At least one meeting was required to identify flood risk in the region. The required public comment opportunity was made during the June and July 2021 planning group meetings. At this time, identified existing information on flood risk information was provided to the public to allow members of the public to identify any flood risk that are not captured. An interactive survey map was also available from the planning group website for the public to add comments on flood risk. Figure 10-2 shows a web capture of the public comment web map.

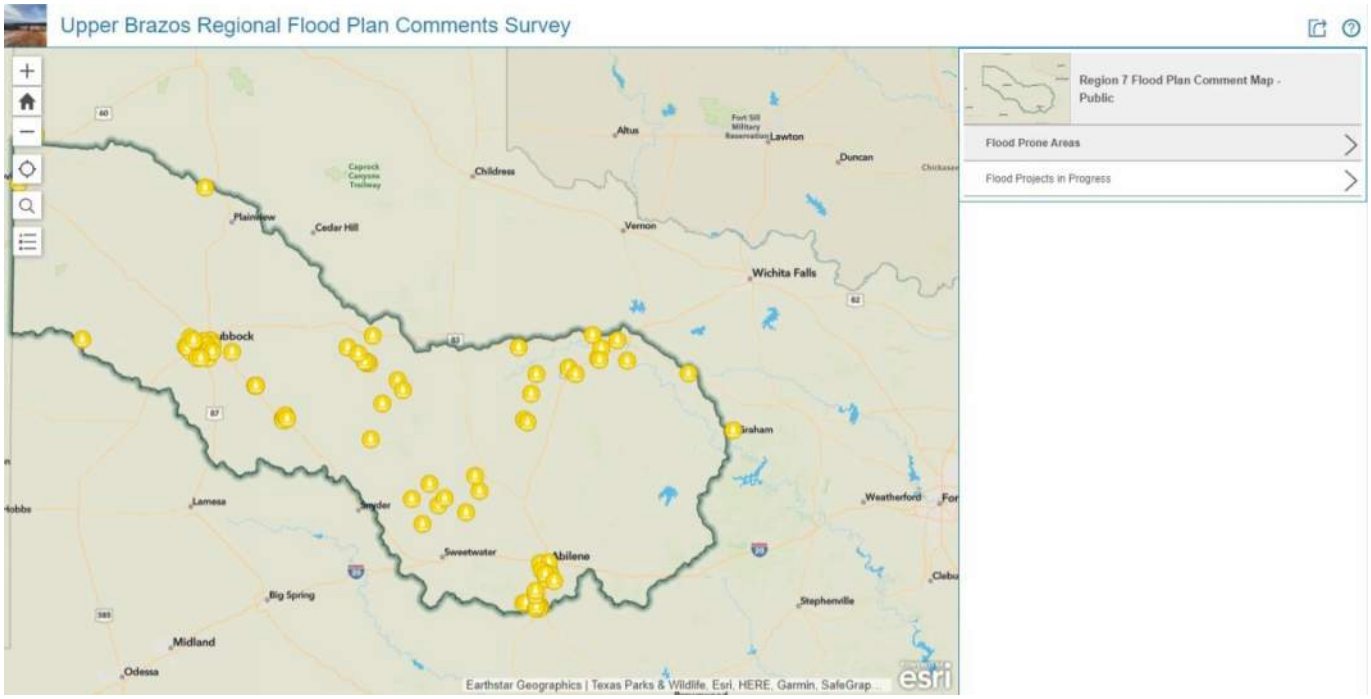


FIGURE 10-2 REGION 7 PUBLIC COMMENT WEB MAP

Draft Flood Plan Public Comment

The Draft Flood Plan public meeting was held in September 2022 to receive feedback to gather general suggestions and recommendations from the public as to issues, provisions, and types of FMSs, FMPs, and FMEs that should be considered or addressed or provisions that should be considered and potentially included during that regional flood planning cycle.

The RFPGs must adopt RFPs and accommodate public participation including soliciting public input and considering and, when appropriate, addressing comments made by the public including indicating whether changes to the plan were made in response to public comments, during the Plan adoption process in accordance with all administrative rules, the Contract, statute, and the RFPG bylaws. Draft Flood Plan comments were received from TWDB, TPWD, and USACE and can be found in Appendix D. A comment log with comment responses has also been provided in Appendix D.

Additional Public Outreach

The RFPG participated in several additional events in the region to introduce the Regional Flood Planning process to community stakeholders. These events included

- SPAG Board of Directors Meetings,
- SPAG Water Contingency Planning Meeting,
- WCTCOG Board of Directors Meetings, and
- Texas Municipal League Meeting.

Plan Adoption

The final plan has been developed and adopted in accordance with 31 TAC §361.50 and §361.60–.61 the flood planning guidance principles 31 TAC §361.20 (31 TAC §362.3). The regional flood plan adequately provides for the preservation of life and property and the development of water supply sources, where applicableThis plan satisfies each of the guidance principles including that the plan will not negatively affect a neighboring area. Table 10-2 below outlines each item in the scope of work and the location in the plan where the related information is located.

TABLE 10-2 SOW COMPLIANCE

Item	Task	SOW Task Name	Abbreviated Description of Deliverable	Location
1		Submission Req.	Two (2) double-sided hard copy and two (2) electronic copies (one in searchable PDF and one in Microsoft Word format).	07_Upper Brazos Draft Plan_Combined
2		Submission Req.	Certification that the draft RFP is complete and adopted by the RFPG (cover letter to the Executive Administrator).	Cover Letter
3		Submission Req.	A statement as to whether the RFPG met all requirements under the Texas Open Meetings Act and Public Information Act.	Adoption of Plan and Public Participation
4	10	Executive Summary	Executive summary documenting key findings.	EXECUTIVE SUMMARY
5	1	Planning Area Description	Planning area description	Character of the Upper Brazos Flood Planning Area
6	1	Entities	Completed feature class Entities	GIS Database
7	1	Watersheds	Completed feature class Watersheds	GIS Database
8	1	Existing Infrastructure	Assessment of existing major infrastructure and natural features including general description of conditions.	Assessment of Flood Infrastructure
9	1	Existing Infrastructure	Summary of existing flood infrastructure and natural features.	Appendix B Required Table 1
10	1	Existing Infrastructure	Completed feature class ExFldInfraPol	GIS Database
11	1	Existing Infrastructure	Completed feature class ExFldInfraLn	GIS Database
12	1	Existing Infrastructure	Completed feature class ExFldInfraPt	GIS Database
13	1	Existing Infrastructure	Map includes general information on condition of infrastructure.	Appendix A Required Map 1
14	1	Deficient Infrastructure	Map of Non-Functional or Deficient Flood Mitigation Features.	Appendix A Required Map 3
15	1	Previous Studies	A list of previous flood studies considered by the RFPG.	Table 1-13 List of Previous Flood Studies Relevant to the RFP
16	1	Existing Projects	Summary of proposed or ongoing flood mitigation projects.	Table 1-14 Existing Projects
17	1	Existing Projects	Summary of proposed or ongoing flood mitigation projects.	Appendix B Required Table 2
18	1	Existing Projects	Completed feature class ExFldProjs	GIS Database
19	1	Existing Projects	Map showing proposed or ongoing projects.	Appendix A Required Map 2
20	2A	Existing Hazard	Identify and compile a comprehensive outlook of existing condition flood hazards in the region.	Existing Conditions Flood Hazard Analysis

Item	Task	SOW Task Name	Abbreviated Description of Deliverable	Location
21	2A	Existing Hazard	Completed feature class ExFldHazard	GIS Database
22	2A	Existing Hazard	Existing Condition Flood Hazard map.	Appendix A Required Map 4
23	2A	Existing Gaps	Completed feature class Ex_Map_Gaps	GIS Database
24	2A	Existing Gaps	Existing Condition Flood Hazard – Gaps Mapping.	Appendix A Required Map 5
25	2A	Existing Exposure	Description of flood exposure analysis, including structures and population in the existing 1% and 0.2% floodplains identified	Existing Conditions Flood Exposure Analysis
26	2A	Existing Exposure	Summary table with findings summarizing flood risk by county.	Appendix B Required Table 3
27	2A	Existing Exposure	Completed feature class ExFldExpPol	GIS Database
28	2A	Existing Exposure	Completed feature class ExFldExpLn	GIS Database
29	2A	Existing Exposure	Completed feature class ExFldExpPt	GIS Database
30	2A	Existing Exposure	Completed feature class ExFldExpAll	GIS Database
31	2A	Existing Exposure	Map of existing condition flood exposure in the region.	Appendix A Required Map 6
32	2A	Existing Vulnerability	GIS coverage map of all existing features with high SVI (over 0.75).	Appendix A Required Map 7
33	2A	Model Coverage	Areas where H&H model results are already available.	Existing Hydrologic & Hydraulic (H&H) Model Availability
34	2A	Model Coverage	Completed feature class ModelCoverage	GIS Database
35	2A	Model Coverage	Map(s) showing where existing H&H models are available.	Appendix A Required Map 22
36	2B	Future Hazard	Identify and compile a comprehensive outlook of future condition flood hazards including how they will change from existing.	Future Conditions Flood Hazard Analysis
37	2B	Future Hazard	Summary table of findings from Task 2B.	Appendix B Required Table 5
38	2B	Future Hazard	Completed feature class FutFldHazard	GIS Database
39	2B	Future Hazard	Future Condition Flood Hazard.	Appendix A Required Map 8
40	2B	Future Map Gaps	Completed feature class Fut_Map_Gaps	GIS Database
41	2B	Future Map Gaps	Future Condition Flood Hazard - Gaps in Mapping	Appendix A Required Map 9
42	2B	Existing vs. Future Hazard	Extent of Increase of Flood Hazard Compared to Existing Condition.	Appendix A Required Map 10
43	2B	Future Exposure	General description, summary of identified items that are located withing the future flood hazard area.	Future Condition Flood Exposure Analysis
44	2B	Future Exposure	Completed feature class FutFldExpPol	GIS Database

Item	Task	SOW Task Name	Abbreviated Description of Deliverable	Location
45	2B	Future Exposure	Completed feature class FutFldExpLn	GIS Database
46	2B	Future Exposure	Completed feature class FutFldExPt	GIS Database
47	2B	Future Exposure	Completed feature class FutFldExpAll	GIS Database
48	2B	Future Exposure	Map of areas added to 1% and 0.2% ACE flood risk in the 30 years.	Appendix A Required Map 11
49	2B	Future Vulnerability	Map of all features with high SVI (over 0.75) in the region.	Appendix A Required Map 12
50	3A	Existing Management	General description and summary of existing floodplain management practices in the region.	Evaluation and Recommendations on Floodplain Management Practices
51	3A	Floodplain Management	Table of flood-related authorities in the region.	Appendix B Required Table 6
52	3A	Floodplain Management	Completed geodatabase table: ExFpMP	GIS Database
53	3A	Floodplain Management	Map of areas with established floodplain management practices.	Appendix A Required Map 13
54	3A	Management Recs	Summary of recommendations and/or adopted standards on Floodplain Management Practices.	Table 3-3 Region 7 Recommended Infrastructure Flood Protection Standards
55	3B	Goals	Written list defining the overarching flood mitigation and floodplain management goals for their regional flood plans.	Table 3-4 Region 7 Flood Mitigation And Floodplain Management Goals
56	3B	Goals	List of adopted flood mitigation and floodplain management goals.	Appendix B Required Table 11
57	3B	Goals	Limited fields of geodatabase table: Goals	GIS Database
58	4A	Needs Analysis	Summary of greatest knowledge gaps and known flood risk.	Needs Analysis Results
59	4A	Greatest Gaps	Map showing the greatest Gaps in Flood Risk Information.	Appendix A Required Map 14
60	4A	Greatest Risk	Map of areas with greatest flood risk in the region.	Appendix A Required Map 15
61	4B	FMS and FMP	Process used to identify potentially feasible FMSs and FMPs.	Process to Identify FMEs, FMPs, and FMSs
62	4B	Streams	Completed feature class Streams	GIS Database
63	4B	FME	Written list of potentially feasible FMEs	Evaluation of Potential FMEs
64	4B	FME	Potential Flood Management Evaluations identified by the RFPG	Appendix B Required Table 12
65	4B	FME	Completed feature class FME	GIS Database

Item	Task	SOW Task Name	Abbreviated Description of Deliverable	Location
66	4B	FME	A GIS coverage map showing the extent of all identified FMEs.	Appendix A Required Map 16
67	4B	FMP	Written list of potentially feasible FMPs.	Potentially Feasible FMPs
68	4B	FMP	List of FMPs that were identified but determined to be infeasible.	Table 4-13 Infeasible FMPs
69	4B	FMP	Potentially feasible flood mitigation projects identified by RFPG	Appendix B Required Table 13
70	4B	FMP	Completed feature class FMP	GIS Database
71	4B	FMP	Map showing the extent of Potential FMPs.	Appendix A Required Map 17
72	4B	FMS	Written list of potentially feasible FMSs.	Potentially Feasible FMSs
73	4B	FMS	List of FMSs that were identified but determined to be infeasible.	Potentially Feasible FMSs
74	4B	FMS	Potentially feasible FMSs.	Appendix B Required Table 14
75	4B	FMS	Completed feature class FMS	GIS Database
76	4B	FMS	Map showing the extent of Potential FMS.	Appendix A Required Map 18
77	5	FME Recs	Description and summary of the approach in recommending FMEs.	Flood Management Evaluations (FMEs)
78	5	FME Recs	List of the FMEs recommended by the RFPG.	Appendix B Required Table 15
79	5	FME Recs	Completed feature class FME	GIS Database
80	5	FME Recs	A GIS coverage map of recommended FMEs.	Appendix A Required Map 19
81	5	FMP Recs	Description and summary of the approach in recommending FMPs.	Flood Mitigation Projects (FMPs)
82	5	FMP Recs	A table of FMPs recommended by the RFPG.	Appendix B Required Table 16
83	5	FMP Recs	Completed feature class FMP	GIS Database
84	5	FMP Recs	A GIS coverage map of recommended FMPs.	Appendix A Required Map 20
85	5	FMP Details	Recommended FMP should have project details Tables 23-40.	GIS Database & Tables Folder
86	5	FMS Recs	Description and summary of the approach in recommending FMSs.	Flood Management Strategies (FMSs)
87	5	FMS Recs	A table of FMSs recommended by the RFPG.	Appendix B Required Table 17
88	5	FMS Recs	Completed feature class FMS	GIS Database
89	5	FMS Recs	A GIS coverage map of recommended FMSs.	Appendix A Required Map 21
90	6A	Impacts	The RFPGs must include a statement that the plan, when implemented, will not negatively affect neighboring areas located within or outside of the FPR.	Impact and Contribution of the Regional Flood Plan

Item	Task	SOW Task Name	Abbreviated Description of Deliverable	Location
91	6A	Impacts	The plan content should speak to the anticipated overall impacts of the plan on several categories.	Impacts of Regional Flood Plan
92	6B	Water Supply	All the recommended FMSs, or FMPs in the flood plan that, if implemented, would measurably contribute to water supply.	Table 6-8 Summary of FMS and FMP impacts to Water Supply
93	6B	Water Supply	Recommended FMS or FMP in the flood plan that, if implemented, would negatively impact and/or measurably reduce water supply.	Table 6-8 Summary of FMS and FMP impacts to Water Supply
94	7	Flood Response	The Plan must contain a written summary of the current state of flood preparedness in the region.	The Nature and Types of Flood Response Preparations
95	7	Flood Response	The Plan must also contain a written summary of entities involved and actions taken or planned for recovery from flood disasters.	Figure 7-1 Flood response Activity From Web Survey
96	8	Policy Recs	Legislative, regulatory, administrative, or other recommendations that can be implemented and support flood risk reduction.	Administrative, Regulatory, and Legislative Recommendations
97	9	Financing	Description of how data was collected, the effectiveness of the survey methodology, percentage of survey completions, and whether an acceptable min % survey completion was achieved.	Flood Infrastructure Financing Analysis
98	9	Financing	FMS, FMP, FME funding survey	Appendix B Required Table 19

REFERENCES

ASCE. 2021. 2021 Texas Infrastructure Report Card: https://infrastructurereportcard.org/wp-content/uploads/2016/10/2021-Texas-Infrastructure-Report-Card.pdf

ASTDR. 2022. CDC/ATSDR Social Vulnerability Index: https://www.atsdr.cdc.gov/placeandhealth/svi/index.html

FEMA. 2021. All Disasters Declarations: https://www.fema.gov/disaster/declarations

First Street Foundation. (2021). The 3rd National Risk Assessment: https://assets.firststreet.org/uploads/2021/09/The-3rd-National-Risk-Assessment-Infrastructure-on-the-Brink.pdf

Lubbock Online. 2010. Tests for Oil Keep Lake Alan Henry Closed. https://www.lubbockonline.com/story/news/local/2010/07/08/tests-oil-keep-lake-closed-2/15269562007/

NOAA. 2018. Texas Isopluvials of 100-year 24-hour Precipitation in inches: https://hdsc.nws.noaa.gov/pub/hdsc/data/tx/tx100y24h.pdf.

NOAA. 2021. National Centers for Environmental Information. Storm Events Database: https://www.ncdc.noaa.gov/stormevents/choosedates.jsp?statefips=48%2CTEXAS

NOAA. 2022. Atlas 14 Point Precipitation Frequency Estimates: (https://hdsc.nws.noaa.gov/hdsc/pfds/pfds_map_cont.html)

NOAA. 2022. Storm Events Database: https://www.ncdc.noaa.gov/stormevents/details.jsp

Office of the Texas State Climatologist. 2021. Climate Change Recommendations for Regional Flood Planning: https://climatexas.tamu.edu/files/CliChFlood.pdf

Railroad Commission of Texas. 2020. Oil & Gas Data Query: http://webapps2.rrc.texas.gov/EWA/ewaMain.do

Texas Almanac. 2021. Population History of Counties from 1850-2010: https://texasalmanac.com/sites/default/files/images/topics/ctypophistweb2010.pdf

Texas Department of Water Resources. 1979. Report 268 Erosion and Sedimentation by Water in Texas: https://www.twdb.texas.gov/publications/reports/numbered_reports/doc/R268/R268_opt.pdf

TWDB. 2021. Floodplain Quilt Prioritization: https://twdb-flood-planning-resources-twdb.hub.arcgis.com/pages/flood-quilt-pri

TWDB. 2022. 2022 State Water Plan: https://www.twdb.texas.gov/waterplanning/swp/2022/index.asp

TWDB. 2022. Exhibit C Tehcnical Guidelines for Regional Flood Planning: https://www.twdb.texas.gov/flood/planning/planningdocu/2023/index.asp

TWDB. 2022. Regional Water Plan Population & Water Demand Projections: https://www.twdb.texas.gov/waterplanning/data/projections/2022/popproj.asp

TWDB. 2022. Texas BLE Status: https://www.twdb.texas.gov/flood/mapping/ble-status-viewer.html

TxPCI. 2022. Playas Work for Texas: https://playasworkfortexans.com/

TxPCI. 2022. Texas Playa Conservation Initiative – Texan By Nature: https://texanbynature.org/projects/texas-playa-conservation-initiative/

U.S. Geological Survey. 2018. The U.S. Wind Turbine Database: https://eerscmap.usgs.gov/uswtdb/

US Census Bureau. 2018. 2018 County Business Patterns. Data Tables by Establishment Industry: https://www.census.gov/data/tables/2018/econ/susb/2018-susb-annual.html

USACE. 2020. Dams of Texas: https://nid.usace.army.mil/#/

USACE. 2022. National Levee Database: https://levees.sec.usace.army.mil/#/levees/system/1605885358/system

USDA, National Agricultural Statistics Service. 2020. 2020 Texas Cropland Data Layer: https://nassgeodata.gmu.edu/CropScape/

USDA. 2017. National Agricultural Statistics Service 2017 Census of Agriculture: https://www.nass.usda.gov/Publications/AgCensus/2017/Full_Report/Volume_1,_Chapter_2_County_Level/Texas/

USGS. 2004. Atlas of Depth-Duration Frequency of Precipitation Annual Maxima for Texas: https://pubs.usgs.gov/sir/2004/5041/pdf/sir2004-5041.pdf