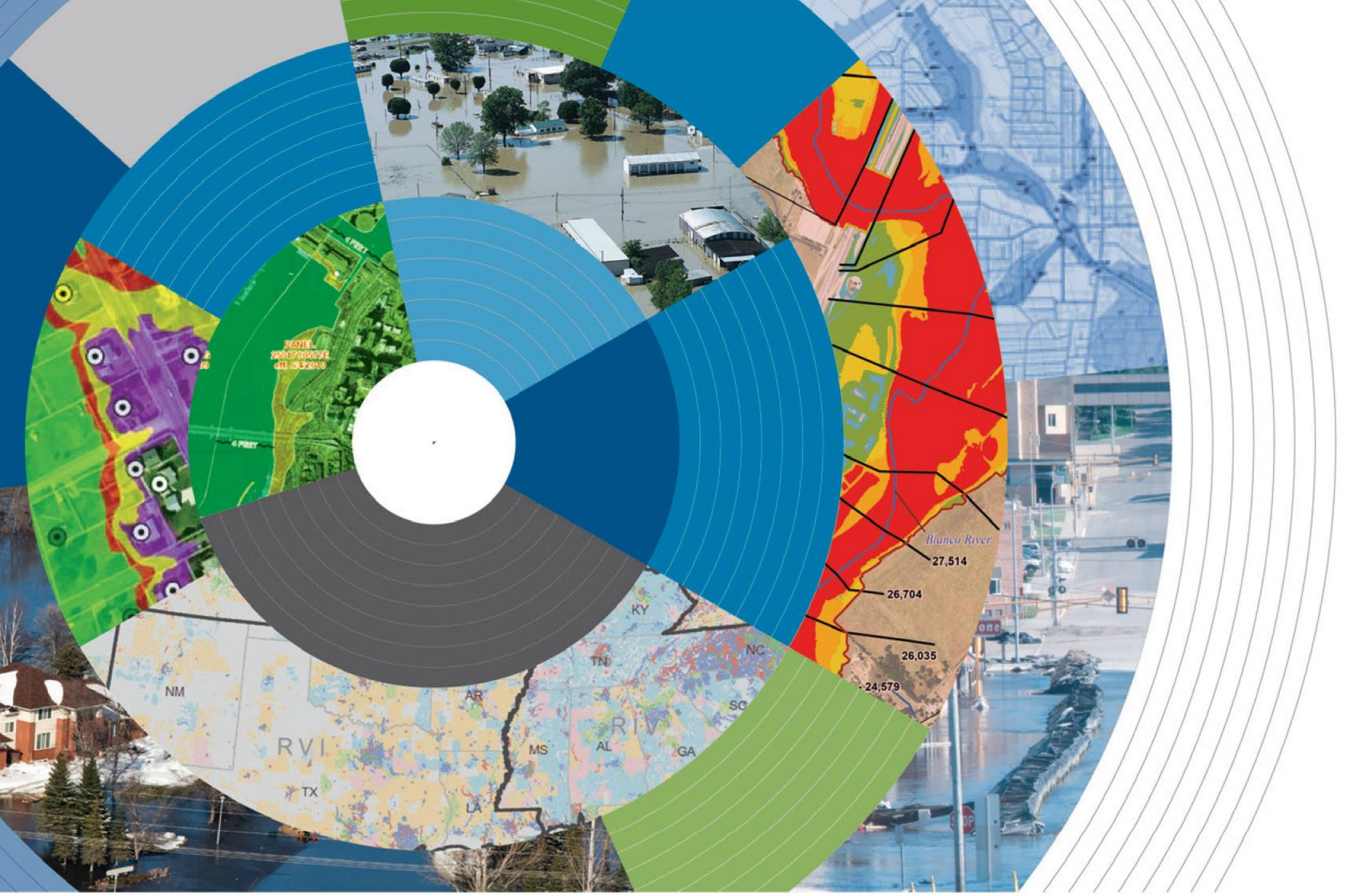


Flood Risk Report

Richland Watershed and Chambers Watershed

HUC-8s 12030108 and 12030109

August 2020

U.S. Department of Homeland Security

FEMA

Project Area Community List

Community Name
Ellis County (unincorporated areas)
Dallas County*
Freestone County (unincorporated areas)
Hill County (unincorporated areas)
Johnson County (unincorporated areas)
Limestone County (unincorporated areas)
Navarro County (unincorporated areas)
Town of Alma
City of Alvarado
City of Angus
City of Bardwell
City of Barry
Town of Blooming Grove
City of Burleson
Town of Bynum
Town of Carl's Corner
City of Cedar Hill
Town of Coolidge
City of Corsicana
Town of Dawson
Town of Emhouse
City of Ennis
City of Eureka
City of Frost
Town of Garrett
City of Grandview
City of Hubbard
Town of Italy

Community Name
City of Itasca
City of Keene
Town of Malone
City of Maypearl
Town of Mertens
City of Midlothian
Town of Mildred
Town of Milford
Town of Mustang
Town of Navarro
Town of Oak Valley
Town of Penelope
Town of Powell
Town of Retreat
City of Rice
Town of Richland
Town of Tehuacana
Town of Venus
City of Waxahachie

*The Dallas County Incorporated community in the project area is the City of Ennis.

Flood Risk Report History

Version Number	Version Date	Summary
v1.0	3/11/2020	Discovery and Flood Risk Report Draft

Preface

The Department of Homeland Security, Federal Emergency Management Agency's (FEMA) Risk Mapping, Assessment, and Planning (Risk MAP) program provides states and local communities with flood risk information, datasets, risk assessments, and tools that they can use to increase their resilience to flooding and better protect their residents. By pairing accurate floodplain maps with risk assessment tools and planning and outreach support, Risk MAP transforms the traditional flood mapping efforts into an integrated process of identifying, assessing, communicating, planning for, and mitigating flood-related risks.

The Flood Risk Report (FRR) is one of the tools created though the Risk MAP program. A FRR provides non-regulatory information to help local officials, floodplain managers, planners, emergency managers, and others. Local along with Federal and state officials can use the information in the FRR to establish a better understanding of their flood risk, take steps to mitigate those risks, and communicate those risks to residents and local businesses.

The FRR serves as a guide when communities update local hazard mitigation plans, community comprehensive plans, and emergency operations and response plans. It is meant to communicate risk to officials and inform them of the modification of development standards, as well as assist in identifying necessary or potential mitigation projects. The FRR extends beyond community limits to provide flood risk data for the Richland and Chambers watersheds.

Flood risk is always changing, and studies, reports, or other sources may be available that provide more comprehensive information. This report is not intended to be the regulatory nor the final authoritative source of all flood risk data in the watershed. Rather, it should be used in conjunction with other data sources to provide a comprehensive picture of flood risk within the project area.

Contents

Executive Summary

The Federal Emergency Management Agency's (FEMA) Risk Mapping, Assessment, and Planning (Risk MAP) program provides communities with flood information to help them understand their current flood risk and make informed decisions about taking action to become stronger and more resilient in the face of future risk. The Risk MAP process provides communities with new or improved information about their flood risk based on watershed models that use information from local, regional, State, and Federal sources. Communities can use the resulting tools and data to enhance mitigation plans and better protect their residents.

This report is one such tool for communities impacted by an updated flood hazard analysis of the Richland watershed and Chambers watershed. The FRR has two goals: (1) **inform communities of their risks** related to certain natural hazards, and (2) **enable communities to act** to reduce their risk. It is intended to assist Federal, State, and local officials with the following:

- Updating local hazard mitigation plans (HMPs) and community comprehensive plans;
- Updating emergency operations and response plans;
- Communicating risk;
- Informing the modification of development standards; and
- Identifying mitigation projects.

Most important, during this phase of the process, communities are encouraged to review the flood hazard changes closely and provide feedback to FEMA Region VI based on their local knowledge and any additional data available.

About the FEMA Risk Mapping, Assessment, and Planning (Risk MAP) Program

Flood risk is continually changing over time due to factors such as new building and development and weather patterns. The goal of FEMA's Risk MAP program is to work with Federal, state, tribal, and local partners to identify and reduce flood risk across communities. These projects are conducted using watershed boundaries and bring together multiple communities to identify broader mitigation actions and create consistency across the watershed. The program provides resources and support that are tailored to each community to help mitigate their risk and work towards a reduction in risk and future loss.

Through coordination and data sharing, the communities in the watershed work as partners in the mapping process. In addition to providing data, the communities can also provide insight into flooding issues and flood prevention within their areas. To prepare for a future study and assist in mitigation, FEMA provides several data sources, including information from the community, such as the following:

- Areas of repeated flooding and insurance claims
- Future development plans
- Areas of low water crossings
- High water marks from recent flooding events

- Areas of evacuation during high water
- Master drainage plans, flood risk reduction projects, and large areas of fill placement
- Local flood studies
- Other flood risk information

For more information about ways communities can take action or take advantage of available resources, please review the attached appendices.

FEMA provides communities with Base Level Engineering (BLE) data for select watersheds during the Risk MAP process. BLE is a form of automated hydrologic and hydraulic modeling which, when completed, can provide modeled flood hazard data in existing Zone As or where no effective flood hazard zone has been designated. Knowing the extent of flooding during the 1-percent-annual-chance flooding event supports both risk reduction efforts and more resilient community planning. Completed BLE data is provided to watershed communities for planning, risk communication, floodplain management, and permitting activities, and to inform future flood study needs. BLE is large scale watershed-based modeling that lacks the detail of Zone AE modeling such as road crossings and the effects of routing storage. BLE does not replace Zone AE data and should be used for comparison purposes only in these areas.

For the Richland watershed and Chambers watershed BLE datasets and products, see MIP case numbers 16-06-0366S (Richland) and 16-06-0367S (Chambers), or visit the Interagency Flood Risk Management (InFRM) estimated Base Flood Elevation (BFE) Viewer at https://webapps.usgs.gov/infrm/estBFE/. For a review of these BLE products, see Appendix II: Base Level Engineering Review Report.

About the Richland Watershed and Chambers Watershed

The North Central Texas Council of Governments (NCTCOG), Texas, became a FEMA Cooperating Technical Partner (CTP) in Fiscal Year 2004 (FY2004) and in FY2017 contracted with FEMA to provide Risk MAP Discovery for the Richland watershed and Chambers watershed, Texas. The project area covers the counties bounded by the Richland Hydrologic Unit Code 8 (HUC-8) watershed: Ellis, Freestone, Hill, Limestone and Navarro Counties and incorporated areas, and by the Chambers HUC-8 watershed: Dallas, Ellis, Hill, Johnson and Navarro Counties and incorporated areas. Locator maps covering the study area can be found in Figure 1 and in Appendix III of this report. BLE products were developed under FY2015 for Richland watershed (16-06-0366S) and Chambers watershed (16-06-0367S).

The first FEMA flood hazard mapping within the Richland watershed and Chambers watershed was released in the 1970s. As of 2019, all the participating communities, except Freestone County, in the Richland watershed and Chambers watershed have modernized countywide Digital Flood Insurance Rate Maps (DFIRMs) and Flood Insurance Study (FIS) Reports. Approximately 88 percent of the area in the Richland watershed and Chambers watershed is undeveloped; including grasslands, cropland, pastures and deciduous forest. Roughly seven percent of the area is developed, and the remaining five percent is open water. Over the past half century, the study area has experienced increased development and many flash floods. The City of Corsicana alone experienced eight severe flash floods in a 40-year period resulting in a total of approximately $20 million in property damages. The Memorial Day floods and Tropical Storm Bill of 2015 damaged roads and claimed lives throughout the Richland watershed and Chambers watershed, causing over $1 billion in damages.

In 2017, FEMA authorized NCTCOG to perform a Discovery and review of the Production and Technical Services (PTS) contractor, Compass, BLE Risk MAP Project data in the Richland watershed and Chambers watershed. The goal of the FY2017 project was to work closely with communities to better understand local flood risks, mitigation efforts, and other topics in order to spark watershed-wide discussions about increasing resilience to flooding.

Introduction

Flood Risk

Floods are naturally occurring phenomena that can and do happen almost anywhere. In its most basic form, a flood is an accumulation of water over a normally dry area. Floods become hazardous to people and property when they inundate an area where development has occurred, causing losses. Mild flood losses may have little impact on people or property, such as damage to landscaping or the accumulation of unwanted debris. Severe flood losses can destroy buildings and crops and cause severe injuries or death.

Calculating Flood Risk

It is not enough to simply identify where flooding may occur. Even if people know where a flood might occur, they may not know the level of flood risk in that area. The most common method for determining flood risk, also referred to as vulnerability, is to identify both the probability and the consequences of flooding:

> **Flood Risk** (or Vulnerability) **= Probability x Consequences**; where
>
> **Probability** = the likelihood of occurrence
>
> **Consequences** = the **estimated** impacts associated with the occurrence on life, property, and infrastructure

The probability of a flood is the likelihood that it will occur. The probability of flooding can change based on physical, environmental, and/or engineering factors. Factors affecting the probability that a flood will have an impact on an area range from changing weather patterns to the existence of mitigation projects. The ability to assess the probability of a flood, and the level of accuracy for that assessment, are also influenced by modeling methodology advancements, better knowledge, and longer periods of record for the body of water in question.

The consequences of a flood are the estimated impacts associated with its occurrence. Consequences relate to human activities within an area and how a flood affects the natural and built environment.

The FRR has two goals: (1) inform communities of their risks related to certain natural hazards, and (2) enable communities to act to reduce their risk. The information within this Risk Report is intended to assist Federal, State and local officials to:

- **Communicate risk** – Local officials can use the information in this report to communicate with property owners, business owners, and other residents about risks and areas of mitigation interest.
- **Update local HMPs and community comprehensive plans** – Planners can use risk information to develop and/or update HMPs, comprehensive plans, future land use maps, and zoning regulations. For example, zoning codes can be changed to provide for more appropriate land uses in high-hazard areas.
- **Update emergency operations and response plans** – Emergency managers can identify high-risk areas for potential evacuation and low-risk areas for sheltering. Risk assessment information may show vulnerable areas, facilities, and infrastructure for which continuity of operations plans, continuity of government plans, and emergency operations plans would be essential.

- **Inform the modification of development standards –** Planners and public works officials can use information in this report to support the adjustment of development standards for certain locations.
- **Identify mitigation projects –** Planners and emergency managers can use this risk assessment to determine specific mitigation projects of interest. For example, a floodplain manager may identify critical facilities that need to be elevated or removed from the floodplain.

This FRR focuses on the FY2017 Risk MAP Discovery and the FY2015 BLE projects. It showcases risk assessments, which analyze how a flood hazard affects the built environment, population, and local economy to identify mitigation actions and develop mitigation strategies.

The information in this report should be used to identify areas for mitigation projects as well as for additional efforts to educate residents on the hazards that may affect them. The areas of greatest hazard impact are identified in the Areas of Mitigation Interest section of this report, which can serve as a starting point for identifying and prioritizing actions a community can take to reduce its risks.

Watershed Basics

Background

The Richland watershed and Chambers watershed are located in North Texas and cover portions of Dallas, Ellis, Freestone, Hill, Johnson, Limestone, and Navarro Counties. The watersheds encompass 46 communities covering approximately 1,991 square miles (sq. mi). See Figure 1 for a location map of the Richland watershed and Chambers watershed.

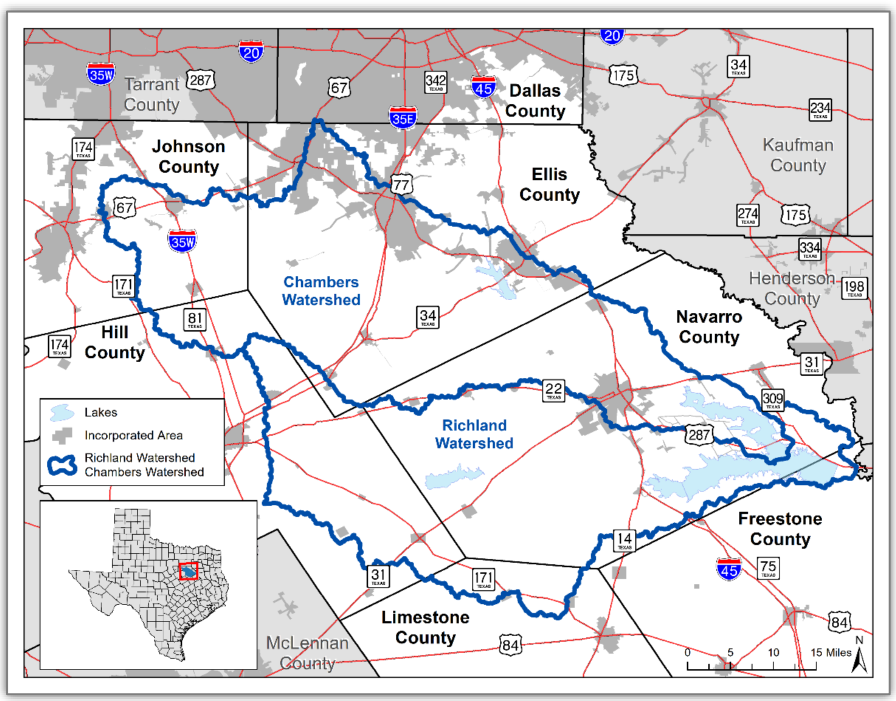


Figure 1: Overview map for the Richland watershed and Chambers watershed

The Richland watershed and Chambers watershed are mainly in the Blackland Prairie ecoregion, which consists of equal parts of cropland and grassland. Crops grown in this region are cotton, grain sorghums, corn, wheat, oats, and hay. Grassland in this region is mostly improved pastures with shallower and steeper soils. Bottomland soils in the Blackland Prairie are black alkaline soils. Some soils in the western portion are shallow to moderately deep over chalk. Blackland Prairie's surface drainage is moderate to rapid. The western edge of the Chambers watershed is in the Eastern Cross Timbers ecoregion, which is mainly wooded land, grasslands, sandstone-capped hills, and pastures. Crops grown in this region are peanuts, grain sorghums, small grains, peaches, pecans, and vegetables. The bottomland soils are reddish brown to dark gray and slightly acid loams. Eastern Cross Timbers' surface runoff is moderate to rapid. The eastern edge of the Chambers watershed and the eastern portion of the Richland watershed is in the Claypan ecoregion, also known as the Post Oak Belt, which is mainly rangeland and improved pastures. Crops grown in this region are cotton, grain sorghums, corn, hay, and forage crops. Upland soils are thin, light-colored, and acid sandy loam over dense multicolored clay.

The Richland watershed and Chambers watershed have approximately 340 dams which are primarily used for flood control. These dams provide other benefits such as irrigation for agriculture, recreation, fire protection, and water supply. Most dams are owned either by the local government or local government agency, but some are privately owned dams. Seven percent of these dams are classified as low hazard dams. The Natural Resources Conservation Service (NRCS) has an estimated 278 dams in the study watersheds. These NRCS dams are mainly used for flood control, prevent erosion damage, improve water supply and irrigation, and also create a habitat for wildlife. The largest dam is the Richland Creek Dam, which was completed in 1987 and is used for water supply and recreation. There are 29 levees in the Richland watershed and Chambers watershed, but none are accredited by FEMA.

Intense, localized thunderstorms and frontal-type storms in spring and summer cause most of the flooding issues in Richland watershed and Chambers watershed. Flash flooding occurs throughout these watersheds, with the clay subsoils often eroding during large rain events. Hill County has minimal flooding issues due to its 58 flood control dams in the study watersheds. Navarro County has the most flood events in the Richland watershed and Chambers watershed, many of which occur in the City of Corsicana.

The most significant recorded historical flood events are in the City of Corsicana and these areas are likely to become more vulnerable over time. Post Oak Creek and Mesquite Branch are located within the City of Corsicana and could see increased runoff due to the increased urbanization in the City of Corsicana. Likewise, in the unincorporated areas of Navarro County, increased runoff from storm events due to increased impervious surfaces can change the areas most susceptible to flooding. Chambers Creek is the only stream in Navarro County with recorded levee failure within the study watersheds. The Navarro LID 10 (Chambers LB levee) and Navarro LID 11 (Chambers LB levee) failed in October 2015, closing multiple roads and bridges.

Limestone County has the least amount of flood damage on average within the Richland watershed and Chambers watershed. The majority of Navarro County's flooding occurs along Post Oak Creek, Rice Branch Creek, and Mesquite Branch, with an average of one and a half years between successive flood events. Both Navarro County and Ellis County contain several streams in the study watersheds that are near population centers and developed areas, increasing their risks during flood events. Lake Halbert, located within Navarro County, and Lake Waxahachie, located within Ellis County, serve only as a water source

Population

A review of land cover changes and population growth patterns in the watersheds revealed that significant development occurred from 2010 to 2017 in many cities in Ellis and Navarro Counties. The Cities of Angus, Frost, Grandview, and Midlothian; and the Towns of Bynum, Emhouse, and Retreat all increased in population between 20 to 36 percent. The City of Frost had the biggest population increase of 36 percent in the Richland watershed and the Town of Bynum had the biggest population increase of 31 percent in the Chambers watershed.

Since 2017, 60 percent of communities within the study watersheds have experienced population growth. However, 18 communities; the Cities of Corsicana, Itasca, Maypearl; and Towns of Alma, Carl's Corner, Coolidge, Dawson, Italy, Malone, Mertens, Milford, Mustang, Navarro, Penelope, Powell, Richland, Retreat, and Tehuacana; and the unincorporated areas of Limestone County have declined in population since 2010, with the Town of Powell serving 55 percent fewer people.

Excluding the combined areas of previously developed land and open water, roughly 812 sq. mi. of the Richland watershed and 937 sq. mi. of the Chambers watershed still has the potential for new construction. Using the average annual growth rate for the cities and unincorporated county areas in the project watersheds, the total population within the watersheds have the potential to substantially rise by 2023. Therefore, the probability is high that populated areas will expand, and some rural land will be developed, thereby increasing impervious areas.

Watershed Land Use

The majority of Richland watershed and Chambers watershed are undeveloped, rural areas. The urban areas within these two watersheds are along the northern and southern borders. The 40 cities range in population between 100 to over 264,000. On the western and central portions of the study watersheds, the land is mainly rural with land use mainly for agriculture, pastures, and deciduous forests. Ellis County has two walking trails along Waxahachie Creek and offers many aquatic features in Lake Bardwell and Lake Waxahachie. Oil and gas exploration sites are plentiful throughout the watershed, with the largest concentration in Navarro County at the Corsicana oilfield. Although most of the study watersheds land is undeveloped as of 2017, it will likely have steady growth due to lower housing costs in the Dallas-Fort Worth (DFW) and Corsicana metroplexes compared to other areas in the nation. The communities in Ellis, Johnson, and Navarro counties are manufacturing and government centers, with many residents of the rural areas of the watershed commuting in for employment.

Table 1: Population and Area Characteristics [1]

Risk MAP Project	Total Population in Study Area (2017)	Average % Population Growth/Yr (2017-2023)	Predicted Population (by 2023)	Land Area	Developed Area	Open Water
Richland Watershed (HUC-8 12030108)	23,536	0.20	23,777	917* sq. mi.	49 sq. mi.	56 sq. mi.
Chambers Watershed (HUC-8 12030109)	143,698	0.72	148,842	1,075* sq. mi.	100 sq. mi.	38 sq. mi.

*Total Land Area includes land and water.

National Flood Insurance Program Status and Regulation

To be a participant in NFIP, all interested communities must adopt and submit floodplain management ordinances that meet or exceed the minimum NFIP regulations. These regulations can be found in the Code of Federal Regulations and most of the community ordinance requirements are in Title 44 parts 59 and 60. The level of regulation depends on the level of information available and the flood hazards in the area. The levels are as follows:

- A: The Federal Emergency Management Agency (FEMA) has not provided any maps or data – 60.3(a)
- B: Community has maps with approximate A zones – 60.3(b)
- C: Community has a Flood Insurance Rate Map (FIRM) with Base Flood Elevations (BFE) – 60.3(c)
- D: Community has a FIRM with BFEs and floodways – 60.3(d)
- E: Community has a FIRM that shows coastal high hazard areas (V zones) – 60.3(e)

To help mitigate the risk to areas where increased population and development are expected, communities can adopt (or exceed) the minimum standards of the National Flood Insurance Program (NFIP). This is recommended as a proactive strategy to manage construction within the floodplain and avoid negative impacts to existing and future development. The Association of State Floodplain Managers (ASFPM) No Adverse Impact Floodplain Management is a good example.

To increase mitigation efforts and community flood awareness through potentially discounted premium rates, an NFIP community that has adopted more stringent ordinances or is actively completing mitigation and outreach activities is encouraged to consider joining the Community Rating System (CRS). The CRS is a voluntary incentive-based program that recognizes and encourages community floodplain management activities that exceed the minimum NFIP requirements. Flood insurance premium rates are discounted to reflect the reduced flood risk resulting from the community actions.

All communities within the project area, except the Cities of Angus, and Eureka; and the Towns of Alma, Bynum, Carl's Corner, Emhouse, Garrett, Mustang, Navarro, Oak Valley, Penelope, Retreat, and Tehuacana, have a level of regulation suitable for managing floodplains with mapped regulatory

[1] Data obtained from the U.S. Census Bureau; ESRI Demographic 5-year Projections; and National Land Cover Database

floodways and Base (1-percent-annual-chance) Flood Elevations (44 CFR 60.3(d)). The Cities of Angus and Eureka; and the Towns of Alma, Bynum, Carl's Corner, Emhouse, Garrett, Mustang, Navarro, Oak Valley, Penelope, Retreat, and Tehuacana do not participate in the NFIP and, therefore, do not have any regulation for managing at any level for non-coastal areas (44 CFR 60.3(a-d)).

Communities can review their current ordinances and reflect potential flood hazard changes by adopting updated ordinances early. This action can reduce future flood losses by affecting how substantial improvements or new construction are regulated.

Hazard Mitigation Plan

State and local governments must develop and adopt HMPs to be eligible for certain types of funding. To remain eligible, communities need to update and resubmit their plans every five years for FEMA approval. Hazard mitigation plans are created to increase education and awareness, identify strategies for risk reduction, and identify other ways to develop long-term strategies to reduce risk and protect people and property.

As of February 2020, Freestone County, the Cities of Angus, Barry, Eureka, Frost, Grandview, and Rice; the Towns of Blooming Grove, Carl's Corner, Dawson, Emhouse, Mildred, Mustang, Oak Valley, Powell, and Richland do not have HMPs. Ellis County and the Cities of Bardwell, Ennis, Maypearl, Midlothian, and Waxahachie, the Towns of Alma, Garrett, Italy, and Milford participate in the Ellis County HMP, which is set to expire in January 2021. Hill County and the Cities of Hubbard and Itasca; the Towns of Bynum, Malone, Mertens, and Penelope are awaiting approval of the Hill County HMP. Johnson County and the Cities of Alvarado, Burleson, and Keene participate in the Johnson County HMP, which is set to expire in September 2020. Limestone County and the Towns of Coolidge and Tehuacana are awaiting approval of the Limestone County HMP. Navarro County and the City of Corsicana participate in the Navarro County HMP, which is set to expire in July 2020. The City of Cedar Hill participates in the Dallas County HMP, which is set to expire in December 2020.

Hazard Mitigation Plans effectively allow for FEMA to assess hazards identified through local, state, and federal partnerships and mitigation action items that communities have identified. These HMPs were used in the compilation and preparation of this report.

Community Rating System

The Community Rating System (CRS) is a voluntary incentive-based program that recognizes and encourages community floodplain management activities that communities undertake in addition to the minimum requirements they must meet when joining the NFIP. Individuals that carry flood insurance in a community that participates in the CRS program can receive a discount on their flood insurance premium. Discounts can range from 5 to 45 percent. The City of Burleson in Johnson County is the only CRS participating community in the two study watersheds. Table 2 depicts NFIP and CRS participation status and provides an overview of the effective flood data availability.

Table 2: NFIP and CRS Participation [2]

Risk MAP Project	Participating NFIP Communities/ Total Communities	Number of CRS Communities	CRS Rating Class Range	Average Years since FIRM Update	Level of Regulations (44 CFR 60.3)
Richland Watershed (HUC-8 12030108)	16/26	0	N/A	6	44 CFR 60.3(d)
Chambers Watershed (HUC-8 12030109)	24/29	1	9	6	44 CFR 60.3(d)

Flood Insurance Rate Maps (FIRMs)

The average age of the effective FIRMs within the study watersheds is 6 years. The oldest effective map is in Freestone County; it is 13 years old and has an effective date of September 1, 2007. The newest effective maps in Hill County are less than a year old and have an effective date of December 20, 2019. As of 2020, all communities except for Freestone County and its municipalities in the watershed have modernized digital county-wide effective DFIRMs.

Dams

Richland watershed and Chambers watershed have abundant water resources. Several dams along numerous streams in the watershed are used to maintain water storage, control flooding, or divert flow. As recorded by the United States Army Corps. of Engineers (USACE) National Inventory of Dams (NID) datasets and the FEMA DFIRM databases, there are approximately 340 dams within the study watersheds, with 317 of these dams classified as high-hazard dams. For these high-hazard dams, the owners and operators are required to develop and maintain Emergency Action Plans (EAP) to reduce the risk of loss of life and property if the dam fails. Figure 2 below shows locations of dams in the study watershed.

[2] Data obtained from FEMA Community Information Systems.

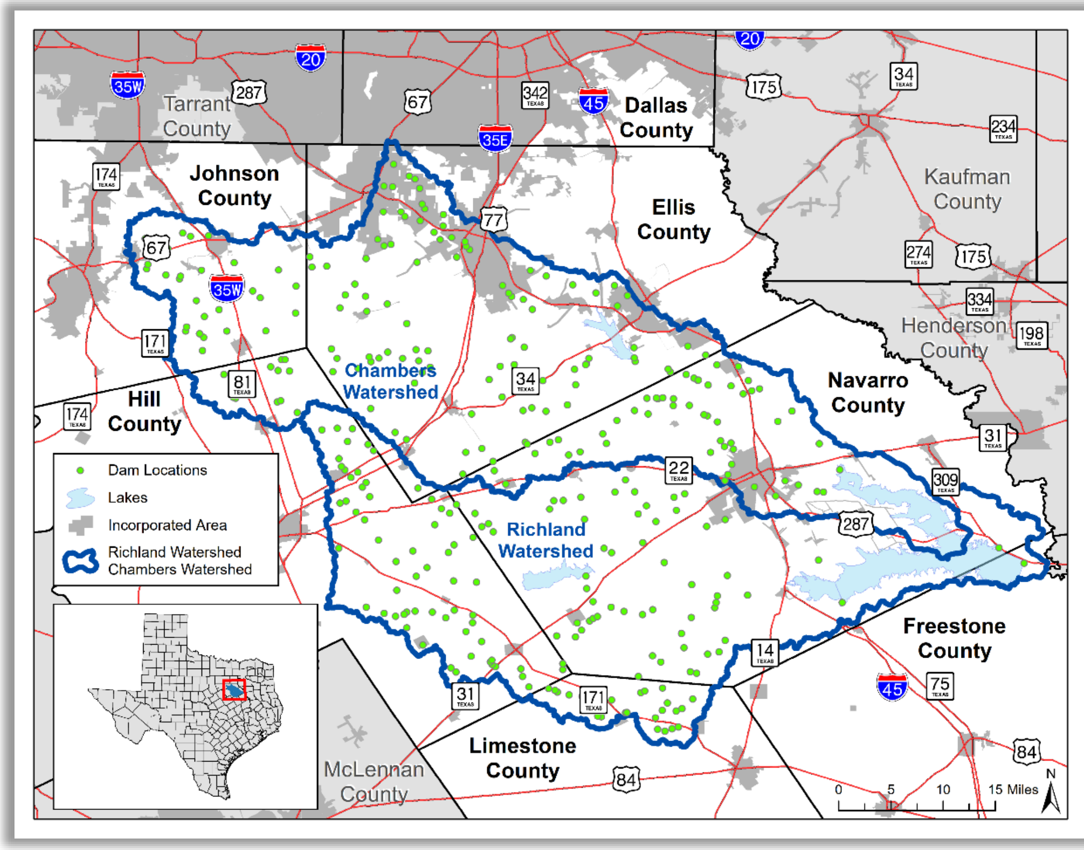


Figure 2: Dam Location Map for Richland watershed and Chambers watershed

Table 3 provides the characteristics of the dams identified in the project area. The Richland Creek Dam is the largest dam in the watershed, storing 1,743,000 acre-feet of water.

Table 3: Risk MAP Project Dam Characteristics[3]

Risk MAP Project	Total Number of Identified Dams	Number of Dams Requiring EAP	Percentage of Dams without EAP	Average Years since Inspection	Average Storage (acre-feet)
Richland Watershed (HUC-8 12030108)	147	144	97.1%	22	74,561
Chambers Watershed (HUC-8 12030109)	193	173	73.4%	13	7,037

[3] Data obtained from USACE National Inventory of Dams

Project Phases and Map Maintenance

Background

FEMA manages several risk analysis programs, including Flood Hazard Mapping, National Dam Safety, the Earthquake Safety Program, Multi-Hazard Mitigation Planning, and the Risk Assessment Program, all of which assess the impact of natural hazards and lead to effective strategies for reducing risk. These programs support the Department of Homeland Security's objective to "strengthen nationwide preparedness and mitigation against natural disasters."

FEMA manages the NFIP, which is the cornerstone of the national strategy for preparing American communities for flood hazards. In the nation's comprehensive emergency management framework, the analysis and awareness of natural hazard risk remains challenging. A consistent risk-based assessment approach and a robust communication system are critical tools to ensure a community's ability to make informed risk management decisions and take mitigation actions. Flood hazard mapping is a basic and vital component for a prepared and resilient nation.

> *Flood-related damage between 1980 and 2013 totaled $260 billion, but the total impact to our Nation was far greater—more people lose their lives annually from flooding than any other natural hazard.*
>
> *FEMA, "Federal Flood Risk Management Standard (FFRMS)" (2015)*

In Fiscal Year 2009, FEMA's Risk MAP program began to synergize the efforts of Federal, state, and local partners to create timely, viable, and credible information identifying natural hazard risks. The intent of the Risk MAP program is to share resources to identify the natural hazard risks a community faces and ascertain possible approaches to minimizing them. Risk MAP aims to provide technically sound flood hazard information to be used in the following ways:

- To update the regulatory flood hazard inventory depicted on FIRMs and the National Flood Hazard Layer
- To provide broad releases of data to expand the identification of flood risk (flood depth grids, water-surface elevation grids, etc.)
- To support sound local floodplain management decisions
- To identify opportunities to mitigate long-term risk across the nation's watersheds

How are FEMA's Flood Hazard Maps Maintained?

FEMA's flood hazard inventory is updated through several types of revisions.

Community-submitted Letters of Map Change (LOMCs). First and foremost, FEMA relies heavily on the local communities that participate in the NFIP to carry out the program's minimum requirements. These requirements include the obligation for communities to notify FEMA of changing flood hazard information and to submit the technical supporting data needed to update the FIRMs.

Although revisions may be requested at any time to change information on a FIRM, FEMA generally will not revise an effective map unless the changes involve modifications to SFHAs. Be aware that the best floodplain management practices and proper assessments of risk result when the flood hazard maps present information that accurately reflects current conditions.

> *Under the current minimum NFIP regulations, a participating community commits to notifying FEMA if changes take place that will affect an effective FIRM no later than 6 months after project completion.*
>
> *Section 65.3, Code of Federal Regulations*

Letters of Map Amendment (LOMAs). The scale of an effective FIRM does not always provide the information required for a site-specific analysis of a property's flood risk. FEMA's LOMA process provides homeowners with an official determination on the relation of their lot or structure to the SFHA. Requesting a LOMA may require a homeowner to work with a surveyor or engineering professional to collect site-specific information related to the structure's elevation; it may also require the determination of a site-specific BFE. Fees are associated with collecting the survey data and developing a site-specific BFE. Local surveying and engineering professionals usually provide an Elevation Certificate to the homeowner, who can use it to request a LOMA. A successful LOMA may remove the Federal mandatory purchase requirement for flood insurance, but lending companies may still require flood insurance if they believe the structure is at risk.

FEMA-Initiated Flood Risk Project. Each year, FEMA initiates a number of Flood Risk Projects to create or revise flood hazard maps. Because of funding constraints, FEMA can study or restudy only a limited number of communities, counties, or watersheds each year. As a result, FEMA prioritizes study needs based on a cost-benefit approach whereby the highest priority is given to studies of areas where development has increased and the existing flood hazard data has been superseded by information based on newer technology or changes to the flooding extent. FEMA understands communities require products that reflect current flood hazard conditions to best communicate risk and implement effective floodplain management.

Flood Risk Projects may be delivered by FEMA or one of its Cooperating Technical Partners (CTPs). The CTP initiative is an innovative program created to foster partnerships between FEMA and participating NFIP communities, as well as regional and state agencies. Qualified partners collaborate in maintaining up-to-date flood maps. In FEMA Region 6, which includes the State of Texas, CTPs are generally statewide agencies that house the State Floodplain Administrator. However, some Region 6 CTPs are also large river authorities, flood control districts, regional planning agencies, or cities. They provide enhanced coordination with local, state, and Federal entities, engage community officials and technical staff, and provide updated technical information that informs the national flood hazard inventory.

Risk MAP has modified FEMA's project investment strategy from a single investment by fiscal year to a multi-year phased investment, which allows the FEMA to be more flexible and responsive to the findings of the project as it moves through the project lifecycle. Flood Risk Projects are funded and completed in phases.

General Flood Risk Project Phases

Each phase of the Flood Risk Project provides both FEMA and its partner communities with an opportunity to discuss the data that has been collected and to determine a path forward. Local engagement throughout each phase enhances the opportunities for partnership, furthers the discussion on current and future risk, and helps identify local projects and activities to reduce long-term natural hazard risk.

Flood Risk Projects may be funded for one or more of the following phases:

- Phase Zero – Investment
- Phase One – Discovery
- Phase Two – Risk Identification and Assessment
- Phase Three – Regulatory Product Update

Local input is critical throughout each phase of a Flood Risk Project. More details about the tasks and objectives of each phase are included below.

Phase Zero: Investment

Phase Zero of a Flood Risk Project initiates FEMA's review and assessment of the inventories of flood hazards and other natural hazards within a watershed area. During the Investment Phase, FEMA reviews the availability of information to assess the current floodplain inventory. FEMA maintains several data systems to perform watershed assessments and selects watersheds for a deeper review of available data and potential investment tasks based on the following factors:

Availability of High-Quality Ground Elevation Data. FEMA reviews readily available and recently acquired ground elevation data. This information helps identify development and earth-moving activities near streams and rivers. Where necessary, FEMA may partner with local, state, and other federal entities to collect necessary ground elevation information within a watershed.

If high-quality ground elevation data is both available for a watershed area and compliant with FEMA's quality requirements, FEMA and its mapping partners may prepare engineering data to assess, revise, replace, or add to the current flood hazard inventory.

Mile Validation Status within Coordinated Needs Management Strategy (CNMS). FEMA uses the CNMS database to track the validity of the flood hazard information prepared for the NFIP. The CNMS database reviews 17 criteria to determine whether the flood hazard information shown on the current FIRM is still valid.

Communities may also inform and request a review or update of the inventory through the CNMS website at https://msc.fema.gov/cnms/. The CNMS Tool Tutorial provides an overview of the online tool and explains how to submit requests.

Local Hazard Mitigation Plans. Reviewing current and historic hazard mitigation plans provides an understanding of a community's comprehension of its flood risk and other natural hazard risks. The mitigation strategies within a local hazard mitigation plan provide a lens to local opportunities and underscore a potential for local adoption of higher standards related to development or other actions to reduce long-term risk.

Cooperating Technical Partner State Business Plans. In some states, a CTP generates an annual state business plan that identifies future Flood Risk Project areas that are of interest to the state. The Texas Water Development Board and the Texas Natural Resources Information System work to develop user-friendly data. In this project area, FEMA has worked closely with both entities to develop the project scope and determine the necessary project tasks.

Communities that have identified local issues are encouraged to indicate their data needs and revision requests to the State CTP so that they can be prioritized and included in the State Business Plans.

Possible Investment Tasks. After a review of the data available within a watershed, FEMA may choose to (1) purchase ground elevation data and/or (2) create some initial engineering modeling against which to compare the current inventory, also known as BLE modeling.

Phase One: Discovery

Phase One, the Discovery Phase, provides opportunities both internally (between the state and FEMA) and externally (with communities and other partners interested in flood potential) to discuss local issues with flooding and examine possibilities for mitigation action. This effort is made to determine where communities currently are with their examination of natural hazard risk throughout their community and to identify how state and Federal support can assist communities in achieving their goals.

The Discovery process includes an opportunity for local communities to provide information about their concerns related to natural hazard risks. Communities may continue to inform the project identification effort by providing previously prepared survey data, as-built stream crossing information, and engineering information.

For a holistic community approach to risk identification and mapping, FEMA relies heavily on the information and data provided at the local level. Flood Risk Projects are focused on identifying (1) areas where the current flood hazard inventory does not provide adequate detail to support local floodplain management activities, (2) areas of mitigation interest that may require more detailed engineering information than is currently available, and (3) community intent to reduce the risk throughout the watershed to assist FEMA's future investment in these project areas. Watersheds are selected for Discovery based on these evaluations of flood risk, data needs, availability of elevation data, Regional knowledge of technical issues, identification of a community-supported mitigation project, and input from Federal, state, and local partners.

Possible Discovery Tasks. Discovery may include a mix of interactive webinar sessions, conference calls, informational tutorials, and in-person meetings to reach out to and engage with communities for input. Data collection, interviews, and interaction with community staff and data-mining activities provide the basis for watershed-, community-, and stream-level reviews to determine potential projects that may benefit the communities. A range of analysis approaches are available to determine the extent of flood risk along streams of concern. FEMA and its mapping partners will work closely with communities to determine the appropriate analysis approach, based on the data needs throughout the community.

These potential projects may include local training sessions, data development activities, outreach support to local communities wanting to step up their efforts, or the development of flood risk datasets within areas of concern to allow a more in-depth discussion of risk.

Phase Two: Risk Identification and Assessment

Phase Two (Risk Identification and Assessment) continues the risk awareness discussion with communities through watershed analysis and assessment. Analyses are prepared to review the effects of physical and meteorological changes within the project watershed. The new or updated analysis provides an opportunity to identify how development has affected the amount of stormwater generated during a range of storm probabilities and shows how effectively stormwater is transported through communities in the watershed.

Coordination with a community's technical staff during engineering and model development allows FEMA and its mapping partners to include local knowledge, based on actual on-the-ground experience, when selecting modeling parameters.

The information prepared and released during Phase Two is intended to promote better local understanding of the existing flood risk by allowing community officials to review the variability of the risk throughout their community. As FEMA strives to support community-identified mitigation actions, it also looks to increase the effectiveness of community floodplain management and planning practices, including local hazard mitigation planning, participation in the NFIP, use of actions identified in the CRS Manual, risk reduction strategies for repetitive loss and severe repetitive loss properties, and the adoption of stricter standards and building codes.

FEMA is eager to work closely with communities and technical staff to determine the current flood risk in the watershed. During the Risk Identification and Assessment phase, FEMA would like to be alerted to any community concerns related to the floodplain mapping and analysis approaches being taken. During this phase, FEMA can engage with communities and review the analysis and results in depth.

Possible Risk Identification and Assessment Tasks. Phase Two may include a mixture of interactive webinars, conference calls, informational tutorials, and in-person meetings to reach out to and engage with communities for input. Flood Risk Project tasks may include hydrologic or hydraulic engineering analysis and modeling, floodplain mapping, risk assessments using Hazus-Multi Hazard software, and preparation of flood risk datasets (water-surface elevation, flood depth, or other analysis grids). Additionally, projects may include local training sessions, data development activities, outreach support to local communities that want to step up their efforts, or the development of flood risk datasets within areas of concern to allow a more in-depth discussion of risk.

Phase Three: Regulatory Products Update

If the analysis prepared in the previous Flood Risk Project phases indicates that physical or meteorological changes in the watershed have significantly changed the flood risk since the last FIRM was printed, FEMA will initiate the update of the regulatory products that communities use for local floodplain management and NFIP activities.

Delivery of the preliminary FIRM and Flood Insurance Study (FIS) report begins another period of coordination between community officials and FEMA to discuss the required statutory and regulatory steps both parties will perform before the preliminary FIRM and FIS report can become effective. As in the previous phases, FEMA and its mapping partners will engage with communities through a variety of conference calls, webinars, and in-person meetings.

Once the preliminary FIRMs are prepared and released to communities, FEMA will initiate the statutory portions of the regulatory product update. FEMA will coordinate a Consultation Coordination Officer meeting and initiate a 90-day comment and appeal period. During this appeal period, local developers and residents may coordinate the submittal of their comments and appeals through their community officials to FEMA for review and consideration.

FEMA welcomes this information because additional proven scientific and technical information increases the accuracy of the mapping products and better reflects the community's flood hazards identified on the FIRMs.

Communities may host or hold Open House meetings for the public. The Open House layout allows attendees to move at their own pace through several stations, collecting information in their own time. This format allows residents to receive one-on-one assistance and ask questions pertinent to their situations or their interests in risk or flood insurance information.

All appeals and comments received during the statutory 90-day appeal period, including the community's written opinion, will be reviewed by FEMA to determine the validity of the appeal. Once FEMA issues the appeal resolution, the associated community and all appellants will receive an appeal resolution letter and FEMA will revise the preliminary FIRM, if warranted. A 30-day period is provided for review and comment on successful appeals. Once all appeals and comments are resolved, the flood map is ready to be finalized.

After the appeal period, FEMA will send community leaders a Letter of Final Determination stating that the preliminary FIRM will become effective in 6 months. The letter also discusses the actions each affected community participating in the NFIP must take to remain in good standing in the NFIP.

After the preceding steps are complete and the 6-month compliance period ends, the FIRMs are considered effective maps and new building and flood insurance requirements become effective.

That is a brief general overview of a Flood Risk Project. The FRR, which is described in the next section, will provide details on the efforts in the Richland watershed and Chambers watershed.

Phase Zero – Investment: FY2017 Richland Watershed and Chambers Watershed Risk MAP Project

The Richland watershed and Chambers watershed represents two of the dominant flooding sources in North Texas and lies in the "flash-flood alley" of Texas. Figure 3 shows the number of flash floods per county in Texas. The watersheds impact over 46 communities which include approximately 167,000 people. The subject communities cover more than 1,991 sq. mi. with over 400 sq. mi. of mapped floodplain. Figure 3 shows an overview of flash flood risk in the Richland watershed and Chambers watershed. Much of the floodplain in the Richland watershed and Chambers watershed is in the unincorporated areas of Ellis County and Navarro County. See Appendix III for figures showing floodplain mapping in the Richland watershed and Chambers watershed.

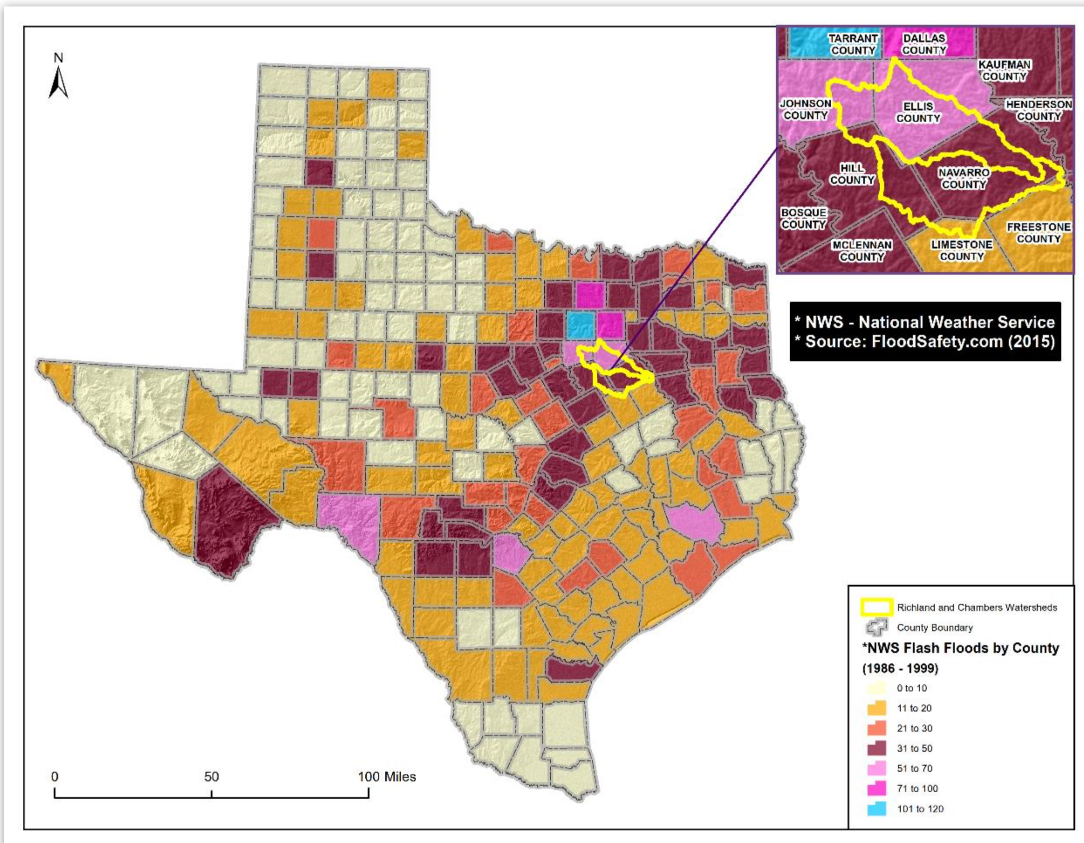


Figure 3: Flash Flood Incidents

All streams in the watersheds are either direct or indirect tributaries to Richland Creek or Chambers Creek. These streams drain 26 of the 59 HUC-12 watersheds within the study area comprising 860 sq. mi. of land. Flooding is highly dependent on rainfall and often follows tropical thunderstorm events hitting the watershed.

Throughout the watershed, annual rainfall totals exceed the Texas average annual precipitation rate of 34 inches. There is an increase in rainfall from the southwestern counties to the northeastern counties, with an average rainfall of 36.3 inches in Johnson County to 42.3 inches in Freestone County. The mainstem of Richland Creek and its many tributaries have several dams along their lengths, including the Navarro Mills Dam on Lake Navarro Mills, located in Navarro County. The mainstem of Chambers

Creek and its many tributaries have several dams along their lengths, including the Thornton Lake Dam on Lake Thornton, located in Navarro County.

All FEMA Risk MAP Project life cycles begins with Phase Zero (Investment) and Phase One (Discovery), and the FY2017 Richland watershed and Chambers watershed project paves the way for the local communities to move towards flooding resilience. FEMA selected and prioritized the watersheds for BLE Investment and Discovery with the overall goal of assisting the local governments in identifying flood risks and strengthening their ability to make informed decisions about reducing these risks. Figure 4 shows communities within the Richland watershed and Chambers watershed.

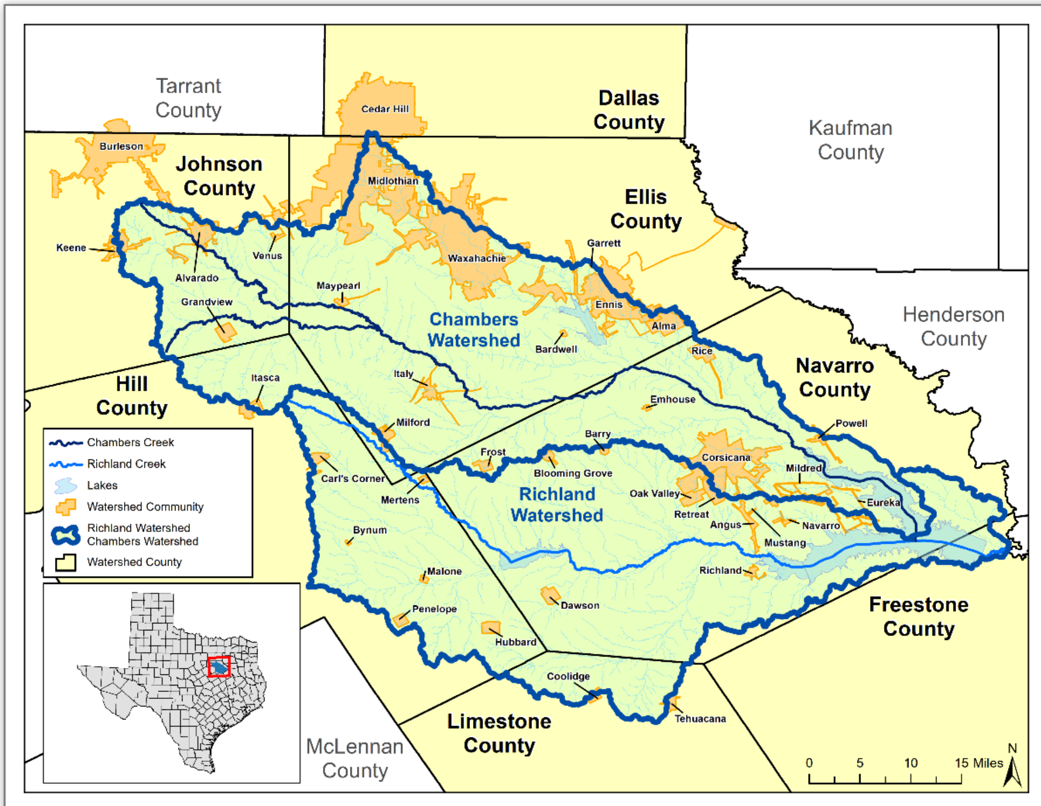


Figure 4: Overview of communities located within the Richland watershed and Chambers watershed.

Watershed Selection Factors

Many factors and criteria are reviewed for watershed selection: flood risk, the age of the current flood hazard data, population growth trends and potential for growth, recent flood claims, and disaster declaration history. The availability of local data and high-quality ground elevation data is reviewed for use in preparing flood hazard data. The CNMS database is reviewed to identify large areas of unknown or unverified data for streams. FEMA consults the State of Texas CTP, the State NFIP Coordinator, and the State Hazard Mitigation Officer when watersheds are identified for study.

Flood Risk. People who live along Richland Creek and Chambers Creek and its tributaries are not strangers to flood events, and numerous flooding events are listed in the historical record. Post Oak Creek in Navarro County puts several homes in danger of flooding and due to the increased urbanization, the area's potential for flood damage may rise.

As recently as September 2018, The City of Venus in Johnson County experienced a slow-moving storm system which caused flash floods across the northern half of the region and required a water rescue. In

October 2018, The City of Corsicana in Navarro County experienced a dynamic weather system which produced flash floods, tornadoes, and hail causing damages to several properties. Road closures are common in Navarro County, where streams such as Post Oak Creek and Mesquite Branch overtop roadways.

Many additional flood related damages have been recorded in the various communities in the watershed. These flood events cause extensive damage to local infrastructure and illustrate the ongoing threat in the Richland watershed and Chambers watershed. Despite a population decline, the City of Corsicana has increased its urban area footprint with more impermeable surfaces.

Growth Potential. Freestone, Hill, Johnson, and Limestone counties are mostly rural, while Ellis and Navarro counties have urban areas within the Richland watershed and Chambers watershed. Ellis County is mostly urban in the eastern half of the county, and rural in the western half. Most of the urbanization from 2010 through 2017 occurred in Ellis County and Navarro County, and these areas increased in both impervious surfaces and population density. The Cities of Angus, Frost, Midlothian, and Grandview; and the Towns of Bynum, Emhouse, and Retreat had some of the highest population growth during the last decade, and will likely experience the most growth in population over the next twenty years.

Age of Current Flood Information. All counties except for Freestone County in the Richland watershed and Chambers watershed have been updated to modernized countywide DFIRMs and FIS reports as part of FEMA's Map Modernization (Map Mod) program that began in 2004. Some studies in the Cities of Alvarado, Burleson, Grandview, Keene and Venus went effective as recently as 2019. However, many of the hydrology and hydraulic models supporting the mapping currently shown on the FIRMs in these counties have not been updated since the late 1970s or 1980s. Over half of the mapping shown on these FIRMs are also Zone A floodplains with no readily available Base Flood Elevations (BFEs).

The combination of related severe floods, outdated flood information, and increasing development indicate that these watersheds need updated flood hazard information to support floodplain management activities, especially in Navarro County.

Availability of High-Quality Ground Elevation Data. FEMA's data availability review indicated that high-quality ground elevation data was available for all of the Richland watershed and the Chambers watershed in the form of Light Detection and Ranging (LiDAR) data. These data provide a great basis for preparing hydrologic and hydraulic modeling and help identify development and earth-moving activities near the streams and creeks. The available LiDAR data was collected by TNRIS and USGS between 2009 and 2014. The United States Geological Survey 3D Elevation Program (3DEP) data were used in areas of Freestone County and Navarro County where no LiDAR was available. The source and date of the LiDAR topographic data coverage used in the FY2017 Discovery and BLE projects for in the Richland watershed and Chambers watershed is shown in Figure 5.

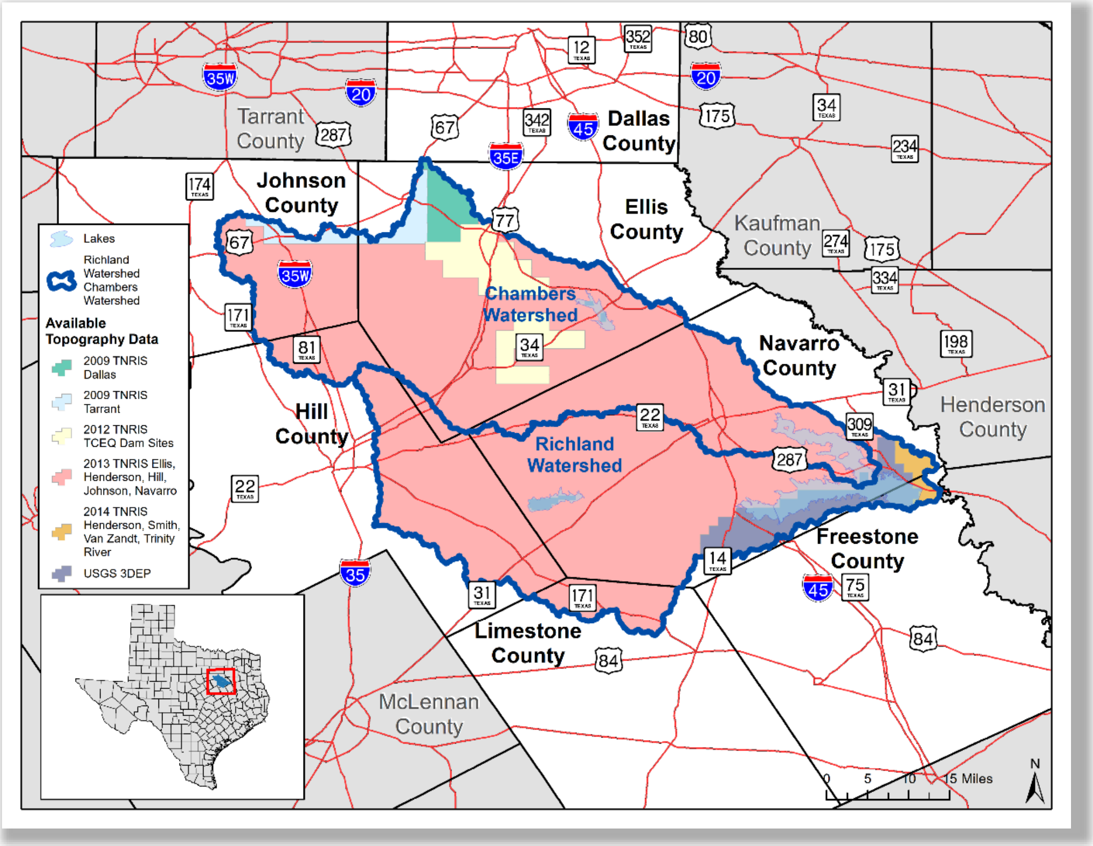


Figure 5: Availability of LiDAR data.

Coordinated Needs Management Strategy Database Review. The CNMS database indicates the validity of FEMA's flood hazard inventory. CNMS reviews 17 criteria to determine whether flood hazard information shown on the current FIRMs is still valid. Streams that are indicated as ***Unverified*** or ***Unknown*** in the database indicate that the information used to map the floodplains currently shown on the FIRM is inaccessible or that a complete evaluation of the critical and secondary CNMS elements could not be performed. Figure 6 shows the CNMS-based attributed streams for the study watersheds.

Unmapped Stream Coverage. FEMA also reviewed the current stream coverage and reviewed the areas against the National Hydrography Dataset (NHD). The NHD medium-resolution data inventoried by the USGS maps created at a 1:100,000 scale was used to review the watercourses within the Richland watershed and the Chambers watershed. Population centers of 1,000 or more were reviewed for additional mileage against the high-resolution data inventoried by the USGS Quadrangle maps created at a 1:24,000 scale. CNMS was completed as part of the BLE project in February 2016 and was updated as part of the Discovery Process. The intent of this review was to identify streams and watercourses and create a complete stream network for preparing BLE data.

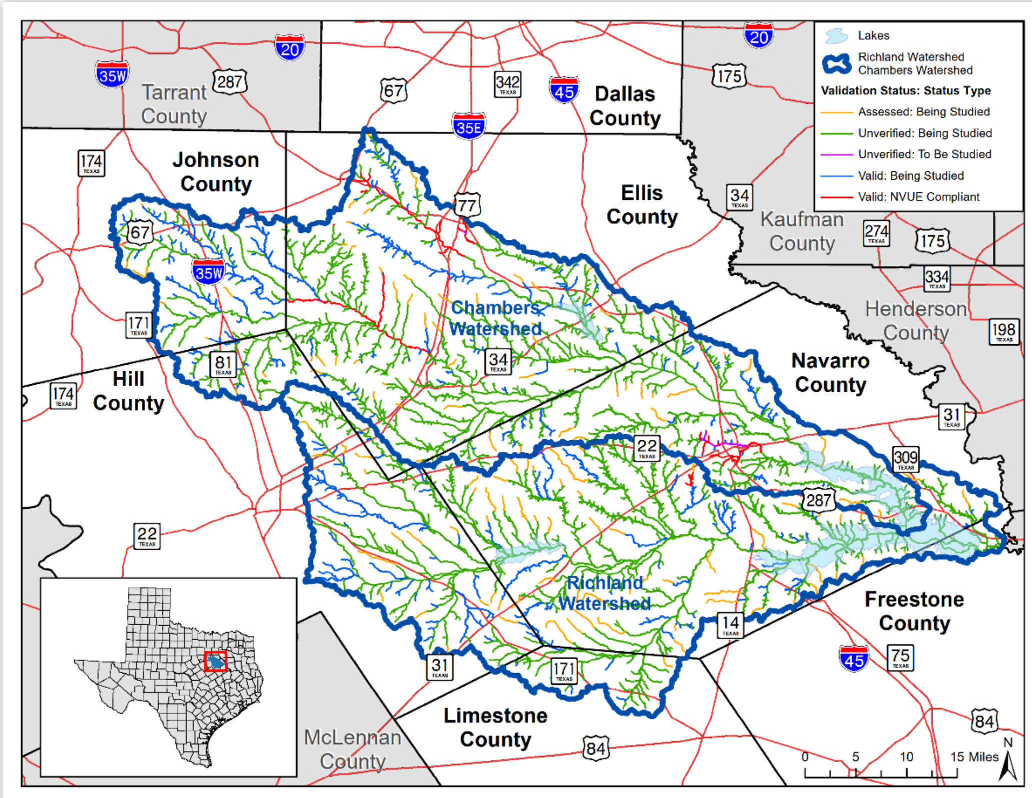


Figure 6: Overview of CNMS streams.

Base Level Engineering (BLE) – Richland Watershed and Chambers Watershed (2016)

In 2015, FEMA through its PTS provider, Compass, began investing in BLE data development for the Richland watershed and the Chambers watershed in Texas. This approach prepares multi-profile hydrologic (how much water) and hydraulic (how is water conveyed in existing drainage) data for a large stream network or river basin to generate floodplain and other flood risk information for the basin area. BLE utilizes USGS regional regression equations with gage analysis to calculate flows. The BLE projects were published in February 2016 as MIP case numbers 16-06-0366S for Richland watershed and 16-06-0367S for Chambers watershed. The BLE reports are included in Appendix II.

BLE provides an opportunity for FEMA to produce and provide non-regulatory flood risk information for a large watershed area in a much shorter time. The data prepared through BLE provides planning-level data that is prepared to meet FEMA's Standards for Floodplain Mapping. BLE is scalable and can be updated for use as regulatory and non-regulatory products. Communities could choose to adopt the BLE as approximate, model-backed mapping in locations without model-backed Zone A mapping. Detailed studies can add structures to the BLE modeling for further refinement into Limited Detail studies or Detailed studies with or without floodway. Figure 7 shows the network of streams analyzed using the BLE approach.

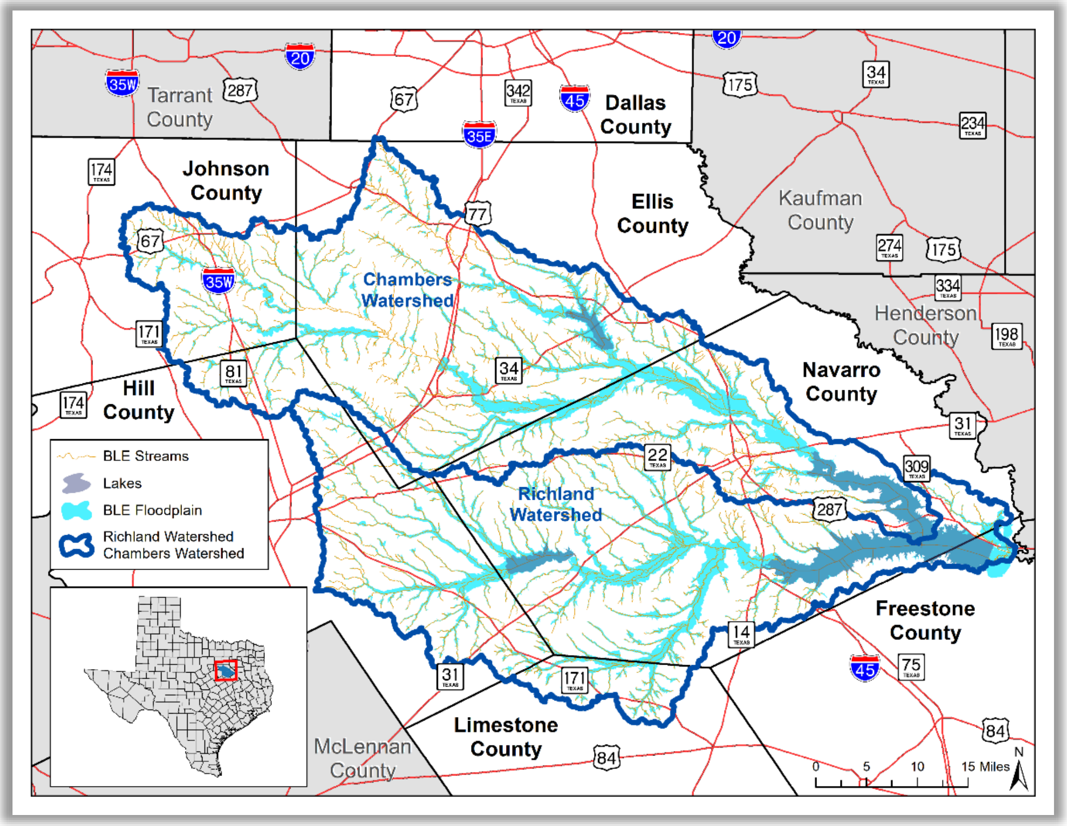


Figure 7: Overview BLE streams and BLE floodplain.

FEMA Investment (2016). The BLE provided the following items for use in the Richland watershed and Chambers watershed:

- Hydrologic modeling (regression) flow values for the 10%, 4%, 2%, 1%, 1%+ and 0.2%, and 1%- frequencies
- Hydraulic (HEC-RAS) modeling for all study streams (for the same frequencies listed above)
- 10-, 1-, and 0.2-percent-annual-chance floodplain boundaries
- 1- and 0.2-percent-annual-chance Water Surface Elevation Grids
- 1- and 0.2-percent-annual-chance Flood Depth Grids
- HAZUS flood analysis for the watershed
- Point file indicating the location of culverts and inline structures that may be informed by local as-built information
- Flood Risk Map (See Appendix III)

The BLE approach prepared flood hazard information for approximately 1,600 miles of stream, thus adding over 100 miles of supplementary flood hazard information for communities throughout the watershed. The BLE information is available on FEMA's Estimated BFE viewer (https://webapps.usgs.gov/infrm/estBFE/) to allow communities for use in planning, risk communication, floodplain management and permitting activities. A FEMA Regional Service Center (RSC) style review of the 2016 BLE project has been conducted as part of the Discovery process and is available in Appendix II. This review examined the data for issues relating to backwaters, stream centerlines, and other issues and is available in Appendix II. A Flood Risk Map was also generated as part of the Discovery process and is available in Appendix II.

CNMS Validation and Assessment. The BLE results were compared to the current flood hazard inventory identified in the CNMS database. This assessment will allow FEMA and NCTCOG to compare this updated flood hazard information to the current effective floodplain mapping throughout the watershed. A key feature of this assessment also included the collection of Areas of Mitigation Interest layers containing suggested structure inventory for the Discovery collection efforts and flood hazard inventory assessments. The BLE CNMS were revised for the study watersheds during Discovery and the report tables are available in Appendix II.

Post-Discovery Webinar and Community Coordination. FEMA and NCTCOG rolled out the results of the Discovery process to the communities in the Spring of 2020. The meeting was a one-hour webinar held on April 2, 2020. Communities were provided information and training to support the use of BLE for planning, floodplain management, permitting, and risk communication activities. FEMA will work with communities to review, interpret and incorporate the BLE information into their daily and future community management and planning activities.

Follow-Up On Phase Project Decisions. The BLE results and the effective DFIRM floodplains were compared to identify any areas of significant change. If the results show large areas of change (expansions and contractions of the floodplain, increases and decreases of the computed BFEs, and increases in expected flow values) FEMA will continue to coordinate with the communities to identify the streams that should be considered for FIRM updates. These updates could be Letter of Map Revisions for small project areas, or a Physical Map Revision for large areas with mapping changes.

To identify other streams for future refinement, community growth patterns and potential growth corridors should be discussed with FEMA. These areas of expected community growth and development may benefit from updated flood hazard information. BLE can be further refined to provide detailed study information for a Flood Risk Identification Study and a FIRM update.

Areas of communities that were developed prior to 1970 (pre-FIRM areas) may include repetitive and severe repetitive loss properties. They may also be areas where re-development is likely to occur. Having updated flood hazard information before re-development and reconstruction activities take place may benefit communities by providing guidance to mitigate future risk.

The Discovery process aims to identify a subset of the BLE stream studies to be updated and included on the FIRMs. Communities may wish to review these possible areas and provide feedback once the BLE data has been received. Local communities can also refine BLE information and submit it through the Letter of Map Revision (LOMR) process to revise the existing flood hazard information and maintain the FIRMs throughout their community.

Phase One – Discovery: FY2017 Richland Watershed and Chambers Watershed

The FY2017 NCTCOG Discovery project was about the "Discovery" of flood hazards and risks throughout the Richland watershed and Chambers watershed. Through the Discovery process, FEMA can determine which areas of the watershed may/will be funded for further flood risk identification and assessment in a collaborative manner, while taking into consideration the information collected from local communities. Discovery initiates open lines of communication and relies on local involvement for productive discussions about flood risk. The process provides a forum for a watershed-wide effort to understand the interrelationships between upstream and downstream community flood risk throughout the watershed.

The Richland watershed and Chambers watershed FY2017 Discovery project was completed through the following activities:

- Pre-Discovery Engagement Efforts
- Data Gathering
- Discovery Meeting
- watershed Findings and Prioritizations

All possible efforts were made to ensure that stakeholders understood Discovery and the Risk MAP process through emails, phone calls, newsletters, and a developed website created for this Discovery project.

Pre-Discovery Engagement Efforts

A Discovery flyer was mailed out to the communities two months prior to the Pre-Discovery meeting. A Discovery newsletter was also developed and distributed to all stakeholders to gain public awareness of the Richland and Chambers Discovery process. The newsletter contained information about FEMA's Risk MAP program, the Discovery process, details of the upcoming Pre-Discovery Meeting, the data collection process, and the Risk MAP process beyond discovery. A copy of the flyer and the newsletter is included in Appendix III.

NCTCOG held one (1) informational Pre-Discovery meeting on June 26, 2019 for stakeholders in the study watersheds at the Ellis County Courthouse in Waxahachie, Texas. A copy of the presentation is available in Appendix III. The Pre-Discovery informational meeting was held to increase awareness of the Discovery process prior to the Discovery Meeting so the stakeholders would be prepared to fully participate in the Discovery process. Five stakeholders participated in the meeting. The goals of the Pre-Discovery meeting were to:

- Explain the Discovery process
- Explain why the NCTCOG was conducting Discovery in the Richland watershed and Chambers watershed
- Explain FEMA's Risk MAP program and benefits
- To obtain information for Discovery in the watershed

Data Gathering

Data was collected from State and Federal organizations. These data were used to generate "backgrounder" information about each watershed community, and included various population metrics, collections of high water marks and low water crossings, and historical flooding information. Table 4 below summarizes the geospatial data collected.

Table 4: Geospatial Data Collection

Data Type	Data Source	Data Description
HUC watershed Boundaries	USGS	HUC boundaries clipped to the Richland HUC-8 and the Chambers HUC-8. Also includes HUC-10 and HUC-12.
Roadways and Railroads	TNRIS Stratmap	Transportation Lines
Jurisdictional Boundaries	TNRIS	Data includes city and county boundaries
Current Effective Floodplain Information	FEMA DFIRMs	Data includes Floodplains, BFEs, and Cross Sections
Stream Lines	FEMA DFIRMs	Stream Centerlines from DFIRM
Locations of Letters of Map Revision (LOMRs)	FEMA	LOMRs incorporated into Effective DFIRM databases and LOMRs filed after Effective DFIRM dates for watershed counties
Coordinated Needs Management Strategy	FEMA	CNMS database dated December 11, 2015
Topography	TNRIS	USGS 3DEP 2009 TNRIS Dallas 2009 TNRIS Tarrant 2012 TNRIS TCEQ Dam Sites 2013 TNRIS Ellis, Henderson, Hill, Johnson, Navarro 2014 TNRIS Henderson, Smith, Van Zandt, Trinity River
HAZUS-based Average Annualized Loss Estimates	FEMA	2015 HAZUS AAL per Census Tract
Coverage of Known Risk Assessment Data	Texas Hazard Mitigation Package	Based on 2000 Census: Population Vulnerability to 1% Flood and Property Value Vulnerability to 1% Flood
Location of Dams	National Inventory of Dams	Dam locations with Emergency Action Plan (EAP) status
Stream Gauges	USGS	Stream Gauge locations
Flood Claims	NFIP	Total claims per jurisdiction
Repetitive Loss or Severe Repetitive Loss Locations	FEMA	RL/SRL locations from 1979 to 2015
Land Use	National Land Cover Database 2011 from TNRIS	Land Use data as of 2011, developed by USGS
Urban Cover	National Land Cover Database 2011 from TNRIS	Urban Cover is a field located in the Land Use
Census Tract Population Data	US Census Bureau	Census Tract Population data based on 2010 Census Data
Population Density	US Census Bureau	Population density based on 2017 American Community Survey
Congressional Areas	US Census Bureau	Congressional District Boundaries
High Water Marks	TNRIS	Historical high water marks obtained by TNRIS from USACE, FEMA Mitigation Team, USGS, and TxDOT
Low Water Crossings	TNRIS	Identified low water crossings in Texas with flooding source and road name

The Discovery engagement process also included the development of a user-friendly website for data collection, verification, and coordination. The website was developed to become a repository to disseminate project information such as community background data, newsletters, planned meeting dates, time, and locations, project data deliverables, and reports.

For the FEMA NCTCOG Discovery project, the website allowed participating stakeholders to view and update flood-related information about their community, including local flood risk, flood hazards, mitigation plans, mitigation activities, flooding history, development plans, and floodplain management activities. It also allowed stakeholders to input mitigation concerns, mapping needs and requests on a web map.

Discovery Meeting

One (1) in-person Discovery Meeting was held in the watershed in an open house (come and go) format. The Discovery Meeting occurred on December 5, 2019 from 10:00am-2:00pm at the Ellis County Courthouse in Waxahachie, Texas. Hosts of this meeting included USACE, NCTCOG, USGS and Halff Associates, Inc.

The main goals of the Discovery Meeting were to gather additional flood risk data; discuss the communities' flooding history, development plans, flood mapping needs, and flood risk concerns; discuss the vision for the watershed's future, and the importance of mitigation planning and community outreach.

The Discovery Meeting was held over a four hour period. Community stakeholders were able to participate in the meeting when most convenient to them. Discovery Ambassadors assisted stakeholder attendees through various stations in an "come and go" format. The stations included:

- *United States Army Corps of Engineers (USACE)* – discussion of current USACE projects in the region
- *NCTCOG Programs* – information on NCTCOG programs available to stakeholders as well as answering NCTCOG questions from attendees
- *United States Geological Survey (USGS)* – information of current USGS projects in the region
- *Laptops* – stakeholders were able to review, edit, or add information entered on the Discovery website.
- *Discovery Maps* – data collection process to capture information on identifying flood risk locations and problems, areas of growth or planned development, answering floodplain questions, and identifying map need locations.

The Richland and Chambers Discovery project gathered 98 comments, including 20 new mapping requests.

Watershed Findings and Prioritizations

Watershed Findings

Following the Discovery meeting, the gathered community comments were placed into categories by comment type and summarized by HUC-12 sub-watersheds, as shown in Table 5.

Upper Waxahachie Creek had the highest number of comments with 35 comments submitted. This sub-watershed included many different types of comments, including roads in the 100-year floodplain that overtop during storm events, structures causing streamflow constrictions, ground conditions not matching the DFIRM mapping, and records of historical flooding events. There were 36 out of 59 HUC-12s which did not receive any comments, and these were mostly in Richland watershed and in the Southern portion of Chambers watershed. Of the 99 unique comments, some are located across multiple watersheds and are listed in each applicable HUC-12 sub-watersheds in Table 5.

Table 5: Richland and Chambers Comment Distribution by HUC-12 watershed

HUC-12 watershed	Mapping Need Type						Total Number of Comments
	Flooding Risk	Mapping Concerns	Mapping Needs	Mitigation Actions-Identified	Mitigation Actions-Completed	Regulations	
Alligator Creek-Pin Oak Creek	**No comments received**						**0**
Armstrong Creek-Cottonwood Creek	**1**					**2**	**3**
Ash Creek-Navarro Mills Lake	**No comments received**						**0**
Baker Branch-Chambers Creek		**1**					**1**
Battle Creek-Richland Creek	**No comments received**						**0**
Board Creek-Pin Oak Creek	**No comments received**						**0**
Briar Creek	**No comments received**						**0**
Bynum Creek		**2**		**1**			**3**
Cedar Creek-Chambers Creek	**No comments received**						**0**
Cedar Creek-Richland Creek	**3**						**3**
Cottonwood Creek-Ash Creek	**No comments received**						**0**
Cottonwood Creek-White Rock Creek	**No comments received**						**0**
Crab Creek	**No comments received**						**0**
Cryer Creek-Chambers Creek	**No comments received**						**0**
Cummins Creek	**No comments received**						**0**
Elm Creek-Pin Oak Creek	**No comments received**						**0**
Elm Creek-Post Oak Creek		**2**					**2**
Grape Creek-Richland Creek	**No comments received**						

Table 5: Richland and Chambers Comment Distribution by HUC-12 watershed (Continued)

HUC-12 watershed	Mapping Need Type						Total Number of Comments
	Flooding Risk	Mapping Concerns	Mapping Needs	Mitigation Actions-Identified	Mitigation Actions-Completed	Regulations	
Greathouse Branch-Chambers Creek		4	1				5
Grove Creek-Pecan Creek	No comments received						0
Hackberry Creek-Navarro Mills Lake	No comments received						0
Headwaters Ash Creek	No comments received						0
Headwaters North Fork Chambers Creek						1	1
Headwaters Richland Creek	No comments received						0
Headwaters Waxahachie Creek		2					2
Hog Pen Slough-Richland Creek	No comments received						0
Houston Creek-Chambers Creek	1		1				2
Island Creek						1	1
Jones Branch-Richland Creek	No comments received						0
Little Pin Oak Creek-Richland Creek	No comments received						0
Long Arm Branch-Chambers Creek	No comments received						0
Lower Big Onion Creek	1						1
Lower Mill Creek	No comments received						0
Lower North Fork Chambers Creek	1	1	3				5
Lower South Fork Chambers Creek	1						1
Lower Waxahachie Creek	1						1
Melton Branch-Richland Creek	No comments received						0
Mesquite Creek-Little Pin Oak Creek	No comments received						0
Middle Mill Creek	2						2

Table 5: Richland and Chambers Comment Distribution by HUC-12 watershed (Continued)

HUC-12 watershed	Mapping Need Type						Total Number of Comments
	Flooding Risk	Mapping Concerns	Mapping Needs	Mitigation Actions-Identified	Mitigation Actions-Completed	Regulations	
Middle North Fork Chambers Creek	**No comments received**						**0**
Middle Waxahachie Creek	**1**						**1**
Munger Branch	**No comments received**						
Mustang Creek-Bardwell Lake	**4**	**5**	**1**	**1**		**3**	**14**
North Fork Pin Oak Creek	**No comments received**						**0**
Oak Branch-Chambers Creek	**1**						**1**
Post Oak Creek	**No comments received**						**0**
Rush Creek	**No comments received**						**0**
South Prong Creek-Lake Waxahachie	**2**	**3**	**1**				**6**
Tom Harris Branch-Navarro Mills Lake	**No comments received**						**0**
Town of Mertens-Richland Creek	**No comments received**						**0**
Town of Union High-Pin Oak Creek	**No comments received**						**0**
Treadwell Branch-Richland Creek	**No comments received**						**0**
Tupelo Branch-Chambers Creek	**No comments received**						**0**
Upper Big Onion Creek	**5**	**2**	**1**				**8**
Upper Mill Creek	**No comments received**						**0**
Upper North Fork Chambers Creek	**1**	**1**	**1**			**3**	**6**
Upper South Fork Chambers Creek	**1**					**4**	**5**
Upper Waxahachie Creek	**12**	**6**	**8**	**5**		**4**	**35**
Yonker Pin Slough-Richland Creek	**No comments received**						

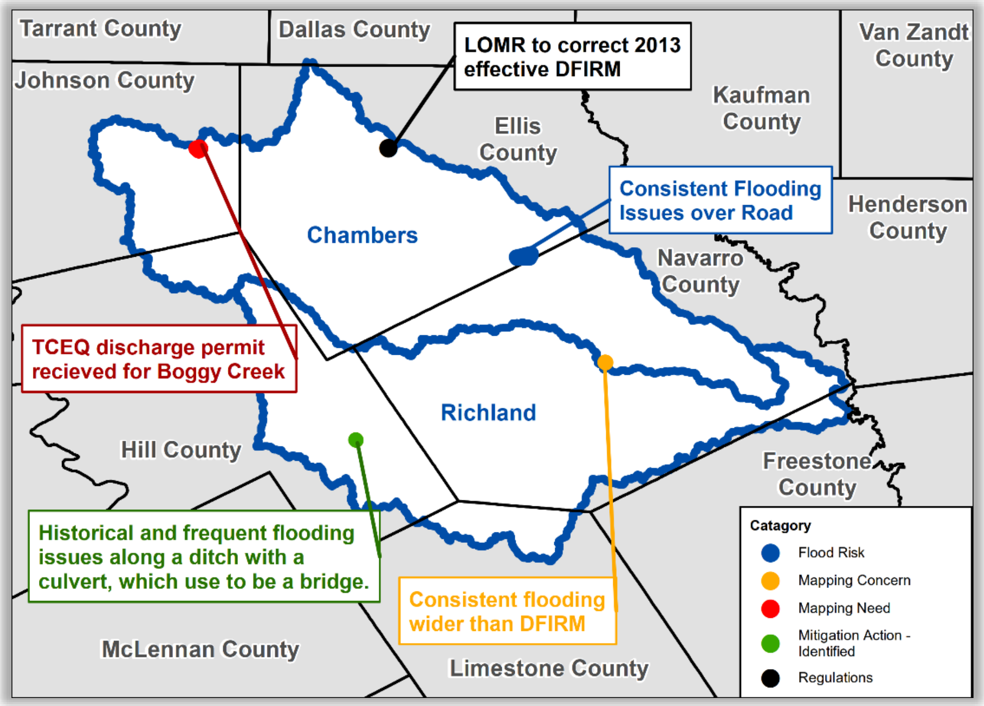


Figure 8: Stakeholder Comment Examples.

Figure 8 above shows a sample of the comments submitted by communities. There were nine comments for key emergency routes overtopping during storms. There were 15 comments about roads overtopping or streets flooding during storm events. There were 23 comments related directly to structures, of which ten were specifically about culverts. There were eight comments related to erosion, whether it was merely stream erosion or also structures impacted by erosion. Communities also submitted nine comments related to studies that are not included on DFIRMs and areas where the DFIRM is not reflecting ground conditions. There are 11 comments related to land use change that could have potential CLOMRs or LOMRs later.

Figure 9 below shows the type and distribution of stakeholder comments across the watershed. Most comments were submitted in the northern central portion of Chambers watershed and tapers off towards the south and the west. Comments tended to be submitted by communities with higher relative populations in the watershed.

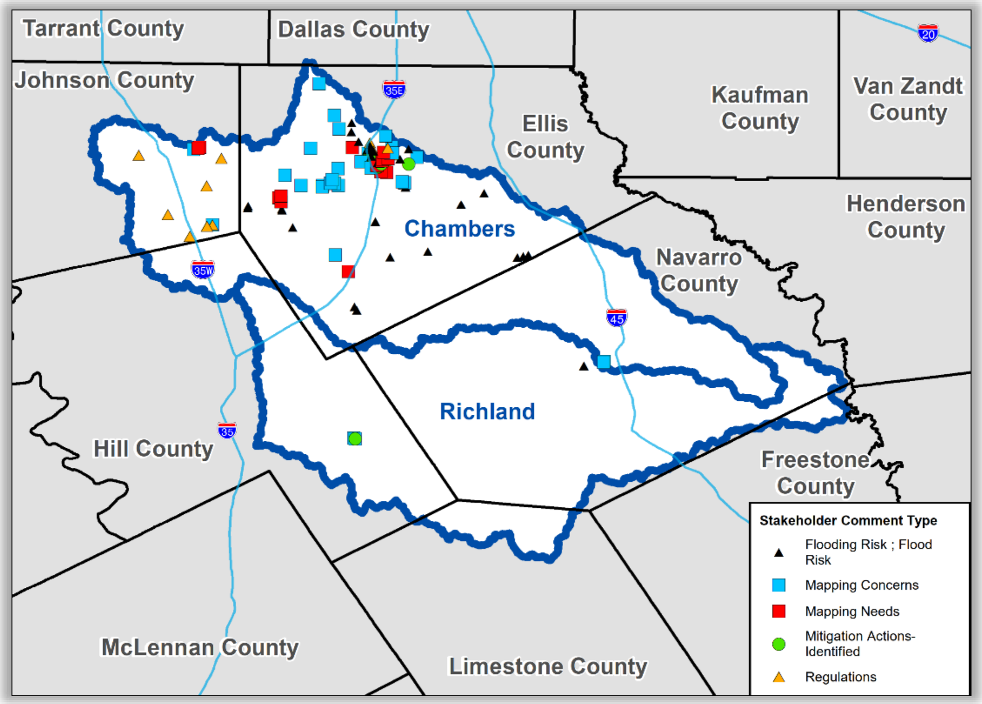


Figure 9: Stakeholder Comment Distribution.

Figure 10 demonstrates the differences in numbers per comment type. Thirty-nine comments were submitted for studies needed due to Flooding Risk, such as roads overtopping during storm events or areas of erosion with no mitigation plans in place. Mapping Concerns include 21 comments related to needs for updated mapping, such as older effective maps which do not match the current drainage patterns.

There were 20 Mapping Needs comments for unmapped sections in the watershed, such as places with new commercial development which need a Hydrology & Hydraulics study. Comments related to mitigation projects (needed or planned but have not yet started) are identified mitigation actions. These 9 identified mitigation actions include bridges or culverts which are damaged or plan to be constructed. No new or completed mitigation actions were reported. The nine comments on Regulations pertain to places where the regulatory information is incorrect, such as conflicting BFE information between DFIRMs and recent studies.

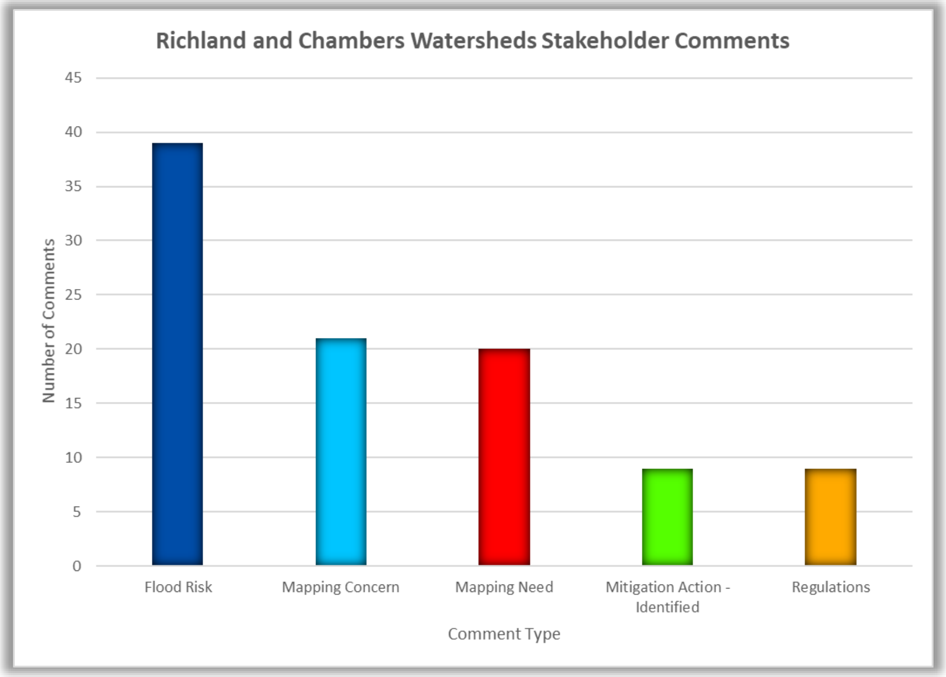


Figure 10: Stakeholder Comment Totals.

Watershed Prioritization

The community comments were one of fourteen criteria for prioritization of the HUC-12 sub-watershed according to the 2009 NCTGOG Upper Trinity River Basin Mapping Needs Assessment (MNA) standard of prioritization, described in Table 6. Criteria number 14, "Stakeholder Mapping Request" were documented from stakeholder comments listed in Table 5. These needs may come from outdated stream studies, large-scale development along a stream, or alterations to a stream itself to reduce flooding risk. An in-depth description of each field in Table 6 is available in the 2009 NCTCOG Upper Trinity River Basin MNA report.

Table 6: Prioritization Criteria

Criteria No.	Description	Weight
1	2017 Population density	10
2	Population change (2010 to 2017)	10
3	Predicted population growth	10
4	History of flood claims	10
5	History of flood events	10
6	Number of Letters of Map Change (LOMR/LOMA)	5
7	Available current topography	10
8	Age of technical data – hydrology	5
9	Age of technical data – hydraulics	5
10	Ability to leverage current studies	5
11	Potential for local funding	5
12	Potential for local "work in kind"	3
13	Previous contribution to a FEMA study	2
14	Stakeholder mapping request	10

The criteria in Table 6 were used to calculate a priority score for each HUC-12. The HUC-12s were ranked into three risk groups (moderate, elevated, and high) based on their scores shown in Table 7.

Table 7: Richland watershed and Chambers watershed Prioritization Rankings (HUC-12 watersheds)

HUC-8 Watershed	HUC-12 Sub-watershed Group	Rank
Chambers	Elm Creek-Post Oak Creek	High
Richland	Headwaters Richland Creek	High
Chambers	Headwaters Waxahachie Creek	High
Chambers	Island Creek	High
Chambers	Middle Waxahachie Creek	High
Chambers	Mustang Creek-Bardwell Lake	High
Chambers	South Prong Creek-Lake Waxahachie	High
Richland	Town of Mertens-Richland Creek	High
Chambers	Upper North Fork Chambers Creek	High
Chambers	Upper Waxahachie Creek	High
Richland	Alligator Creek-Pin Oak Creek	Elevated
Chambers	Armstrong Creek-Cottonwood Creek	Elevated
Chambers	Baker Branch-Chambers Creek	Elevated
Richland	Cedar Creek-Richland Creek	Elevated
Richland	Cottonwood Creek-White Rock Creek	Elevated
Chambers	Cryer Creek-Chambers Creek	Elevated
Chambers	Cummins Creek	Elevated
Chambers	Greathouse Branch-Chambers Creek	Elevated
Chambers	Headwaters North Fork Chambers Creek	Elevated
Chambers	Houston Creek-Chambers Creek	Elevated
Chambers	Lower Big Onion Creek	Elevated
Chambers	Lower Mill Creek	Elevated

Table 7: Richland watershed and Chambers watershed Prioritization Rankings (HUC-12 watersheds) (Continued)

HUC-8 Watershed	HUC-12 Sub-watershed Group	Rank
Chambers	Lower North Fork Chambers Creek	Elevated
Chambers	Lower South Fork Chambers Creek	Elevated
Chambers	Lower Waxahachie Creek	Elevated
Chambers	Middle Mill Creek	Elevated
Chambers	Middle North Fork Chambers Creek	Elevated
Chambers	Oak Branch-Chambers Creek	Elevated
Chambers	Upper Big Onion Creek	Elevated
Chambers	Upper Mill Creek	Elevated
Chambers	Upper South Fork Chambers Creek	Elevated
Richland	Ash Creek-Navarro Mills Lake	Moderate
Richland	Battle Creek-Richland Creek	Moderate
Richland	Board Creek-Pin Oak Creek	Moderate
Chambers	Briar Creek	Moderate
Richland	Bynum Creek	Moderate
Chambers	Cedar Creek-Chambers Creek	Moderate
Richland	Cottonwood Creek-Ash Creek	Moderate
Richland	Crab Creek	Moderate
Richland	Elm Creek-Pin Oak Creek	Moderate
Richland	Grape Creek-Richland Creek	Moderate
Richland	Grove Creek-Pecan Creek	Moderate
Richland	Hackberry Creek-Navarro Mills Lake	Moderate
Richland	Headwaters Ash Creek	Moderate
Richland	Hog Pen Slough-Richland Creek	Moderate
Richland	Jones Branch-Richland Creek	Moderate

Table 7: Richland watershed and Chambers watershed Prioritization Rankings (HUC-12 watersheds) (Continued)

HUC-8 Watershed	HUC-12 Sub-watershed Group	Rank
Richland	Little Pin Oak Creek-Richland Creek	Moderate
Chambers	Long Arm Branch-Chambers Creek	Moderate
Richland	Melton Branch-Richland Creek	Moderate
Richland	Mesquite Creek-Little Pin Oak Creek	Moderate
Richland	Munger Branch	Moderate
Richland	North Fork Pin Oak Creek	Moderate
Richland	Post Oak Creek	Moderate
Richland	Rush Creek	Moderate
Richland	Tom Harris Branch-Navarro Mills Lake	Moderate
Richland	Town of Union High-Pin Oak Creek	Moderate
Richland	Treadwell Branch-Richland Creek	Moderate
Chambers	Tupelo Branch-Chambers Creek	Moderate
Richland	Yonker Pin Slough-Richland Creek	Moderate

The prioritization rankings listed in Table 7 will be used by FEMA to determine targeted action items, potential projects, and multi-year flood risk project plans within the Richland watershed and Chambers watershed. Other figures, including Figure 15 and Figure 21 in Appendix III display the watershed-based prioritization ranking.

Pursuing studies along the entirety of requested miles would be cost prohibitive, so it was necessary for NCTCOG to reduce the list of potential stream projects. The seven Study Stream Requests, listed in Table 8, are possible project highlights based on stakeholder comments and the results of the HUC-12 sub-watershed prioritization.

Table 8: Stream Study Requests

Communities	Stream	HUC-12s	HUC 12 Rank
Cedar Hill Ellis County City of Midlothian	North Prong Creek	Headwaters Waxahachie Creek	High
Ellis County City of Midlothian City of Waxahachie	South Prong Creek	South Prong Creek-Lake Waxahachie	High
Ellis County City of Midlothian City of Waxahachie	Waxahachie Creek	Headwaters Waxahachie Creek Upper Waxahachie Creek	High High
Ellis County City of Waxahachie	Mustang Creek	Mustang Creek-Bardwell Lake	High
Ellis County City of Waxahachie	Mustang Creek Unnamed Tributary	Mustang Creek-Bardwell Lake	High
Johnson County	South Fork Chambers Creek	Upper South Fork Chambers Creek	Elevated
City of Retreat	Elm Creek	Elm Creek-Post Oak Creek	High

Potential Study Strems

Table 8 lists the streams with comments related to requests for updated Hydrology and Hydraulic studies along streams. Waxahachie Creek, and its tributary North Prong Creek, are Zone As on the existing DFIRM maps. However, these Zone A mapping areas do not match limited detail studies produced by the City of Waxahachie and developers. The current effective mapping currently places many houses inside the floodplain resulting in several LOMA applications removing these houses from the floodplain because of higher ground elevations. Additionally, the portion of Waxahachie Creek in the City of Waxahachie is based on a model from the 1970s, which is nearly 50 years out-of-date. A bridge along Matthews Street has even had flooding reach its low chord. Nearby, South Prong Creek also has Zone A models which do not match newer, limited detail study models from developers and the City of Waxahachie. Due to the multiple comments spread across Waxahachie Creek, North Prong Creek, one cohesive connectivity model in the Cities of Cedar Hill and Waxahachie, as well as Ellis County would benefit all these communities.

Mustang Creek had updated models prior to the 2013 Map MOD that increased the area of the floodplain. However, since 2013 Map MOD, updated a tributary which reduced the mainstem floodplain without carrying the change over to the effective floodplain of Mustang Creek. There is also a new bridge along Farley Street which is not shown on the DFIRM. There is a new sewer line in construction along Mustang Creek, which is anticipated to contain the residential or commercial growth along the Mustang Creek floodplain after completion in three or four years. The sewer line project also extends to an unnamed Zone A stream, colloquially known as Cole Creek. Though the comment was submitted by the City of Waxahachie, a new study or update to the DFIRM would benefit both Waxahachie and Ellis County.

South Fork Chambers Creek contains BFEs set at seven feet above natural ground; however, these BFEs are widely different in multiple engineering studies in the area. By sifting through these studies, and possibly creating a new model, the most accurate model and its floodplain can go through a LOMR process and become effective, benefiting Johnson County. In the City of Corsicana, storm events along Elm Creek have flooded wider than the DFIRM floodplain nearly 3 times in 40 years. Though the Discovery Project does not include documented scientific evidence of the floods, it is worth investigating further and possibly updating the effective models based on the most current rainfall events.

The HUC-12 sub-watershed prioritizations and potential study stream projects are shown in Figures 15, 17, and 21 in Appendix III. FEMA's Hazards U.S. Multi-Hazard (HAZUS-MH) software was used to assess the consequences of flood events in the Richland watershed and Chambers watershed.

Flood Risk Assessments Results

HAZUS is a risk assessment software program for analyzing potential losses in dollars from floods, hurricane winds, and earthquakes. The BLE flood data developed for this project was used as input data for the HAZUS-based flood risk assessment. The Richland watershed and Chambers watershed have an estimated $4.3 billion worth of vulnerable assets, including residential, commercial, and other asset types. If a 100-year storm event were to occur throughout the watershed, HAZUS estimated nearly one percent of the assets will be damaged, with losses estimated at nearly $320 million dollars to physical assets. There will also be economic losses, including lost wages, inventory losses, losses in production, and economic opportunity losses, valued at $5.9 million. Figures 11 and 12 below shows the capital stock inventory within the study watersheds and the corresponding 100-year event losses.

The HAZUS-based 100-year flood loss estimates were aggregated to the watershed communities to assess risk on a community level. The Cities of Corsicana, Ennis, Midlothian, and Waxahachie, along with the unincorporated areas of Ellis and Navarro County, have the highest potential losses due to flooding damage, ranging from $4.7 billion to $1.6 billion dollars of losses in the study watersheds.

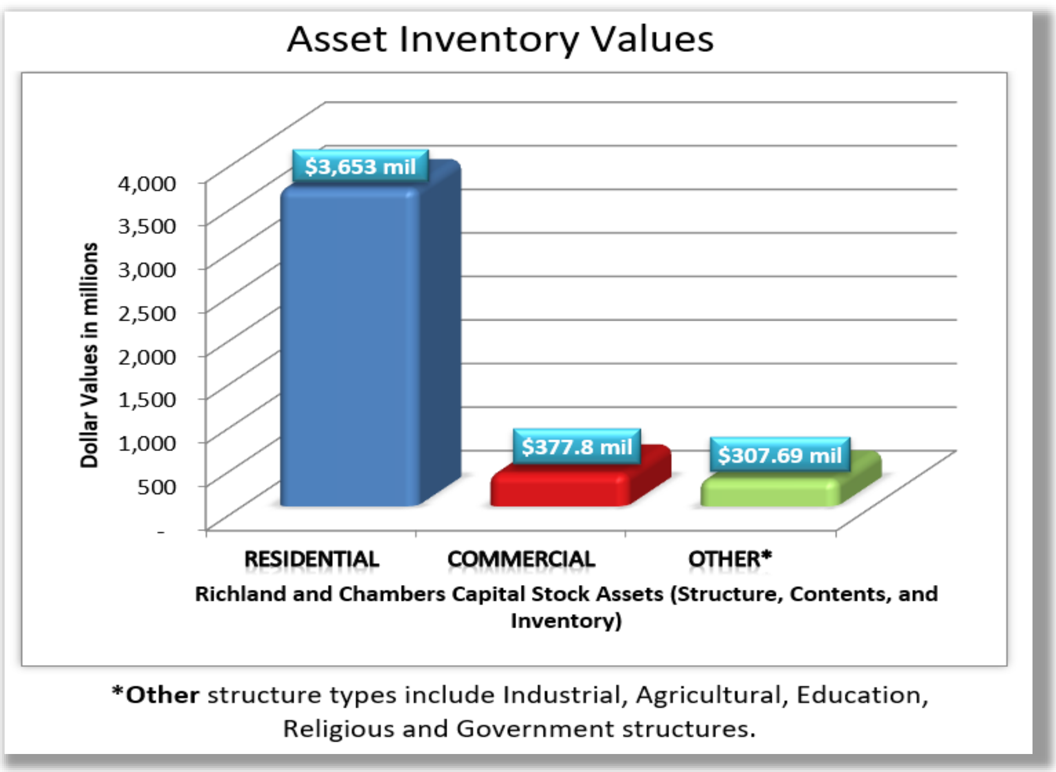


Figure 11: Asset Inventory Value Totals.

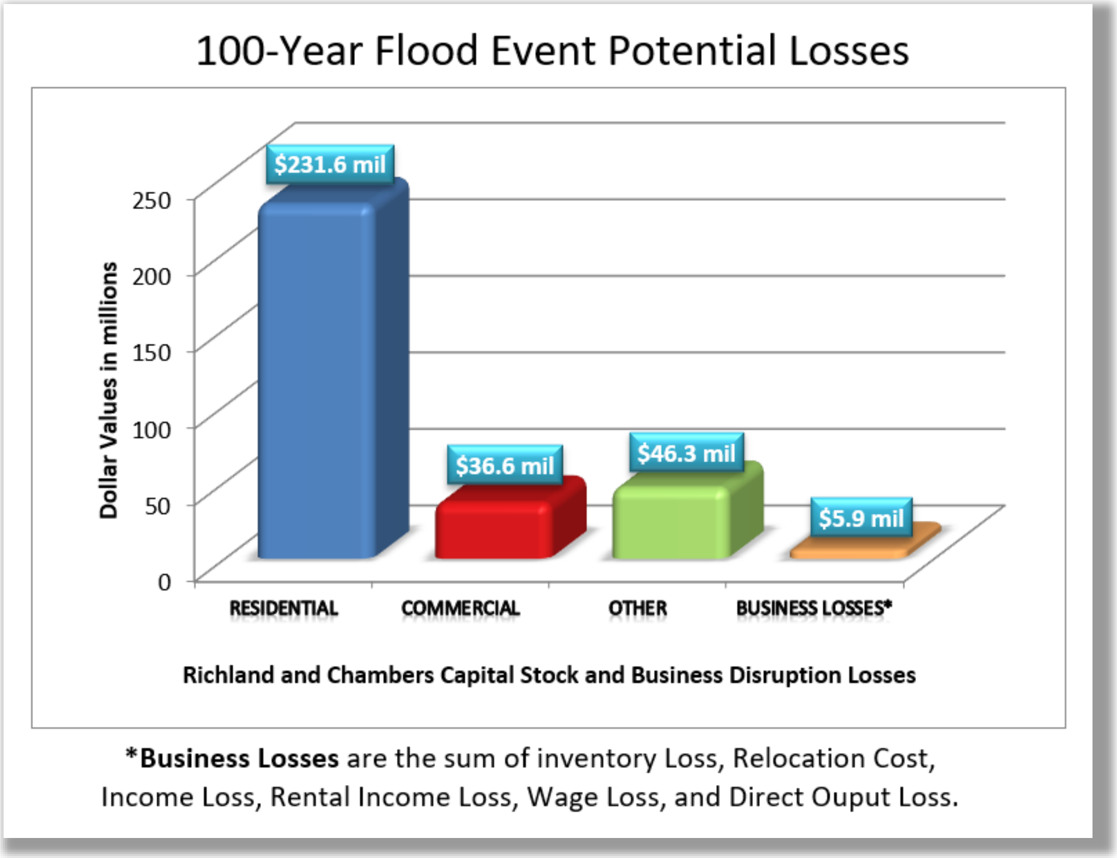


Figure 12: 100-Year Flood Event Potential Loss Totals.

About 16 communities in the Richland and Chambers watersheds include land in at least one other HUC-8 watershed, these HAZUS-based 100-year flood loss estimates are not indicative of their total potential loss estimates. Hence, the losses shown in this report do not necessarily represent community-wide totals.

Aggregating the HAZUS-based 100-year flood loss estimates to HUC-12 sub-watersheds provides another method to prioritize new studies and hazard mitigation projects in the watershed. Figure 13 below ranks the HUC-12s by estimated flood losses. Elm Creek-Post Oak Creek has the highest potential loss, with $3,636 billion in loss if there is a 100-year flood event in the watershed. There are 52 HUC-12 sub-watersheds with elevated risks, and four HUC-12 sub-watersheds with moderate risks, and three HUC-12 sub-watersheds with high risk based on the 100-year flood loss estimates.

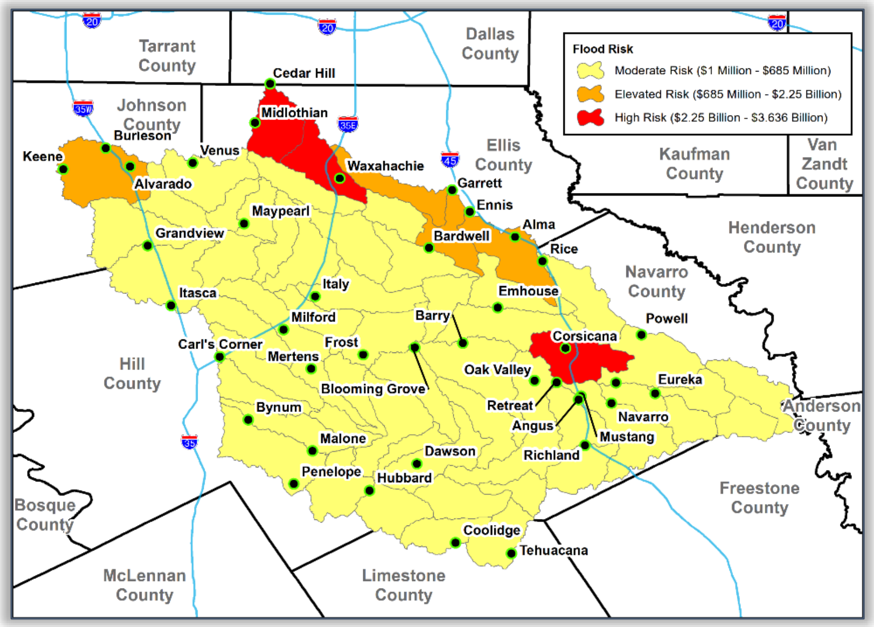


Figure 13: HAZUS-based 1% Annual Chance Loss Estimates by HUC-12s.

Post-Discovery Coordination Effort

NCTCOG held one Post-Discovery Moinformational webinar on April 2, 2020 for stakeholders in the watershed. A copy of the presentation is available in Appendix III.

The Post-Discovery informational webinar was held to discuss the results of the Discovery process and findings, including a review of comments received, preliminary HAZUS results, and BLE data. The FEMA Estimated BFE viewer (https://webapps.usgs.gov/infrm/estBFE/), which can be used for reporting and downloading data, was presented and demonstrated to community stakeholders. The goals of the Post-Discovery webinar were to:

- Recap the FEMA's Risk MAP program's benefits and the Discovery process
- Discuss comments received by stakeholders
- Explain watershed prioritization and stream study requests
- Review HAZUS results
- Demonstrate the permanent FEMA BFE viewer
- Release a draft report to the communities prior to the release of the final report.

Appendix I: Community-Specific Reports

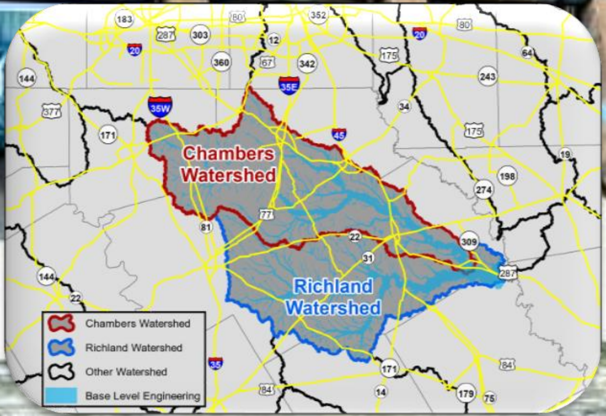
CID	Community	*Total Community Population[1]*	Percent of Population in Study watershed	Total Community Land Area (sq. mi)	Percent of Land Area in Study watershed	NFIP Participant
480165	**Dallas County**	*7,614*	0%	71.2	0%	Y
480168	**City of Cedar Hill**	*44,777*	2.6%	35.8	2.6%	Y
480798	**Ellis County**	*54,353*	61.1%	772.0	61.1%	Y
481546	**Town of Alma**	*331*	99.8%	4.6	99.8%	N
481087	**City of Bardwell**	*649*	100.0%	0.2	100.0%	Y
480207	**City of Ennis**	*18,513*	71.0%	28.5	71.0%	Y
480799	**Town of Garrett**	*806*	57.7%	0.2	57.7%	N
480800	**Town of Italy**	*1,863*	100.0%	2.2	100.0%	Y
480208	**City of Maypearl**	*934*	100.0%	0.8	100.0%	Y
480801	**City of Midlothian**	*18,037*	60.0%	50.0	60.0%	Y
480802	**Town of Milford**	*728*	100.0%	2.0	100.0%	Y
480883	**Town of Venus**	*2,895*	27.9%	3.3	27.9%	Y
480211	**City of Waxahachie**	*29,621*	79.6%	50.8	79.6%	Y
480822	**Freestone County**	*11,819*	1.8%	882.0	1.8%	Y
480857	**Hill County**	*19,017*	32.9%	962.0	32.9%	Y
481308	**Town of Bynum**	*199*	100.0%	0.1	100.0%	N
480270	**Town of Carl's Corner**	*173*	82.8%	2.0	82.8%	N
480859	**City of Hubbard**	*1,423*	100.0%	1.7	100.0%	Y
480860	**City of Itasca**	*1,644*	33.1%	2.1	33.1%	Y
480861	**Town of Malone**	*269*	100.0%	0.4	100.0%	Y
480862	**Town of Mertens**	*125*	100.0%	0.5	100.0%	Y
480864	**Town of Penelope**	*198*	100.0%	1.0	100.0%	N
480879	**Johnson County**	*67,796*	23.6%	624.1	23.6%	Y
480397	**City of Alvarado**	*3,785*	90.8%	5.6	90.8%	Y
485459	**City of Burleson**	*29,111*	0.97%	24.1	0.97%	Y
480881	**City of Grandview**	*1,561*	100.0%	1.9	100.0%	Y
481107	**City of Keene**	*6,106*	54.3%	3.9	54.3%	Y
480910	**Limestone County**	*8,294*	6.7%	917.6	6.7%	Y
480911	**Town of Coolidge**	*955*	35.9%	1.0	35.9%	Y
480913	**Town of Tehuacana**	*283*	21.2%	1.6	21.2%	N

CID	Community	*Total Community Population[1]*	Percent of Population in Study watershed	Total Community Land Area (sq. mi)	Percent of Land Area in Study watershed	NFIP Participant
480950	**Navarro County**	*9,367*	78.3%	1035.2	78.3%	Y
481547	**City of Angus**	*414*	100.0%	1.0	100.0%	N
480951	**City of Barry**	*242*	100.0%	0.4	100.0%	Y
480952	**Town of Blooming Grove**	*821*	100.0%	0.9	100.0%	Y
480498	**City of Corsicana**	*23,770*	100.0%	23.5	100.0%	Y
480953	**Town of Dawson**	*807*	100.0%	1.8	100.0%	Y
480389	**Town of Emhouse**	*133*	100.0%	0.3	100.0%	N
480367	**City of Eureka**	*307*	100.0%	2.1	100.0%	N
480954	**City of Frost**	*643*	100.0%	1.2	100.0%	Y
480380	**Town of Mildred**	*368*	100.0%	2.3	100.0%	Y
481554	**Town of Mustang**	*21*	100.0%	0.1	100.0%	N
480382	**Town of Navarro**	*210*	100.0%	0.6	100.0%	N
480386	**Town of Oak Valley**	*368*	100.0%	2.0	100.0%	N
480390	**Town of Powell**	*136*	75.4%	1.7	75.4%	Y
481158	**Town of Retreat**	*377*	100.0%	5.0	100.0%	N
480957	**City of Rice**	*923*	99.5%	2.6	99.5%	Y
480958	**Town of Richland**	*264*	100.0%	0.9	100.0%	Y
[1]2010 United States Census Bureau Population Estimate						

[1]US Census (2010)

RICHLAND AND CHAMBERS WATERSHEDS

KNOW YOUR RISK



1,991
sq. mi.
Of community land area in Risk MAP project extent

167,000
Population based on 2017 ACS

8% population growth from 2010-2023

688
Total claims for structures repeatedly damaged by flood

$351M
in total severe repetitive loss

6
Average years since last effective FIRM*

33 communities participating in the National Flood Insurance Program

CNMS Stream Miles
2,275.8

Percentage of stream miles which are detailed study in the study watersheds
2.4%

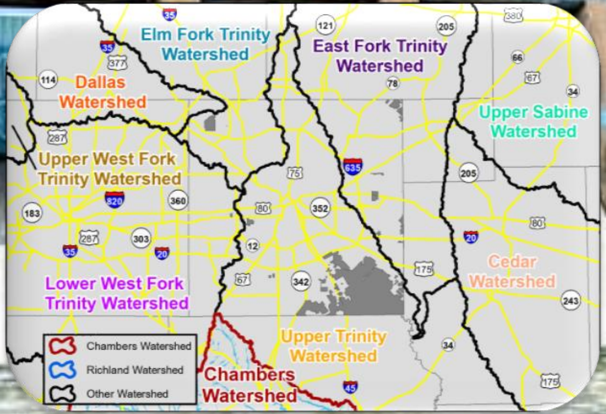
43 dams require **Emergency Action Plans**

*Effective FIRMs within the study watersheds

RiskMAP
Increasing Resilience Together

DALLAS COUNTY*

KNOW YOUR RISK



0.9
sq. mi.
of the community's land area is in the study watershed

1,267
Population based on 2017 ACS in the study watershed

5% expected population growth predicted from 2017-2023 in the community

78
policies totaling approximately $19,704,300 in coverage

1
documented repetitive loss property damaged by flood in the study watershed

0
documented severe repetitive loss properties in the study watershed

2%
Of the community's FEMA mapped** 1%-annual-chance storm flood extent areas are in the Chambers Watershed

Participating in the National Flood Insurance Program

CNMS Stream Miles in the study watershed
1.1

The are no detailed study stream miles in the study watershed
NA

4
Flood-related presidential disaster declarations in your Discovery study county

*Dallas Discovery study county has no unincorporated land in the study watershed, so these values represent the total of the incorporated community (Cedar Hill) within the part of Dallas Discovery study county in the study watershed
**National Flood Hazard Layer (NFHL)

DALLAS COUNTY

TAKE ACTION: Potential Next Step

Your Hazard Mitigation Plan is set to expire **February 22, 2021.**

The hazard mitigation goals identified projects for:

- Limit development in flood plain areas
- Buy-out repetitive loss properties
- Expand and coordinate Early Warning Systems currently in use
- Provide public education materials to residents and private sector
- Increase participation in the National Flood Insurance Program (NFIP) and Community Rating System (CRS)

FEMA's Hazard Mitigation Grant Program (HMGP), the Pre-Disaster Mitigation Grant (PDM), and TWDB's Flood Mitigation Assistance (FMA) Grant Program all fund localized Flood Risk Reduction Projects. There may be eligibility, benefit cost analysis, and cost-share requirements. The 5% Initiative in the HMGP is used for projects for which it may be difficult to conduct a standard BCA to prove cost-effectiveness, such as emergency notification, public awareness, or sirens. Information about FEMA's HMA grants[1] can be found on our website, as well as on the Texas Department of Public Safety's Emergency Management Forms and Publications[2] website. The State Hazard Mitigation Officer may be contacted for additional information. Participation in FEMA's Community Rating System[3] (CRS) reduces insurance premiums up to 45%, and FEMA will provide free technical assistance in designing and implementing programs designed to reduce flood damage. The State Hazard Mitigation Officer may be contacted for additional information.

Texas Water Development Board's[4] Flood Protection Planning (FPP) Grant, Clean and Drinking Water State Revolving Fund (CWSRF), and Texas Water Development Fund (DFund) provide additional funding or loans for hazard mitigation planning, Emergency Action plans for High Hazard dams, and other planning studies. Both CWSRF and DFund are long term-fixed interest loans which can be used for acquisition or flood-proofing insured structures, building water quality and green infrastructure.

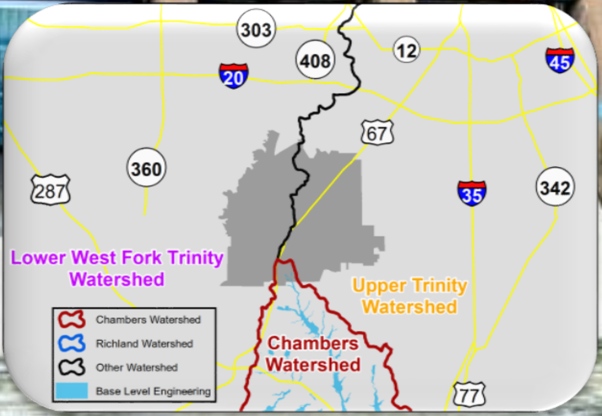
The minimum requirements for floodplain regulations are outlined in 44 Code of Federal Regulations 60.3, and local communities may choose to adopt more restrictive codes. FEMA Regional Office VI offers assistance in developing stricter codes, such as regulating construction or elevational changes in the floodplain.

1. https://www.fema.gov/hazard-mitigation-assistance.
2. https://www.dps.texas.gov/dem/downloadableforms.htm#hmgpgrants.
3. https://www.fema.gov/national-flood-insurance-program-community-rating-system
4. https://www.twdb.texas.gov/financial/programs/.

RiskMAP
Increasing Resilience Together

CITY OF CEDAR HILL

KNOW YOUR RISK



0.9 sq. mi.

of the community's land area is in the study watershed

1,267

Population based on 2017 ACS in the study watershed

5% expected population growth predicted from 2017-2023 in the community

78

policies totaling approximately $19,704,300 in coverage

1

documented repetitive loss property damaged by flood in the study watershed

0

documented severe repetitive loss properties in the study watershed

2%

Of the community's FEMA mapped* 1%-annual-chance storm flood extent areas are in the Chambers Watershed

Participating in the National Flood Insurance Program

CNMS Stream Miles in the study watershed

1.1

The are no detailed study stream miles in the study watershed

NA

4

Flood-related presidential disaster declarations in your Discovery study counties

*National Flood Hazard Layer (NFHL)

CITY OF CEDAR HILL

TAKE ACTION: Potential Next Step

Your Hazard Mitigation Plan is set to expire **February 22, 2021.**

The hazard mitigation goals identified projects for:

- Limit development in flood plain areas
- Buy-out repetitive loss properties
- Expand and coordinate Early Warning Systems currently in use
- Provide public education materials to residents and private sector
- Increase participation in the National Flood Insurance Program (NFIP) and Community Rating System (CRS)

FEMA's Hazard Mitigation Grant Program (HMGP), the Pre-Disaster Mitigation Grant (PDM), and TWDB's Flood Mitigation Assistance (FMA) Grant Program all fund localized Flood Risk Reduction Projects. There may be eligibility, benefit cost analysis, and cost-share requirements. The 5% Initiative in the HMGP is used for projects for which it may be difficult to conduct a standard BCA to prove cost-effectiveness, such as emergency notification, public awareness, or sirens. Information about FEMA's HMA grants[1] can be found on our website, as well as on the Texas Department of Public Safety's Emergency Management Forms and Publications[2] website. The State Hazard Mitigation Officer may be contacted for additional information. Participation in FEMA's Community Rating System[3] (CRS) reduces insurance premiums up to 45%, and FEMA will provide free technical assistance in designing and implementing programs designed to reduce flood damage. The State Hazard Mitigation Officer may be contacted for additional information.

Texas Water Development Board's[4] Flood Protection Planning (FPP) Grant, Clean and Drinking Water State Revolving Fund (CWSRF), and Texas Water Development Fund (DFund) provide additional funding or loans for hazard mitigation planning, Emergency Action plans for High Hazard dams, and other planning studies. Both CWSRF and DFund are long term-fixed interest loans which can be used for acquisition or flood-proofing insured structures, building water quality and green infrastructure.

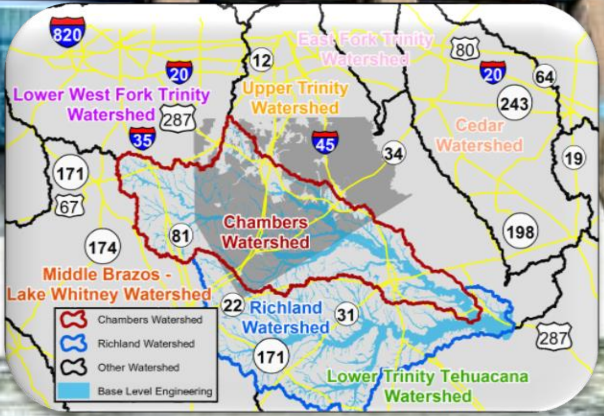
The minimum requirements for floodplain regulations are outlined in 44 Code of Federal Regulations 60.3, and local communities may choose to adopt more restrictive codes. FEMA Regional Office VI offers assistance in developing stricter codes, such as regulating construction or elevational changes in the floodplain.

1. https://www.fema.gov/hazard-mitigation-assistance.
2. https://www.dps.texas.gov/dem/downloadableforms.htm#hmgpgrants.
3. https://www.fema.gov/national-flood-insurance-program-community-rating-system
4. https://www.twdb.texas.gov/financial/programs/.

RiskMAP
Increasing Resilience Together

ELLIS COUNTY

KNOW YOUR RISK



471.7 sq. mi.

of the community's land area is in the study watersheds

33,339

Population based on 2017 ACS in the study watersheds

0% expected population growth predicted from 2017-2023 in the community

270

policies totaling approximately $74,439,800 in coverage

5

documented repetitive loss properties damaged by flood in the study watersheds

0

documented severe repetitive loss properties in the study watersheds

53%

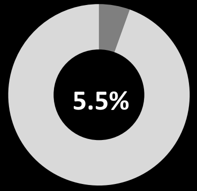
Of the community’s FEMA mapped* 1%-annual-chance storm flood extent areas are in the Chambers Watershed and Richland Watershed

Participating in the National Flood Insurance Program

CNMS Stream Miles in the study watersheds

594.3

Percentage of stream miles which are detailed study in the study watersheds



4

Flood-related presidential disaster declarations in your Discovery study county

*National Flood Hazard Layer (NFHL)

ELLIS COUNTY

TAKE ACTION: Potential Next Step

Your Hazard Mitigation Plan is set to expire **January 4, 2021.**

The hazard mitigation goals identified projects for:

- Develop and implement a comprehensive public education program
- Promote and support the CASA Weather Radar System
- Promote the use of Outdoor Warning Sirens
- Develop and execute new programs which identify and reduce threats from natural hazards

FEMA's Hazard Mitigation Grant Program (HMGP), the Pre-Disaster Mitigation Grant (PDM), and TWDB's Flood Mitigation Assistance (FMA) Grant Program all fund localized Flood Risk Reduction Projects. There may be eligibility, benefit cost analysis, and cost-share requirements. The 5% Initiative in the HMGP is used for projects for which it may be difficult to conduct a standard BCA to prove cost-effectiveness, such as emergency notification, public awareness, or sirens. Information about FEMA's HMA grants[1] can be found on our website, as well as on the Texas Department of Public Safety's Emergency Management Forms and Publications[2] website. The State Hazard Mitigation Officer may be contacted for additional information. The North Central Texas Council of Governments has proposed 8 Collaborative Adaptive Sensing of Atmosphere (CASA WX)[3] Radar systems to use for the Urban Test Bed. They are actively looking for public and private stakeholders in a metropolitan area for the next radar deployment.

Texas Water Development Board's[4] Flood Protection Planning (FPP) Grant, Clean and Drinking Water State Revolving Fund (CWSRF), and Texas Water Development Fund (DFund) provide additional funding or loans for hazard mitigation planning, Emergency Action plans for High Hazard dams, and other planning studies. Both CWSRF and DFund are long term-fixed interest loans which can be used for acquisition or flood-proofing insured structures, building water quality and green infrastructure.

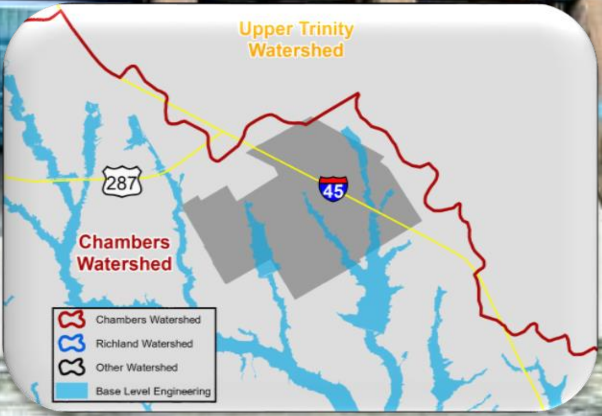
The minimum requirements for floodplain regulations are outlined in 44 Code of Federal Regulations 60.3, and local communities may choose to adopt more restrictive codes. FEMA Regional Office VI offers assistance in developing stricter codes, such as regulating construction or elevational changes in the floodplain.

1. https://www.fema.gov/hazard-mitigation-assistance
2. https://www.dps.texas.gov/dem/downloadableforms.htm#hmgpgrants
3. https://www.nctcog.org/ep/casawx
4. https://www.twdb.texas.gov/financial/programs/

RiskMAP
Increasing Resilience Together

TOWN OF ALMA

KNOW YOUR RISK



4.6 sq. mi.
of the community's land area is in the study watershed

310
Population based on 2017 ACS in the study watershed

5% expected population decline predicted from 2017-2023 in the community

0
policies totaling approximately $0 in coverage

0
documented repetitive loss properties damaged by flood in the study watershed

0
documented severe repetitive loss properties in the study watershed

100%
Of the community's FEMA mapped* 1%-annual-chance storm flood extent areas are in the Chambers Watershed

X
Not participating in the National Flood Insurance Program

CNMS Stream Miles in the study watershed
4.4

The are no detailed study stream miles in the study watershed
NA

4
Flood-related presidential disaster declarations in your Discovery study county

*National Flood Hazard Layer (NFHL)

TOWN OF ALMA

TAKE ACTION: Potential Next Step

Your Hazard Mitigation Plan is set to expire **January 4, 2021.**

The hazard mitigation goals identified projects for:

- Join National Flood Insurance Program (NFIP)
- Promote comprehensive public education program
- Promote and support the CASA Weather Radar System
- Promote the use of Outdoor Warning Sirens
- Develop and execute new programs which identify and reduce threats from hazards

FEMA’s Hazard Mitigation Grant Program (HMGP), the Pre-Disaster Mitigation Grant (PDM), and TWDB's Flood Mitigation Assistance (FMA) Grant Program all fund localized Flood Risk Reduction Projects. There may be eligibility, benefit cost analysis, and cost-share requirements. The 5% Initiative in the HMGP is used for projects for which it may be difficult to conduct a standard BCA to prove cost-effectiveness, such as emergency notification, public awareness, or sirens. FEMA also offers the National Dam Safety Program (NDSP)[1] to determine which dams are eligible for rehabilitation. Information about FEMA’s HMA grants[2] can be found on our website, as well as on the Texas Department of Public Safety’s Emergency Management Forms and Publications[3] website. The State Hazard Mitigation Officer may be contacted for additional information. The National Flood Insurance Program (NFIP) insures structures within the Special Flood Hazard Area, provides post-disaster assistance, and encourages local community regulation. More information about joining the NFIP[4] can be found on our website. The North Central Texas Council of Governments has proposed 8 Collaborative Adaptive Sensing of Atmosphere (CASA WX)[5] Radar systems to use for the Urban Test Bed. They are actively looking for public and private stakeholders in a metropolitan area for the next radar deployment.

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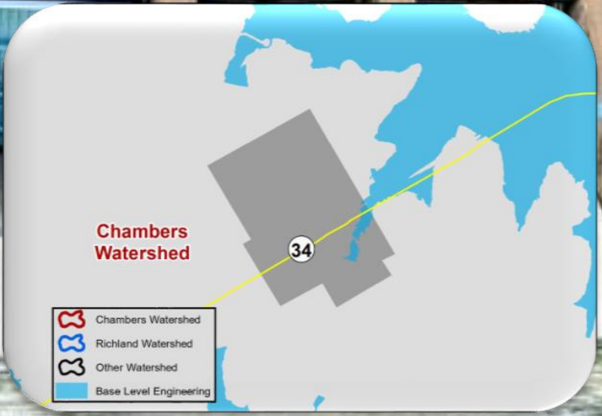
1. https://damsafety.org/dam-owners/dam-rehabilitation-funding#Grants
2. https://www.fema.gov/hazard-mitigation-assistance.
3.https://www.dps.texas.gov/dem/downloadableforms.htm#hmgpgrants
4. https://www.fema.gov/media-library/assets/documents/13610
5. https://www.nctcog.org/ep/casawx
6. https://www.twdb.texas.gov/financial/programs/.

RiskMAP
Increasing Resilience Together

CITY OF BARDWELL

KNOW YOUR RISK



0.2
sq. mi.
of the community's land area is in the study watershed

727
Population based on 2017 ACS in the study watershed

8% expected population growth predicted from 2017-2023 in the community

3
policies totaling approximately $405,000 in coverage

1
documented repetitive loss property damaged by flood in the study watershed

0
documented severe repetitive loss properties in the study watershed

100%
Of the community's FEMA mapped* 1%-annual-chance storm flood extent areas are in the Chambers Watershed

Participating in the National Flood Insurance Program

CNMS Stream Miles in the study watershed
0.4

The are no detailed study stream miles in the study watershed
NA

4
Flood-related presidential disaster declarations in your Discovery study county

*National Flood Hazard Layer (NFHL)

CITY OF BARDWELL

TAKE ACTION: Potential Next Step

Your Hazard Mitigation Plan is set to expire **January 4, 2021.**

The hazard mitigation goals identified projects for:

- Promote comprehensive public education program
- Promote and support the CASA Weather Radar System
- Promote the use of Outdoor Warning Sirens
- Develop and execute new programs which identify and reduce threats from natural hazards

FEMA's Hazard Mitigation Grant Program (HMGP), the Pre-Disaster Mitigation Grant (PDM), and TWDB's Flood Mitigation Assistance (FMA) Grant Program all fund localized Flood Risk Reduction Projects. There may be eligibility, benefit cost analysis, and cost-share requirements. The 5% Initiative in the HMGP is used for projects for which it may be difficult to conduct a standard BCA to prove cost-effectiveness, such as emergency notification, public awareness, or sirens. FEMA also offers the National Dam Safety Program (NDSP)[1] to determine which dams are eligible for rehabilitation. Information about FEMA's HMA grants[2] can be found on our website, as well as on the Texas Department of Public Safety's Emergency Management Forms and Publications[3] website. The State Hazard Mitigation Officer may be contacted for additional information. The North Central Texas Council of Governments has proposed 8 Collaborative Adaptive Sensing of Atmosphere (CASA WX)[4] Radar systems to use for the Urban Test Bed. They are actively looking for public and private stakeholders in a metropolitan area for the next radar deployment.

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2. https://www.fema.gov/hazard-mitigation-assistance
3. https://www.dps.texas.gov/dem/downloadableforms.htm#hmgpgrants
4. https://www.nctcog.org/ep/casawx
5. https://www.twdb.texas.gov/financial/programs/

RiskMAP
Increasing Resilience Together

CITY OF ENNIS

KNOW YOUR RISK

20.2
sq. mi.
of the community's land area is in the study watershed

13,401
Population based on 2017 ACS in the study watershed

1% expected population growth predicted from 2017-2023 in the community

38
policies totaling approximately $9,020,600 in coverage

0
documented repetitive loss properties damaged by flood in the study watershed

0
documented severe repetitive loss properties in the study watershed

61%
Of the community's FEMA mapped* 1%-annual-chance storm flood extent areas are in the Chambers Watershed

Participating in the National Flood Insurance Program

CNMS Stream Miles in the study watershed
9.2

The are no detailed study stream miles in the study watershed
NA

4
Flood-related presidential disaster declarations in your Discovery study county

*National Flood Hazard Layer (NFHL)

CITY OF ENNIS

TAKE ACTION: Potential Next Step

Your Hazard Mitigation Plan is set to expire **January 4, 2021.**

The hazard mitigation goals identified projects for:

- Promote comprehensive public education program
- Promote and support the CASA Weather Radar System
- Promote the use of Outdoor Warning Sirens
- Develop and execute new programs which identify and reduce threats from hazards

FEMA's Hazard Mitigation Grant Program (HMGP), the Pre-Disaster Mitigation Grant (PDM), and TWDB's Flood Mitigation Assistance (FMA) Grant Program all fund localized Flood Risk Reduction Projects. There may be eligibility, benefit cost analysis, and cost-share requirements. The 5% Initiative in the HMGP is used for projects for which it may be difficult to conduct a standard BCA to prove cost-effectiveness, such as emergency notification, public awareness, or sirens. FEMA also offers the National Dam Safety Program (NDSP)[1] to determine which dams are eligible for rehabilitation. Information about FEMA's HMA grants[2] can be found on our website, as well as on the Texas Department of Public Safety's Emergency Management Forms and Publications[3] website. The State Hazard Mitigation Officer may be contacted for additional information. The North Central Texas Council of Governments has proposed 8 Collaborative Adaptive Sensing of Atmosphere (CASA WX)[4] Radar systems to use for the Urban Test Bed. They are actively looking for public and private stakeholders in a metropolitan area for the next radar deployment.

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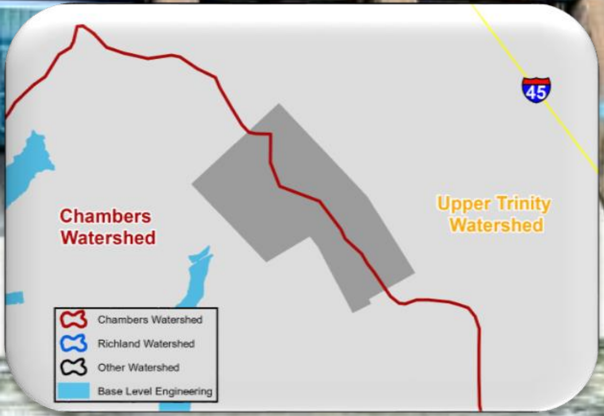
5. https://www.twdb.texas.gov/financial/programs/

TOWN OF GARRETT

KNOW YOUR RISK



0.1
sq. mi.
of the community's land area is in the study watershed

526
Population based on 2017 ACS in the study watershed

8% expected population growth predicted from 2017-2023 in the community

0
policies totaling approximately $0 in coverage

0
documented repetitive loss properties damaged by flood in the study watershed

0
documented severe repetitive loss properties in the study watershed

X
Garrett does not contain FEMA mapped* 1%-annual-chance storm flood extent areas in the Chambers Watershed

X
Not participating in the National Flood Insurance Program

CNMS Stream Miles in the study watershed
0

The are no detailed study stream miles in the study watershed
NA

4
Flood-related presidential disaster declarations in your Discovery study county

*National Flood Hazard Layer (NFHL)

TOWN OF GARRETT

TAKE ACTION: Potential Next Step

Your Hazard Mitigation Plan is set to expire **January 4, 2021.**

The hazard mitigation goals identified projects for:

- Join National Flood Insurance Program (NFIP)
- Promote comprehensive public education program
- Promote and support the CASA Weather Radar System
- Promote the use of Outdoor Warning Sirens
- Develop and execute new programs which identify and reduce threats from hazards

FEMA's Hazard Mitigation Grant Program (HMGP), the Pre-Disaster Mitigation Grant (PDM), and TWDB's Flood Mitigation Assistance (FMA) Grant Program all fund localized Flood Risk Reduction Projects. There may be eligibility, benefit cost analysis, and cost-share requirements. The 5% Initiative in the HMGP is used for projects for which it may be difficult to conduct a standard BCA to prove cost-effectiveness, such as emergency notification, public awareness, or sirens. FEMA also offers the National Dam Safety Program (NDSP)[1] to determine which dams are eligible for rehabilitation. Information about FEMA's HMA grants[2] can be found on our website, as well as on the Texas Department of Public Safety's Emergency Management Forms and Publications[3] website. The State Hazard Mitigation Officer may be contacted for additional information. The National Flood Insurance Program (NFIP) insures structures within the Special Flood Hazard Area, provides post-disaster assistance, and encourages local community regulation. More information about joining the NFIP[4] can be found on our website. The North Central Texas Council of Governments has proposed 8 Collaborative Adaptive Sensing of Atmosphere (CASA WX)[5] Radar systems to use for the Urban Test Bed. They are actively looking for public and private stakeholders in a metropolitan area for the next radar deployment.

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The minimum requirements for floodplain regulations are outlined in 44 Code of Federal Regulations 60.3, and local communities may choose to adopt more restrictive codes. FEMA Regional Office VI offers assistance in developing stricter codes, such as regulating construction or elevational changes in the floodplain.

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3. https://www.dps.texas.gov/dem/downloadableforms.htm#hmgpgrants
4. https://www.fema.gov/media-library/assets/documents/13610
5. https://www.nctcog.org/ep/casawx
6 https://www.twdb.texas.gov/financial/programs/

RiskMAP
Increasing Resilience Together

TOWN OF ITALY

KNOW YOUR RISK

2.2
sq. mi.
of the community's land area is in the study watershed

1,835
Population based on 2017 ACS in the study watershed

1% expected population decline predicted from 2017-2023 in the community

4
policies totaling approximately $1,015,000 in coverage

0
documented repetitive loss properties damaged by flood in the study watershed

0
documented severe repetitive loss properties in the study watershed

100%
Of the community's FEMA mapped* 1%-annual-chance storm flood extent areas are in the Chambers Watershed

Participating in the National Flood Insurance Program

CNMS Stream Miles in the study watershed
1.9

The are no detailed study stream miles in the study watershed
NA

4
Flood-related presidential disaster declarations in your Discovery study county

*National Flood Hazard Layer (NFHL)

TOWN OF ITALY

TAKE ACTION: Potential Next Step

Your Hazard Mitigation Plan is set to expire **January 4, 2021.**

The hazard mitigation goals identified projects for:

- Promote comprehensive public education program
- Promote and support the CASA Weather Radar System
- Promote the use of Outdoor Warning Sirens
- Develop and execute new programs which identify and reduce threats from hazards

FEMA's Hazard Mitigation Grant Program (HMGP), the Pre-Disaster Mitigation Grant (PDM), and TWDB's Flood Mitigation Assistance (FMA) Grant Program all fund localized Flood Risk Reduction Projects. There may be eligibility, benefit cost analysis, and cost-share requirements. The 5% Initiative in the HMGP is used for projects for which it may be difficult to conduct a standard BCA to prove cost-effectiveness, such as emergency notification, public awareness, or sirens. FEMA also offers the National Dam Safety Program (NDSP)[1] to determine which dams are eligible for rehabilitation. Information about FEMA's HMA grants[2] can be found on our website, as well as on the Texas Department of Public Safety's Emergency Management Forms and Publications[3] website. The State Hazard Mitigation Officer may be contacted for additional information. The North Central Texas Council of Governments has proposed 8 Collaborative Adaptive Sensing of Atmosphere (CASA WX)[4] Radar systems to use for the Urban Test Bed. They are actively looking for public and private stakeholders in a metropolitan area for the next radar deployment.

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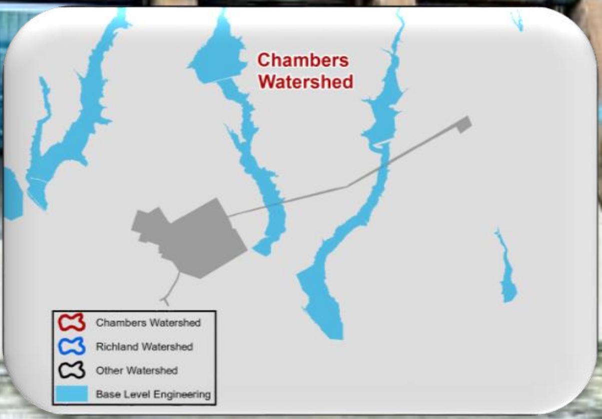
5. https://www.twdb.texas.gov/financial/programs/

RiskMAP
Increasing Resilience Together

CITY OF MAYPEARL

KNOW YOUR RISK



0.8
sq. mi.
of the community's land area is in the study watershed

809
Population based on 2017 ACS in the study watershed

11% expected population decline predicted from 2017-2023 in the community

3
policies totaling approximately $1,075,000 in coverage

0
documented repetitive loss properties damaged by flood in the study watershed

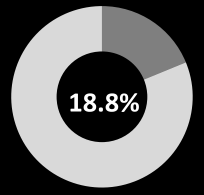
0
documented severe repetitive loss properties in the study watershed

100%
Of the community's FEMA mapped* 1%-annual-chance storm flood extent areas are in the Chambers Watershed

Participating in the National Flood Insurance Program

CNMS Stream Miles in the study watershed
0.8

Percentage of stream miles which are detailed study in the study watershed



4
Flood-related presidential disaster declarations in your Discovery study county

*National Flood Hazard Layer (NFHL)

CITY OF MAYPEARL

TAKE ACTION: Potential Next Step

Your Hazard Mitigation Plan is set to expire **January 4, 2021.**

The hazard mitigation goals identified projects for:

- Promote comprehensive public education program
- Promote and support the CASA Weather Radar System
- Promote the use of Outdoor Warning Sirens
- Develop and execute new programs which identify and reduce threats from hazards

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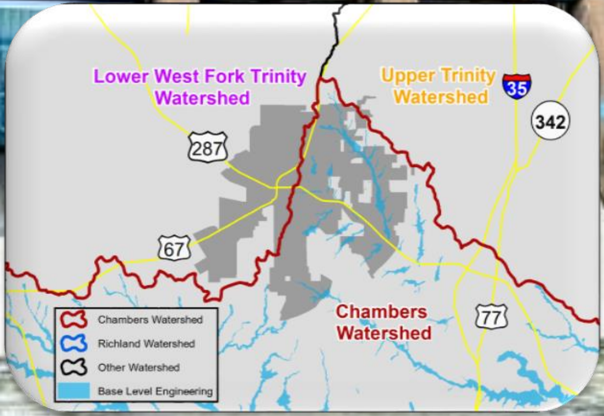
RiskMAP
Increasing Resilience Together

CITY OF MIDLOTHIAN

KNOW YOUR RISK



30.0
sq. mi.
of the community's land area is in the study watershed

13,576
Population based on 2017 ACS in the study watershed

14% expected population growth predicted from 2017-2023 in the community

71
policies totaling approximately $19,935,800 in coverage

0
documented repetitive loss properties damaged by flood in the study watershed

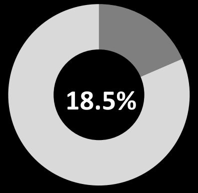
0
documented severe repetitive loss properties in the study watershed

58%
Of the community's FEMA mapped* 1%-annual-chance storm flood extent areas are in the Chambers Watershed

Participating in the National Flood Insurance Program

CNMS Stream Miles in the study watershed
21.1

Percentage of stream miles which are detailed study in the study watershed



4
Flood-related presidential disaster declarations in your Discovery study county

*National Flood Hazard Layer (NFHL)

CITY OF MIDLOTHIAN

TAKE ACTION: Potential Next Step

Your Hazard Mitigation Plan is set to expire **January 4, 2021.**

The hazard mitigation goals identified projects for:

- Promote comprehensive public education program
- Promote and support the CASA Weather Radar System
- Promote the use of Outdoor Warning Sirens
- Develop and execute new programs which identify and reduce threats from hazards

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The minimum requirements for floodplain regulations are outlined in 44 Code of Federal Regulations 60.3, and local communities may choose to adopt more restrictive codes. FEMA Regional Office VI offers assistance in developing stricter codes, such as regulating construction or elevational changes in the floodplain.

1. https://damsafety.org/dam-owners/dam-rehabilitation-funding#Grants
2. https://www.fema.gov/hazard-mitigation-assistance
3. https://www.dps.texas.gov/dem/downloadableforms.htm#hmgpgrants
4. https://www.nctcog.org/ep/casawx
5. https://www.twdb.texas.gov/financial/programs/

RiskMAP
Increasing Resilience Together

TOWN OF MILFORD

KNOW YOUR RISK

2.0 sq. mi.

of the community's land area is in the study watersheds

717

Population based on 2017 ACS in the study watersheds

1% expected population decline predicted from 2017-2023 in the community

0

policies totaling approximately $0 in coverage

0

documented repetitive loss properties damaged by flood in the study watersheds

0

documented severe repetitive loss properties in the study watersheds

100%

Of the community's FEMA mapped* 1%-annual-chance storm flood extent areas are in the Chambers Watershed and Richland Watershed

Participating in the National Flood Insurance Program

CNMS Stream Miles in the study watersheds

0.6

The are no detailed study stream miles in the study watersheds

NA

4

Flood-related presidential disaster declarations in your Discovery study county

*National Flood Hazard Layer (NFHL)

TOWN OF MILFORD

TAKE ACTION: Potential Next Step

Your Hazard Mitigation Plan is set to expire **January 4, 2021.**

The hazard mitigation goals identified projects for:

- Promote comprehensive public education program
- Promote and support the CASA Weather Radar System
- Promote the use of Outdoor Warning Sirens
- Develop and execute new programs which identify and reduce threats from hazards

FEMA's Hazard Mitigation Grant Program (HMGP), the Pre-Disaster Mitigation Grant (PDM), and TWDB's Flood Mitigation Assistance (FMA) Grant Program all fund localized Flood Risk Reduction Projects. There may be eligibility, benefit cost analysis, and cost-share requirements. The 5% Initiative in the HMGP is used for projects for which it may be difficult to conduct a standard BCA to prove cost-effectiveness, such as emergency notification, public awareness, or sirens. FEMA also offers the National Dam Safety Program (NDSP)[1] to determine which dams are eligible for rehabilitation. Information about FEMA's HMA grants[2] can be found on our website, as well as on the Texas Department of Public Safety's Emergency Management Forms and Publications[3] website. The State Hazard Mitigation Officer may be contacted for additional information. The North Central Texas Council of Governments has proposed 8 Collaborative Adaptive Sensing of Atmosphere (CASA WX)[4] Radar systems to use for the Urban Test Bed. They are actively looking for public and private stakeholders in a metropolitan area for the next radar deployment.

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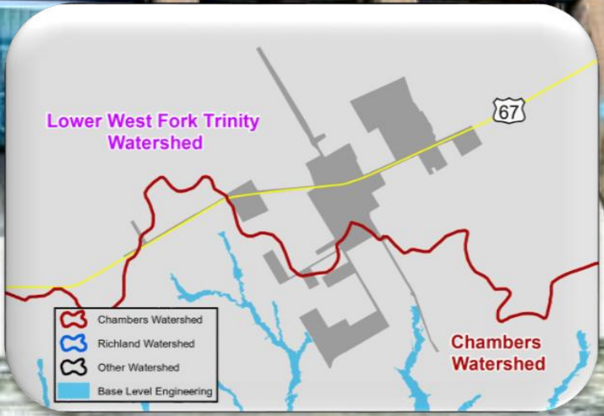
4. https://www.nctcog.org/ep/casawx
5. https://www.twdb.texas.gov/financial/programs/

TOWN OF VENUS

KNOW YOUR RISK



0.9
sq. mi.
of the community's land area is in the study watershed

905
Population based on 2017 ACS in the study watershed

8% expected population growth predicted from 2017-2023 in the community

5
policies totaling approximately $524,900 in coverage

0
documented repetitive loss properties damaged by flood in the study watershed

0
documented severe repetitive loss properties in the study watershed

3%
Of the community's FEMA mapped* 1%-annual-chance storm flood extent areas are in the Chambers Watershed

Participating in the National Flood Insurance Program

CNMS Stream Miles in the study watershed
0

The are no detailed study stream miles in the study watershed
NA

8
Flood-related presidential disaster declarations in your Discovery study counties

*National Flood Hazard Layer (NFHL)

TOWN OF VENUS

TAKE ACTION: Potential Next Step

You **do not** have a Hazard Mitigation Plan.

The hazard mitigation goals identified projects for:

- Create and adopt a Hazard Mitigation Plan
- Promote comprehensive public education program
- Promote and support the CASA Weather Radar System
- Promote the use of Outdoor Warning Sirens
- Develop and execute new programs which identify and reduce threats from hazards

FEMA's Hazard Mitigation Grant Program (HMGP), the Pre-Disaster Mitigation Grant (PDM), and TWDB's Flood Mitigation Assistance (FMA) Grant Program all fund localized Flood Risk Reduction Projects. There may be eligibility, benefit cost analysis, and cost-share requirements. The 5% Initiative in the HMGP is used for projects for which it may be difficult to conduct a standard BCA to prove cost-effectiveness, such as emergency notification, public awareness, or sirens. FEMA also offers the National Dam Safety Program (NDSP)[1] to determine which dams are eligible for rehabilitation. Information about FEMA's HMA grants[2] can be found on our website, as well as on the Texas Department of Public Safety's Emergency Management Forms and Publications[3] website. The State Hazard Mitigation Officer may be contacted for additional information. The North Central Texas Council of Governments has proposed 8 Collaborative Adaptive Sensing of Atmosphere (CASA WX)[4] Radar systems to use for the Urban Test Bed. They are actively looking for public and private stakeholders in a metropolitan area for the next radar deployment.

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The minimum requirements for floodplain regulations are outlined in 44 Code of Federal Regulations 60.3, and local communities may choose to adopt more restrictive codes. FEMA Regional Office VI offers assistance in developing stricter codes, such as regulating construction or elevational changes in the floodplain.

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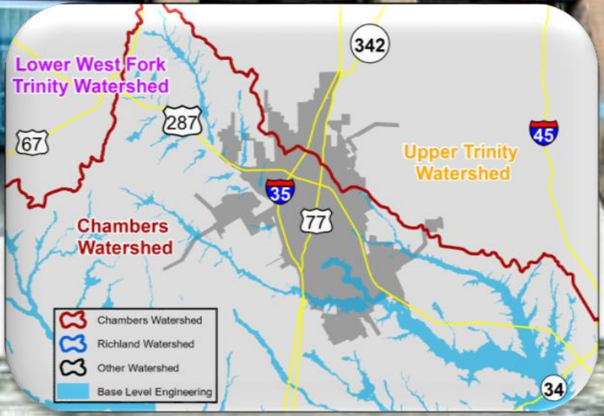
2. https://www.fema.gov/hazard-mitigation-assistance
3. https://www.dps.texas.gov/dem/downloadableforms.htm#hmgpgrants
4. https://www.nctcog.org/ep/casawx
5. https://www.twdb.texas.gov/financial/programs/

RiskMAP
Increasing Resilience Together

CITY OF WAXAHACHIE

KNOW YOUR RISK



40.5
sq. mi.
of the community's land area is in the study watershed

26,465
Population based on 2017 ACS in the study watershed

8% expected population growth predicted from 2017-2023 in the community

141
policies totaling approximately $35,970,300 in coverage

3
documented repetitive loss properties damaged by flood in the study watershed

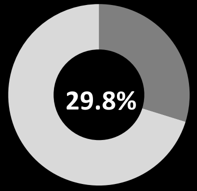
0
documented severe repetitive loss properties in the study watershed

88%
Of the community's FEMA mapped* 1%-annual-chance storm flood extent areas are in the Chambers Watershed

Participating in the National Flood Insurance Program

CNMS Stream Miles in the study watershed
29.4

Percentage of stream miles which are detailed study in the study watershed



4
Flood-related presidential disaster declarations in your Discovery study county

*National Flood Hazard Layer (NFHL)

CITY OF WAXAHACHIE

TAKE ACTION: Potential Next Step

Your Hazard Mitigation Plan is set to expire **January 4, 2021.**

The hazard mitigation goals identified projects for:

- Promote comprehensive public education program
- Promote and support the CASA Weather Radar System
- Promote the use of Outdoor Warning Sirens
- Develop and execute new programs which identify and reduce threats from hazards

FEMA's Hazard Mitigation Grant Program (HMGP), the Pre-Disaster Mitigation Grant (PDM), and TWDB's Flood Mitigation Assistance (FMA) Grant Program all fund localized Flood Risk Reduction Projects. There may be eligibility, benefit cost analysis, and cost-share requirements. The 5% Initiative in the HMGP is used for projects for which it may be difficult to conduct a standard BCA to prove cost-effectiveness, such as emergency notification, public awareness, or sirens. FEMA also offers the National Dam Safety Program (NDSP)[1] to determine which dams are eligible for rehabilitation. Information about FEMA's HMA grants[2] can be found on our website, as well as on the Texas Department of Public Safety's Emergency Management Forms and Publications[3] website. The State Hazard Mitigation Officer may be contacted for additional information. The North Central Texas Council of Governments has proposed 8 Collaborative Adaptive Sensing of Atmosphere (CASA WX)[4] Radar systems to use for the Urban Test Bed. They are actively looking for public and private stakeholders in a metropolitan area for the next radar deployment.

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The minimum requirements for floodplain regulations are outlined in 44 Code of Federal Regulations 60.3, and local communities may choose to adopt more restrictive codes. FEMA Regional Office VI offers assistance in developing stricter codes, such as regulating construction or elevational changes in the floodplain.

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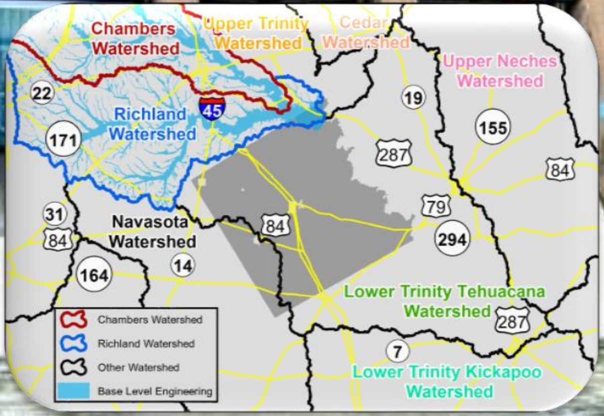
3. https://www.dps.texas.gov/dem/downloadableforms.htm#hmgpgrants
4. https://www.nctcog.org/ep/casawx
5. https://www.twdb.texas.gov/financial/programs/

RiskMAP
Increasing Resilience Together

FREESTONE COUNTY

KNOW YOUR RISK



15.8
sq. mi.
of the community's land area is in the study watershed

212
Population based on 2017 ACS in the study watershed

0% expected population growth predicted from 2017-2023 in the community

30
policies totaling approximately $7,453,500 in coverage

0
documented repetitive loss properties damaged by flood in the study watershed

0
documented severe repetitive loss properties in the study watershed

24%
Of the community's FEMA mapped* 1%-annual-chance storm flood extent areas are in the Richland Watershed

Participating in the National Flood Insurance Program

CNMS Stream Miles in the study watershed
22.2

The are no detailed study stream miles in the study watershed
NA

5
Flood-related presidential disaster declarations in your Discovery study county

*National Flood Hazard Layer (NFHL)

FREESTONE COUNTY

TAKE ACTION: Potential Next Step

Your Hazard Mitigation Plan is **expired.**

The hazard mitigation goals identified projects for:

- Create and adopt a Hazard Mitigation Plan
- Promote the use of Early Warning Systems
- Educate the public about emergency preparedness
- Create and implement buyout program for structures within the 100 year floodplain

FEMA's Hazard Mitigation Grant Program (HMGP), the Pre-Disaster Mitigation Grant (PDM), and TWDB's Flood Mitigation Assistance (FMA) Grant Program all fund localized Flood Risk Reduction Projects. HMGP and PDM allow for the funding of generators at critical facilities. There may be eligibility, benefit cost analysis, and cost-share requirements. The 5% Initiative in the HMGP is used for projects for which it may be difficult to conduct a standard BCA to prove cost-effectiveness, such as emergency notification, public awareness, or sirens. HMGP also offers funding for post disaster code enforcement, including debris removal strategies. PDM grants are able to fund stream restoration projects. Information about FEMA's HMA grants[1] can be found on our website, as well as on the Texas Department of Public Safety's Emergency Management Forms and Publications[2] website. The State Hazard Mitigation Officer may be contacted for additional information.

Texas Water Development Board's[3] Flood Protection Planning (FPP) Grant, Clean and Drinking Water State Revolving Fund (CWSRF), and Texas Water Development Fund (DFund) provide additional funding or loans for hazard mitigation planning, Emergency Action plans for High Hazard dams, and other planning studies. Both CWSRF and DFund are long term-fixed interest loans which can be used for acquisition or flood-proofing insured structures, building water quality and green infrastructure.

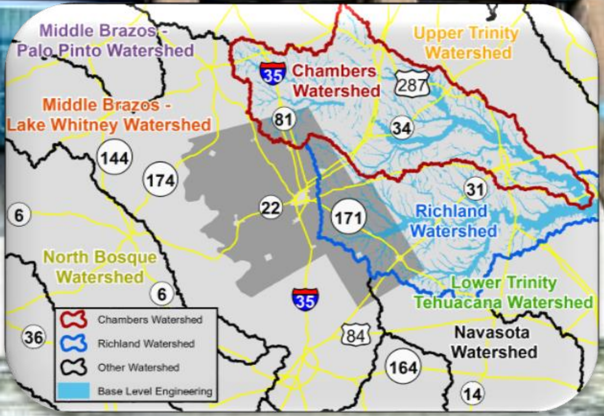
The minimum requirements for floodplain regulations are outlined in 44 Code of Federal Regulations 60.3, and local communities may choose to adopt more restrictive codes. FEMA Regional Office VI offers assistance in developing stricter codes, such as regulating construction or elevational changes in the floodplain.

1. https://www.fema.gov/hazard-mitigation-assistance.
2. https://www.dps.texas.gov/dem/downloadableforms.htm#hmgpgrants.
3. https://www.twdb.texas.gov/financial/programs/.

RiskMAP
Increasing Resilience Together

HILL COUNTY

KNOW YOUR RISK



315.9 sq. mi.

of the community's land area is in the study watersheds

6,300

Population based on 2017 ACS in the study watersheds

1% expected population growth predicted from 2017-2023 in the community

41

policies totaling approximately $10,133,400 in coverage

0

documented repetitive loss properties damaged by flood in the study watersheds

0

documented severe repetitive loss properties in the study watersheds

28%

Of the community's FEMA mapped* 1%-annual-chance storm flood extent areas are in the Chambers Watershed and Richland Watershed

Participating in the National Flood Insurance Program

CNMS Stream Miles in the study watersheds

334.3

The are no detailed study stream miles in the study watersheds

NA

8

Flood-related presidential disaster declarations in your Discovery study county

*National Flood Hazard Layer (NFHL)

HILL COUNTY

TAKE ACTION: Potential Next Step

Your Hazard Mitigation Plan is **awaiting approval.**

The hazard mitigation goals identified projects for:

- Adopt new Hazard Mitigation Plan
- Use Early Warning Systems
- Educate the public on actions to take to prevent or reduce loss of life or property
- Maximize the use of outside sources of funding
- Promote beneficial uses of hazardous areas while expanding open spaces and recreational opportunities

FEMA's Hazard Mitigation Grant Program (HMGP), the Pre-Disaster Mitigation Grant (PDM), and TWDB's Flood Mitigation Assistance (FMA) Grant Program all fund localized Flood Risk Reduction Projects. HMGP and PDM allow for the funding of generators at critical facilities. There may be eligibility, benefit cost analysis, and cost-share requirements. The 5% Initiative in the HMGP is used for projects for which it may be difficult to conduct a standard BCA to prove cost-effectiveness, such as emergency notification, public awareness, or sirens. HMGP also offers funding for post disaster code enforcement, including debris removal strategies. PDM grants are able to fund stream restoration projects. Information about FEMA's HMA grants[1] can be found on our website, as well as on the Texas Department of Public Safety's Emergency Management Forms and Publications[2] website. The State Hazard Mitigation Officer may be contacted for additional information.

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The minimum requirements for floodplain regulations are outlined in 44 Code of Federal Regulations 60.3, and local communities may choose to adopt more restrictive codes. FEMA Regional Office VI offers assistance in developing stricter codes, such as regulating construction or elevational changes in the floodplain.

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3. https://www.twdb.texas.gov/financial/programs/.

RiskMAP
Increasing Resilience Together

TOWN OF BYNUM

KNOW YOUR RISK

0.1
sq. mi.
of the community's land area is in the study watershed

260
Population based on 2017 ACS in the study watershed

17% expected population growth predicted from 2017-2023 in the community

0
policies totaling approximately $0 in coverage

0
documented repetitive loss properties damaged by flood in the study watershed

0
documented severe repetitive loss properties in the study watershed

X
Bynum does not contain FEMA mapped* 1%-annual-chance storm flood extent areas in the Richland Watershed

X
Not participating in the National Flood Insurance Program

CNMS Stream Miles in the study watershed
0

The are no detailed study stream miles in the study watershed
NA

8
Flood-related presidential disaster declarations in your Discovery study county

*National Flood Hazard Layer (NFHL)

TOWN OF BYNUM

TAKE ACTION: Potential Next Step

Your Hazard Mitigation Plan is **awaiting approval.**

The hazard mitigation goals identified projects for:

- Join National Flood Insurance Program (NFIP)
- Adopt new Hazard Mitigation Plan
- Use Early Warning Systems
- Educate the public on actions to take to prevent or reduce loss of life or property
- Maximize the use of outside sources of funding

FEMA's Hazard Mitigation Grant Program (HMGP), the Pre-Disaster Mitigation Grant (PDM), and TWDB's Flood Mitigation Assistance (FMA) Grant Program all fund localized Flood Risk Reduction Projects. HMGP and PDM allow for the funding of generators at critical facilities. There may be eligibility, benefit cost analysis, and cost-share requirements. The 5% Initiative in the HMGP is used for projects for which it may be difficult to conduct a standard BCA to prove cost-effectiveness, such as emergency notification, public awareness, or sirens. HMGP also offers funding for post disaster code enforcement, including debris removal strategies. PDM grants are able to fund stream restoration projects. Information about FEMA's HMA grants[1] can be found on our website, as well as on the Texas Department of Public Safety's Emergency Management Forms and Publications[2] website. The State Hazard Mitigation Officer may be contacted for additional information. The National Flood Insurance Program (NFIP) insures structures within the Special Flood Hazard Area, provides post-disaster assistance, and encourages local community regulation. More information about and about joining the NFIP[3] can be found on our website

Texas Water Development Board's[4] Flood Protection Planning (FPP) Grant, Clean and Drinking Water State Revolving Fund (CWSRF), and Texas Water Development Fund (DFund) provide additional funding or loans for hazard mitigation planning, Emergency Action plans for High Hazard dams, and other planning studies. Both CWSRF and DFund are long term-fixed interest loans which can be used for acquisition or flood-proofing insured structures, building water quality and green infrastructure.

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2. https://www.dps.texas.gov/dem/downloadableforms.htm#hmgpgrants.
3. https://www.fema.gov/media-library/assets/documents/13610
4. https://www.twdb.texas.gov/financial/programs/.

RiskMAP
Increasing Resilience Together

TOWN OF CARL’S CORNER

KNOW YOUR RISK

1.6 sq. mi.

of the community's land area is in the study watershed

142

Population based on 2017 ACS in the study watershed

1% expected population decline predicted from 2017-2023 in the community

0

policies totaling approximately $0 in coverage

0

documented repetitive loss properties damaged by flood in the study watershed

0

documented severe repetitive loss properties in the study watershed

100%

Of the community’s FEMA mapped* 1%-annual-chance storm flood extent areas are in the Richland Watershed

X

Not participating in the National Flood Insurance Program

CNMS Stream Miles in the study watershed

0

The are no detailed study stream miles in the study watershed

NA

8

Flood-related presidential disaster declarations in your Discovery study county

*National Flood Hazard Layer (NFHL)

TOWN OF CARL'S CORNER

TAKE ACTION: Potential Next Step

You **do not** have a Hazard Mitigation Plan.

The hazard mitigation goals identified projects for:

- Join National Flood Insurance Program (NFIP)
- Create and adopt a Hazard Mitigation Plan
- Use Early Warning Systems
- Educate the public on actions to take to prevent or reduce loss of life or property
- Maximize the use of outside sources of funding

FEMA's Hazard Mitigation Grant Program (HMGP), the Pre-Disaster Mitigation Grant (PDM), and TWDB's Flood Mitigation Assistance (FMA) Grant Program all fund localized Flood Risk Reduction Projects. HMGP and PDM allow for the funding of generators at critical facilities. There may be eligibility, benefit cost analysis, and cost-share requirements. The 5% Initiative in the HMGP is used for projects for which it may be difficult to conduct a standard BCA to prove cost-effectiveness, such as emergency notification, public awareness, or sirens. HMGP also offers funding for post disaster code enforcement, including debris removal strategies. PDM grants are able to fund stream restoration projects. Information about FEMA's HMA grants[1] can be found on our website, as well as on the Texas Department of Public Safety's Emergency Management Forms and Publications[2] website. The State Hazard Mitigation Officer may be contacted for additional information. The National Flood Insurance Program (NFIP) insures structures within the Special Flood Hazard Area, provides post-disaster assistance, and encourages local community regulation. More information about and about joining the NFIP[3] can be found on our website

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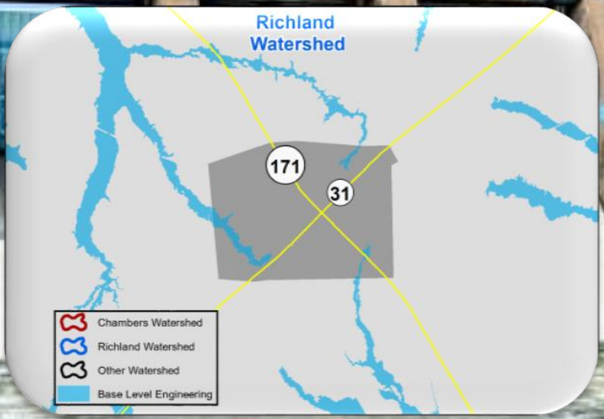
3. https://www.fema.gov/media-library/assets/documents/13610
4. https://www.twdb.texas.gov/financial/programs/.

CITY OF HUBBARD

KNOW YOUR RISK



1.7 sq. mi.
of the community's land area is in the study watershed

1,607
Population based on 2017 ACS in the study watershed

8% expected population growth predicted from 2017-2023 in the community

0
policies totaling approximately $0 in coverage

0
documented repetitive loss properties damaged by flood in the study watershed

0
documented severe repetitive loss properties in the study watershed

100%
Of the community's FEMA mapped* 1%-annual-chance storm flood extent areas are in the Richland Watershed

Participating in the National Flood Insurance Program

CNMS Stream Miles in the study watershed
1.8

The are no detailed study stream miles in the study watershed
NA

8
Flood-related presidential disaster declarations in your Discovery study county

*National Flood Hazard Layer (NFHL)

CITY OF HUBBARD

TAKE ACTION: Potential Next Step

Your Hazard Mitigation Plan is **awaiting approval.**

The hazard mitigation goals identified projects for:

- Adopt new Hazard Mitigation Plan
- Use Early Warning Systems
- Educate the public on actions to take to prevent or reduce loss of life or property
- Maximize the use of outside sources of funding
- Promote beneficial uses of hazardous areas while expanding open spaces

FEMA's Hazard Mitigation Grant Program (HMGP), the Pre-Disaster Mitigation Grant (PDM), and TWDB's Flood Mitigation Assistance (FMA) Grant Program all fund localized Flood Risk Reduction Projects. HMGP and PDM allow for the funding of generators at critical facilities. There may be eligibility, benefit cost analysis, and cost-share requirements. The 5% Initiative in the HMGP is used for projects for which it may be difficult to conduct a standard BCA to prove cost-effectiveness, such as emergency notification, public awareness, or sirens. HMGP also offers funding for post disaster code enforcement, including debris removal strategies. PDM grants are able to fund stream restoration projects. Information about FEMA's HMA grants[1] can be found on our website, as well as on the Texas Department of Public Safety's Emergency Management Forms and Publications[2] website. The State Hazard Mitigation Officer may be contacted for additional information.

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RiskMAP
Increasing Resilience Together

CITY OF ITASCA

KNOW YOUR RISK

0.7 sq. mi.
of the community's land area is in the study watershed

434
Population based on 2017 ACS in the study watershed

18% expected population decline predicted from 2017-2023 in the community

1
policies totaling approximately $241,000 in coverage

0
documented repetitive loss properties damaged by flood in the study watershed

0
documented severe repetitive loss properties in the study watershed

X
Itasca does not contain FEMA mapped* 1%-annual-chance storm flood extent areas in the Chambers Watershed

Participating in the National Flood Insurance Program

CNMS Stream Miles in the study watershed
0

The are no detailed study stream miles in the study watershed
NA

8
Flood-related presidential disaster declarations in your Discovery study county

*National Flood Hazard Layer (NFHL)

CITY OF ITASCA

TAKE ACTION: Potential Next Step

Your Hazard Mitigation Plan is **awaiting approval.**

The hazard mitigation goals identified projects for:

- Adopt new Hazard Mitigation Plan
- Use Early Warning Systems
- Educate the public on actions to take to prevent or reduce loss of life or property
- Maximize the use of outside sources of funding
- Promote beneficial uses of hazardous areas while expanding open spaces

FEMA's Hazard Mitigation Grant Program (HMGP), the Pre-Disaster Mitigation Grant (PDM), and TWDB's Flood Mitigation Assistance (FMA) Grant Program all fund localized Flood Risk Reduction Projects. HMGP and PDM allow for the funding of generators at critical facilities. There may be eligibility, benefit cost analysis, and cost-share requirements. The 5% Initiative in the HMGP is used for projects for which it may be difficult to conduct a standard BCA to prove cost-effectiveness, such as emergency notification, public awareness, or sirens. HMGP also offers funding for post disaster code enforcement, including debris removal strategies. PDM grants are able to fund stream restoration projects. Information about FEMA's HMA grants[1] can be found on our website, as well as on the Texas Department of Public Safety's Emergency Management Forms and Publications[2] website. The State Hazard Mitigation Officer may be contacted for additional information.

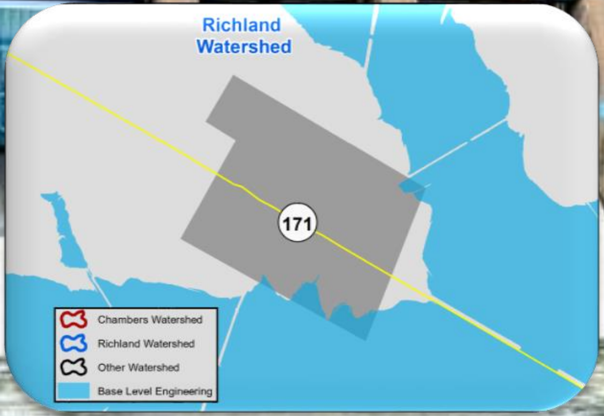
Texas Water Development Board's[3] Flood Protection Planning (FPP) Grant, Clean and Drinking Water State Revolving Fund (CWSRF), and Texas Water Development Fund (DFund) provide additional funding or loans for hazard mitigation planning, Emergency Action plans for High Hazard dams, and other planning studies. Both CWSRF and DFund are long term-fixed interest loans which can be used for acquisition or flood-proofing insured structures, building water quality and green infrastructure.

The minimum requirements for floodplain regulations are outlined in 44 Code of Federal Regulations 60.3, and local communities may choose to adopt more restrictive codes. FEMA Regional Office VI offers assistance in developing stricter codes, such as regulating construction or elevational changes in the floodplain.

1. https://www.fema.gov/hazard-mitigation-assistance.
2. https://www.dps.texas.gov/dem/downloadableforms.htm#hmgpgrants.
3. https://www.twdb.texas.gov/financial/programs/.

TOWN OF MALONE

KNOW YOUR RISK



0.4 sq. mi.

of the community's land area is in the study watershed

265

Population based on 2017 ACS in the study watershed

1% expected population decline predicted from 2017-2023 in the community

0

policies totaling approximately $0 in coverage

0

documented repetitive loss properties damaged by flood in the study watershed

0

documented severe repetitive loss properties in the study watershed

100%

Of the community's FEMA mapped* 1%-annual-chance storm flood extent areas are in the Richland Watershed

Participating in the National Flood Insurance Program

CNMS Stream Miles in the study watershed

1.2

The are no detailed study stream miles in the study watershed

NA

8

Flood-related presidential disaster declarations in your Discovery study county

*National Flood Hazard Layer (NFHL)

TOWN OF MALONE

TAKE ACTION: Potential Next Step

Your Hazard Mitigation Plan is **awaiting approval.**

The hazard mitigation goals identified projects for:

- Adopt new Hazard Mitigation Plan
- Use Early Warning Systems
- Educate the public on actions to take to prevent or reduce loss of life or property
- Maximize the use of outside sources of funding
- Promote beneficial uses of hazardous areas while expanding open spaces

FEMA's Hazard Mitigation Grant Program (HMGP), the Pre-Disaster Mitigation Grant (PDM), and TWDB's Flood Mitigation Assistance (FMA) Grant Program all fund localized Flood Risk Reduction Projects. HMGP and PDM allow for the funding of generators at critical facilities. There may be eligibility, benefit cost analysis, and cost-share requirements. The 5% Initiative in the HMGP is used for projects for which it may be difficult to conduct a standard BCA to prove cost-effectiveness, such as emergency notification, public awareness, or sirens. HMGP also offers funding for post disaster code enforcement, including debris removal strategies. PDM grants are able to fund stream restoration projects. Information about FEMA's HMA grants[1] can be found on our website, as well as on the Texas Department of Public Safety's Emergency Management Forms and Publications[2] website. The State Hazard Mitigation Officer may be contacted for additional information.

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The minimum requirements for floodplain regulations are outlined in 44 Code of Federal Regulations 60.3, and local communities may choose to adopt more restrictive codes. FEMA Regional Office VI offers assistance in developing stricter codes, such as regulating construction or elevational changes in the floodplain.

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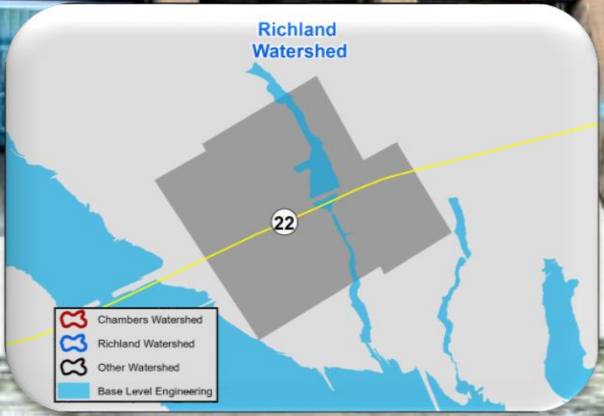
3. https://www.twdb.texas.gov/financial/programs/.

TOWN OF MERTENS

KNOW YOUR RISK



0.5 sq. mi.

of the community's land area is in the study watershed

119

Population based on 2017 ACS in the study watershed

4% expected population decline predicted from 2017-2023 in the community

0

policies totaling approximately $0 in coverage

0

documented repetitive loss properties damaged by flood in the study watershed

0

documented severe repetitive loss properties in the study watershed

100%

Of the community's FEMA mapped* 1%-annual-chance storm flood extent areas are in the Richland Watershed

Participating in the National Flood Insurance Program

CNMS Stream Miles in the study watershed

0

The are no detailed study stream miles in the study watershed

NA

8

Flood-related presidential disaster declarations in your Discovery study county

*National Flood Hazard Layer (NFHL)

TOWN OF MERTENS

TAKE ACTION: Potential Next Step

Your Hazard Mitigation Plan is **awaiting approval.**

The hazard mitigation goals identified projects for:

- Adopt new Hazard Mitigation Plan
- Use Early Warning Systems
- Educate the public on actions to take to prevent or reduce loss of life or property
- Maximize the use of outside sources of funding
- Promote beneficial uses of hazardous areas while expanding open spaces

FEMA's Hazard Mitigation Grant Program (HMGP), the Pre-Disaster Mitigation Grant (PDM), and TWDB's Flood Mitigation Assistance (FMA) Grant Program all fund localized Flood Risk Reduction Projects. HMGP and PDM allow for the funding of generators at critical facilities. There may be eligibility, benefit cost analysis, and cost-share requirements. The 5% Initiative in the HMGP is used for projects for which it may be difficult to conduct a standard BCA to prove cost-effectiveness, such as emergency notification, public awareness, or sirens. HMGP also offers funding for post disaster code enforcement, including debris removal strategies. PDM grants are able to fund stream restoration projects. Information about FEMA's HMA grants[1] can be found on our website, as well as on the Texas Department of Public Safety's Emergency Management Forms and Publications[2] website. The State Hazard Mitigation Officer may be contacted for additional information.

Texas Water Development Board's[3] Flood Protection Planning (FPP) Grant, Clean and Drinking Water State Revolving Fund (CWSRF), and Texas Water Development Fund (DFund) provide additional funding or loans for hazard mitigation planning, Emergency Action plans for High Hazard dams, and other planning studies. Both CWSRF and DFund are long term-fixed interest loans which can be used for acquisition or flood-proofing insured structures, building water quality and green infrastructure.

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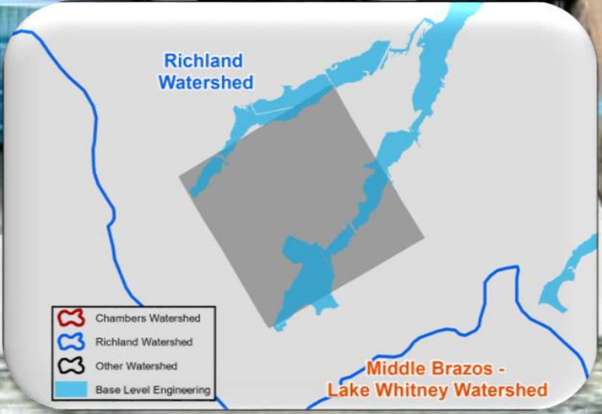
2. https://www.dps.texas.gov/dem/downloadableforms.htm#hmgpgrants.
3. https://www.twdb.texas.gov/financial/programs/.

TOWN OF PENELOPE

KNOW YOUR RISK



1.0 sq. mi.

of the community's land area is in the study watershed

146

Population based on 2017 ACS in the study watershed

25% expected population decline predicted from 2017-2023 in the community

0

policies totaling approximately $0 in coverage

0

documented repetitive loss properties damaged by flood in the study watershed

0

documented severe repetitive loss properties in the study watershed

100%

Of the community's FEMA mapped* 1%-annual-chance storm flood extent areas are in the Richland Watershed

Not participating in the National Flood Insurance Program

CNMS Stream Miles in the study watershed

2.7

The are no detailed study stream miles in the study watershed

NA

8

Flood-related presidential disaster declarations in your Discovery study county

*National Flood Hazard Layer (NFHL)

TOWN OF PENELOPE

TAKE ACTION: Potential Next Step

Your Hazard Mitigation Plan is **awaiting approval.**

The hazard mitigation goals identified projects for:

- Join National Flood Insurance Program (NFIP)
- Adopt new Hazard Mitigation Plan
- Use Early Warning Systems
- Educate the public on actions to take to prevent or reduce loss of life or property
- Maximize the use of outside sources of funding

FEMA's Hazard Mitigation Grant Program (HMGP), the Pre-Disaster Mitigation Grant (PDM), and TWDB's Flood Mitigation Assistance (FMA) Grant Program all fund localized Flood Risk Reduction Projects. HMGP and PDM allow for the funding of generators at critical facilities. There may be eligibility, benefit cost analysis, and cost-share requirements. The 5% Initiative in the HMGP is used for projects for which it may be difficult to conduct a standard BCA to prove cost-effectiveness, such as emergency notification, public awareness, or sirens. HMGP also offers funding for post disaster code enforcement, including debris removal strategies. PDM grants are able to fund stream restoration projects. Information about FEMA's HMA grants[1] can be found on our website, as well as on the Texas Department of Public Safety's Emergency Management Forms and Publications[2] website. The State Hazard Mitigation Officer may be contacted for additional information. The National Flood Insurance Program (NFIP) insures structures within the Special Flood Hazard Area, provides post-disaster assistance, and encourages local community regulation. More information about and about joining the NFIP[3] can be found on our website

Texas Water Development Board's[4] Flood Protection Planning (FPP) Grant, Clean and Drinking Water State Revolving Fund (CWSRF), and Texas Water Development Fund (DFund) provide additional funding or loans for hazard mitigation planning, Emergency Action plans for High Hazard dams, and other planning studies. Both CWSRF and DFund are long term-fixed interest loans which can be used for acquisition or flood-proofing insured structures, building water quality and green infrastructure.

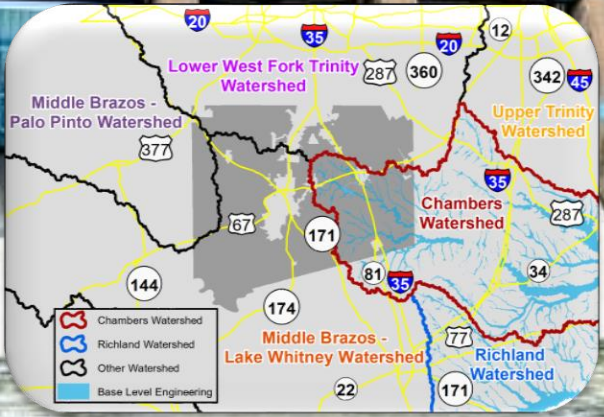
The minimum requirements for floodplain regulations are outlined in 44 Code of Federal Regulations 60.3, and local communities may choose to adopt more restrictive codes. FEMA Regional Office VI offers assistance in developing stricter codes, such as regulating construction or elevational changes in the floodplain.

1. https://www.fema.gov/hazard-mitigation-assistance.
2. https://www.dps.texas.gov/dem/downloadableforms.htm#hmgpgrants.
3. https://www.fema.gov/media-library/assets/documents/13610
4. https://www.twdb.texas.gov/financial/programs/.

RiskMAP
Increasing Resilience Together

JOHNSON COUNTY

KNOW YOUR RISK



151.2
sq. mi.

of the community's land area is in the study watershed

16,256

Population based on 2017 ACS in the study watershed

1% expected population growth predicted from 2017-2023 in the community

302
policies totaling approximately $74,830,000 in coverage

19
documented repetitive loss properties damaged by flood in the study watershed

3
documented severe repetitive loss properties in the study watershed

25%
Of the community's FEMA mapped* 1%-annual-chance storm flood extent areas are in the Chambers Watershed

Participating in the National Flood Insurance Program

CNMS Stream Miles in the study watershed
171.1

The are no detailed study stream miles in the study watershed

NA

4

Flood-related presidential disaster declarations in your Discovery study county

*National Flood Hazard Layer (NFHL)

JOHNSON COUNTY

TAKE ACTION: Potential Next Step

Your Hazard Mitigation Plan is set to expire **September 30, 2020.**

The hazard mitigation goals identified projects for:

- Expand and coordinate use of Early Warning Systems
- Purchase and install a CASA WX Radar System
- Develop a buyout program for properties located in high hazard flood zones
- Develop a community education campaign to enhance public awareness about chronic floods

FEMA's Hazard Mitigation Grant Program (HMGP), the Pre-Disaster Mitigation Grant (PDM), and TWDB's Flood Mitigation Assistance (FMA) Grant Program all fund localized Flood Risk Reduction Projects. There may be eligibility, benefit cost analysis, and cost-share requirements. The 5% Initiative in the HMGP is used for projects for which it may be difficult to conduct a standard BCA to prove cost-effectiveness, such as emergency notification, public awareness, or sirens. Information about FEMA's HMA grants[1] can be found on our website, as well as on the Texas Department of Public Safety's Emergency Management Forms and Publications[2] website. The State Hazard Mitigation Officer may be contacted for additional information. The North Central Texas Council of Governments has proposed 8 Collaborative Adaptive Sensing of Atmosphere (CASA WX)[3] Radar systems to use for the Urban Test Bed. They are actively looking for public and private stakeholders in a metropolitan area for the next radar deployment.

Texas Water Development Board's[4] Flood Protection Planning (FPP) Grant, Clean and Drinking Water State Revolving Fund (CWSRF), and Texas Water Development Fund (DFund) provide additional funding or loans for hazard mitigation planning, Emergency Action plans for High Hazard dams, and other planning studies. Both CWSRF and DFund are long term-fixed interest loans which can be used for acquisition or flood-proofing insured structures, building water quality and green infrastructure.

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1. https://www.fema.gov/hazard-mitigation-assistance.
2. https://www.dps.texas.gov/dem/downloadableforms.htm#hmgpgrants
3. https://www.nctcog.org/ep/casawx
4. https://www.twdb.texas.gov/financial/programs/.

RiskMAP
Increasing Resilience Together

CITY OF ALVARADO

KNOW YOUR RISK

4.9
sq. mi.
of the community's land area is in the study watershed

3,553
Population based on 2017 ACS in the study watershed

2% expected population growth predicted from 2017-2023 in the community

7
policies totaling approximately $3,753,000 in coverage

0
documented repetitive loss properties damaged by flood in the study watershed

0
documented severe repetitive loss properties in the study watershed

100%
Of the community's FEMA mapped* 1%-annual-chance storm flood extent areas are in the Chambers Watershed

Participating in the National Flood Insurance Program

CNMS Stream Miles in the study watershed
4.5

The are no detailed study stream miles in the study watershed
NA

4
Flood-related presidential disaster declarations in your Discovery study county

*National Flood Hazard Layer (NFHL)

CITY OF ALVARADO

TAKE ACTION: Potential Next Step

Your Hazard Mitigation Plan is set to expire **September 30, 2020.**

The hazard mitigation goals identified projects for:

- Expand and coordinate use of Early Warning Systems
- Purchase and install a CASA WX Radar System
- Develop a buyout program for properties located in high hazard flood zones
- Develop a community education campaign to enhance public awareness about chronic floods

FEMA's Hazard Mitigation Grant Program (HMGP), the Pre-Disaster Mitigation Grant (PDM), and TWDB's Flood Mitigation Assistance (FMA) Grant Program all fund localized Flood Risk Reduction Projects. There may be eligibility, benefit cost analysis, and cost-share requirements. The 5% Initiative in the HMGP is used for projects for which it may be difficult to conduct a standard BCA to prove cost-effectiveness, such as emergency notification, public awareness, or sirens. Information about FEMA's HMA grants[1] can be found on our website, as well as on the Texas Department of Public Safety's Emergency Management Forms and Publications[2] website. The State Hazard Mitigation Officer may be contacted for additional information. The North Central Texas Council of Governments has proposed 8 Collaborative Adaptive Sensing of Atmosphere (CASA WX)[3] Radar systems to use for the Urban Test Bed. They are actively looking for public and private stakeholders in a metropolitan area for the next radar deployment.

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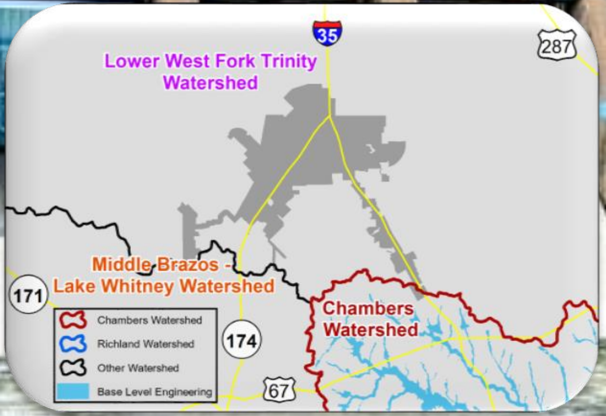
2. https://www.dps.texas.gov/dem/downloadableforms.htm#hmgpgrants.
3. https://www.nctcog.org/ep/casawx
4. https://www.twdb.texas.gov/financial/programs/.

RiskMAP
Increasing Resilience Together

CITY OF BURLESON

KNOW YOUR RISK



0.2 sq. mi.
of the community's land area is in the study watershed

334
Population based on 2017 ACS in the study watershed

11% expected population growth predicted from 2017-2023 in the community

136
policies totaling approximately $34,442,800 in coverage

6
documented repetitive loss properties damaged by flood in the study watershed

0
documented severe repetitive loss properties in the study watershed

X
Burleson does not contain FEMA mapped* 1%-annual-chance storm flood extent areas in the Chambers Watershed

Participating in the National Flood Insurance Program

CNMS Stream Miles in the study watershed
0

The are no detailed study stream miles in the study watershed
NA

4
Flood-related presidential disaster declarations in your Discovery study county

*National Flood Hazard Layer (NFHL)

CITY OF BURLESON

TAKE ACTION: Potential Next Step

Your Hazard Mitigation Plan is set to expire **September 30, 2020.**

The hazard mitigation goals identified projects for:

- Expand and coordinate use of Early Warning Systems
- Purchase and install a CASA WX Radar System
- Develop a buyout program for properties located in high hazard flood zones
- Develop a community education campaign to enhance public awareness about chronic floods

FEMA's Hazard Mitigation Grant Program (HMGP), the Pre-Disaster Mitigation Grant (PDM), and TWDB's Flood Mitigation Assistance (FMA) Grant Program all fund localized Flood Risk Reduction Projects. There may be eligibility, benefit cost analysis, and cost-share requirements. The 5% Initiative in the HMGP is used for projects for which it may be difficult to conduct a standard BCA to prove cost-effectiveness, such as emergency notification, public awareness, or sirens. Information about FEMA's HMA grants[1] can be found on our website, as well as on the Texas Department of Public Safety's Emergency Management Forms and Publications[2] website. The State Hazard Mitigation Officer may be contacted for additional information. The North Central Texas Council of Governments has proposed 8 Collaborative Adaptive Sensing of Atmosphere (CASA WX)[3] Radar systems to use for the Urban Test Bed. They are actively looking for public and private stakeholders in a metropolitan area for the next radar deployment.

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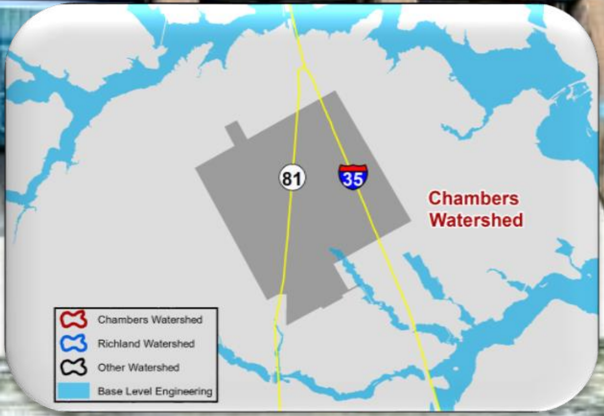
3. https://www.nctcog.org/ep/casawx
4. https://www.twdb.texas.gov/financial/programs/.

RiskMAP
Increasing Resilience Together

CITY OF GRANDVIEW

KNOW YOUR RISK



1.9
sq. mi.
of the community's land area is in the study watershed

1,895
Population based on 2017 ACS in the study watershed

13% expected population growth predicted from 2017-2023 in the community

3
policies totaling approximately $805,000 in coverage

0
documented repetitive loss properties damaged by flood in the study watershed

0
documented severe repetitive loss properties in the study watershed

100%
Of the community's FEMA mapped* 1%-annual-chance storm flood extent areas are in the Chambers Watershed

Participating in the National Flood Insurance Program

CNMS Stream Miles in the study watershed
0

The are no detailed study stream miles in the study watershed
NA

4
Flood-related presidential disaster declarations in your Discovery study county

*National Flood Hazard Layer (NFHL)

CITY OF GRANDVIEW

TAKE ACTION: Potential Next Step

You **do not** have a Hazard Mitigation Plan.

The hazard mitigation goals identified projects for:

- Create and adopt a Hazard Mitigation Plan
- Expand and coordinate use of Early Warning Systems
- Develop a buyout program for properties located in high hazard flood zones
- Develop a community education campaign to enhance public awareness about chronic floods

FEMA's Hazard Mitigation Grant Program (HMGP), the Pre-Disaster Mitigation Grant (PDM), and TWDB's Flood Mitigation Assistance (FMA) Grant Program all fund localized Flood Risk Reduction Projects. There may be eligibility, benefit cost analysis, and cost-share requirements. The 5% Initiative in the HMGP is used for projects for which it may be difficult to conduct a standard BCA to prove cost-effectiveness, such as emergency notification, public awareness, or sirens. PDM grants are able to fund stream restoration projects. Information about FEMA's HMA grants[1] can be found on our website, as well as on the Texas Department of Public Safety's Emergency Management Forms and Publications[2] website. The State Hazard Mitigation Officer may be contacted for additional information.

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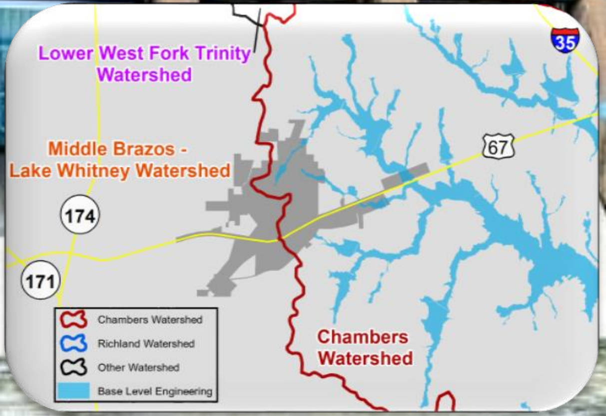
3. https://www.twdb.texas.gov/financial/programs/.

CITY OF KEENE

KNOW YOUR RISK



2.1
sq. mi.
of the community's land area is in the study watershed

3,402
Population based on 2017 ACS in the study watershed

2% expected population growth predicted from 2017-2023 in the community

7
policies totaling approximately $1,848,000 in coverage

1
documented repetitive loss property damaged by flood in the study watershed

0
documented severe repetitive loss properties in the study watershed

55%
Of the community's FEMA mapped* 1%-annual-chance storm flood extent areas are in the Chambers Watershed

Participating in the National Flood Insurance Program

CNMS Stream Miles in the study watershed
1.0

The are no detailed study stream miles in the study watershed
NA

4
Flood-related presidential disaster declarations in your Discovery study county

*National Flood Hazard Layer (NFHL)

CITY OF KEENE

TAKE ACTION: Potential Next Step

Your Hazard Mitigation Plan is set to expire **September 30, 2020.**

The hazard mitigation goals identified projects for:

- Expand and coordinate use of Early Warning Systems
- Purchase and install a CASA WX Radar System
- Develop a buyout program for properties located in high hazard flood zones
- Develop a community education campaign to enhance public awareness about chronic floods

FEMA's Hazard Mitigation Grant Program (HMGP), the Pre-Disaster Mitigation Grant (PDM), and TWDB's Flood Mitigation Assistance (FMA) Grant Program all fund localized Flood Risk Reduction Projects. There may be eligibility, benefit cost analysis, and cost-share requirements. The 5% Initiative in the HMGP is used for projects for which it may be difficult to conduct a standard BCA to prove cost-effectiveness, such as emergency notification, public awareness, or sirens. Information about FEMA's HMA grants[1] can be found on our website, as well as on the Texas Department of Public Safety's Emergency Management Forms and Publications[2] website. The State Hazard Mitigation Officer may be contacted for additional information. The North Central Texas Council of Governments has proposed 8 Collaborative Adaptive Sensing of Atmosphere (CASA WX)[3] Radar systems to use for the Urban Test Bed. They are actively looking for public and private stakeholders in a metropolitan area for the next radar deployment.

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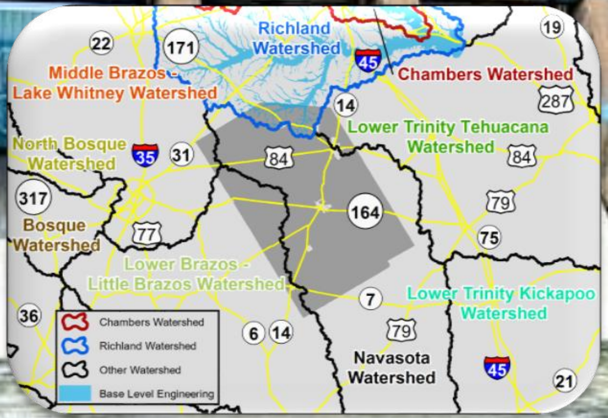
3. https://www.nctcog.org/ep/casawx
4. https://www.twdb.texas.gov/financial/programs/.

RiskMAP
Increasing Resilience Together

LIMESTONE COUNTY

KNOW YOUR RISK



61.4 sq. mi.

of the community's land area is in the study watershed

554

Population based on 2017 ACS in the study watershed

0% expected population growth predicted from 2017-2023 in the community

71

policies totaling approximately $14,368,800 in coverage

39

documented repetitive loss properties damaged by flood in the study watershed

10

documented severe repetitive loss properties in the study watershed

8%

Of the community's FEMA mapped* 1%-annual-chance storm flood extent areas are in the Richland Watershed

Participating in the National Flood Insurance Program

CNMS Stream Miles in the study watershed

74.1

The are no detailed study stream miles in the study watershed

NA

5

Flood-related presidential disaster declarations in your Discovery study county

*National Flood Hazard Layer (NFHL)

LIMESTONE COUNTY

TAKE ACTION: Potential Next Step

Your Hazard Mitigation Plan is **awaiting approval.**

The hazard mitigation goals identified projects for:

- Adopt new Hazard Mitigation Plan
- Educate the public on actions to take to prevent or reduce the loss of life or property
- Enhance us of Early Warning Systems
- Reduce repetitive losses to the National Flood Insurance Program (NFIP)
- Maximize the use of outside sources of funding

FEMA's Hazard Mitigation Grant Program (HMGP), the Pre-Disaster Mitigation Grant (PDM), and TWDB's Flood Mitigation Assistance (FMA) Grant Program all fund localized Flood Risk Reduction Projects. HMGP and PDM allow for the funding of generators at critical facilities. There may be eligibility, benefit cost analysis, and cost-share requirements. The 5% Initiative in the HMGP is used for projects for which it may be difficult to conduct a standard BCA to prove cost-effectiveness, such as emergency notification, public awareness, or sirens. HMGP also offers funding for post disaster code enforcement, including debris removal strategies. PDM grants are able to fund stream restoration projects. Information about FEMA's HMA grants[1] can be found on our website, as well as on the Texas Department of Public Safety's Emergency Management Forms and Publications[2] website. The State Hazard Mitigation Officer may be contacted for additional information.

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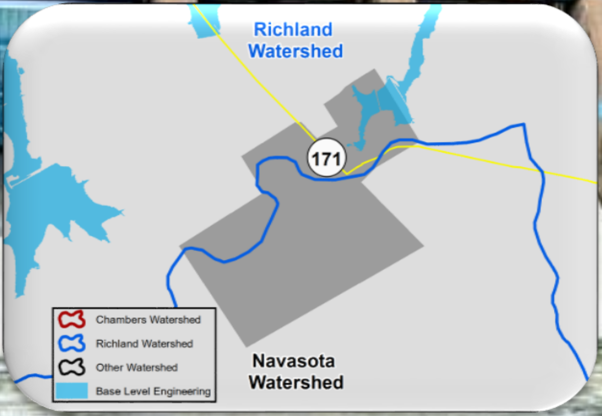
The minimum requirements for floodplain regulations are outlined in 44 Code of Federal Regulations 60.3, and local communities may choose to adopt more restrictive codes. FEMA Regional Office VI offers assistance in developing stricter codes, such as regulating construction or elevational changes in the floodplain.

1. https://www.fema.gov/hazard-mitigation-assistance.
2. https://www.dps.texas.gov/dem/downloadableforms.htm#hmgpgrants.
3. https://www.twdb.texas.gov/financial/programs/.

RiskMAP
Increasing Resilience Together

TOWN OF COOLIDGE

KNOW YOUR RISK



0.4
sq. mi.

of the community's land area is in the study watershed

308

Population based on 2017 ACS in the study watershed

8% expected population decline predicted from 2017-2023 in the community

0

policies totaling approximately $0 in coverage

0

documented repetitive loss properties damaged by flood in the study watershed

0

documented severe repetitive loss properties in the study watershed

99%

Of the community's FEMA mapped* 1%-annual-chance storm flood extent areas are in the Richland Watershed

Participating in the National Flood Insurance Program

CNMS Stream Miles in the study watershed

0

The are no detailed study stream miles in the study watershed

NA

5

Flood-related presidential disaster declarations in your Discovery study county

*National Flood Hazard Layer (NFHL)

TOWN OF COOLIDGE

TAKE ACTION: Potential Next Step

Your Hazard Mitigation Plan is **awaiting approval.**

The hazard mitigation goals identified projects for:

- Adopt new Hazard Mitigation Plan
- Educate the public on actions to take to prevent or reduce the loss of life or property
- Enhance us of Early Warning Systems
- Reduce repetitive losses to the National Flood Insurance Program (NFIP)
- Maximize the use of outside sources of funding

FEMA's Hazard Mitigation Grant Program (HMGP), the Pre-Disaster Mitigation Grant (PDM), and TWDB's Flood Mitigation Assistance (FMA) Grant Program all fund localized Flood Risk Reduction Projects. HMGP and PDM allow for the funding of generators at critical facilities. There may be eligibility, benefit cost analysis, and cost-share requirements. The 5% Initiative in the HMGP is used for projects for which it may be difficult to conduct a standard BCA to prove cost-effectiveness, such as emergency notification, public awareness, or sirens. HMGP also offers funding for post disaster code enforcement, including debris removal strategies. PDM grants are able to fund stream restoration projects. Information about FEMA's HMA grants[1] can be found on our website, as well as on the Texas Department of Public Safety's Emergency Management Forms and Publications[2] website. The State Hazard Mitigation Officer may be contacted for additional information.

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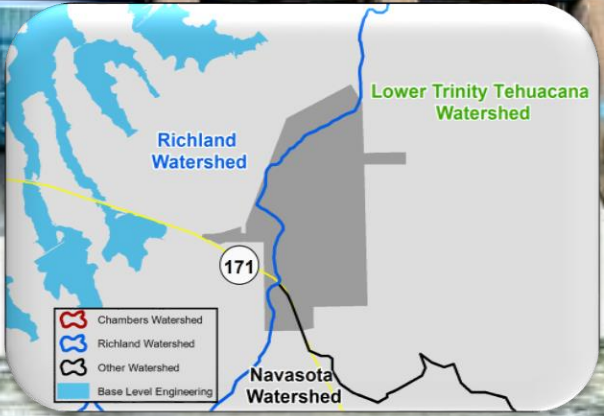
TOWN OF TEHUACANA

KNOW YOUR RISK



0.3 sq. mi. of the community's land area is in the study watershed

44 Population based on 2017 ACS in the study watershed

26% expected population decline predicted from 2017-2023 in the community

0 policies totaling approximately $0 in coverage

0 documented repetitive loss properties damaged by flood in the study watershed

0 documented severe repetitive loss properties in the study watershed

X — Tehuacana does not contain FEMA mapped* 1%-annual-chance storm flood extent areas in the Richland Watershed

X — Not participating in the National Flood Insurance Program

CNMS Stream Miles in the study watershed **0**

The are no detailed study stream miles in the study watershed — **NA**

5 Flood-related presidential disaster declarations in your Discovery study county

*National Flood Hazard Layer (NFHL)

TOWN OF TEHUACANA

TAKE ACTION: Potential Next Step

Your Hazard Mitigation Plan is **awaiting approval.**

The hazard mitigation goals identified projects for:

- Join National Flood Insurance Program (NFIP)
- Adopt new Hazard Mitigation Plan
- Educate the public on actions to take to prevent or reduce the loss of life or property
- Enhance us of Early Warning Systems
- Maximize the use of outside sources of funding

FEMA's Hazard Mitigation Grant Program (HMGP), the Pre-Disaster Mitigation Grant (PDM), and TWDB's Flood Mitigation Assistance (FMA) Grant Program all fund localized Flood Risk Reduction Projects. HMGP and PDM allow for the funding of generators at critical facilities. There may be eligibility, benefit cost analysis, and cost-share requirements. The 5% Initiative in the HMGP is used for projects for which it may be difficult to conduct a standard BCA to prove cost-effectiveness, such as emergency notification, public awareness, or sirens. HMGP also offers funding for post disaster code enforcement, including debris removal strategies. PDM grants are able to fund stream restoration projects. Information about FEMA's HMA grants[1] can be found on our website, as well as on the Texas Department of Public Safety's Emergency Management Forms and Publications[2] website. The State Hazard Mitigation Officer may be contacted for additional information. The National Flood Insurance Program (NFIP) insures structures within the Special Flood Hazard Area, provides post-disaster assistance, and encourages local community regulation. More information about and about joining the NFIP[3] can be found on our website

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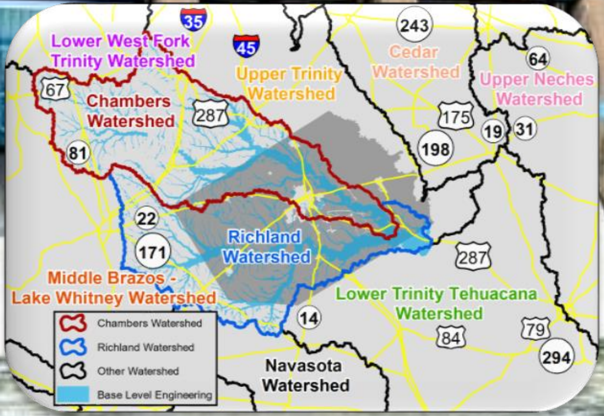
2. https://www.dps.texas.gov/dem/downloadableforms.htm#hmgpgrants.
3. https://www.fema.gov/media-library/assets/documents/13610
4. https://www.twdb.texas.gov/financial/programs/.

NAVARRO COUNTY

KNOW YOUR RISK



810.5
sq. mi.
of the community's land area is in the study watersheds

7,396
Population based on 2017 ACS in the study watersheds

1% expected population growth predicted from 2017-2023 in the community

65
policies totaling approximately $16,549,000 in coverage

0
documented repetitive loss properties damaged by flood in the study watersheds

0
documented severe repetitive loss properties in the study watersheds

79%
Of the community's FEMA mapped* 1%-annual-chance storm flood extent areas are in the Chambers Watershed and Richland Watershed

Participating in the National Flood Insurance Program

CNMS Stream Miles in the study watersheds
947

Percentage of stream miles which are detailed study in the study watersheds
0.1%

7
Flood-related presidential disaster declarations in your Discovery study county

*National Flood Hazard Layer (NFHL)

NAVARRO COUNTY

TAKE ACTION: Potential Next Step

Your Hazard Mitigation Plan is set to expire **July 8, 2020.**

The hazard mitigation goals identified projects for:

- Rehabilitate high hazard critical infrastructure
- Promote and support the CASA WX Radar System
- Expand the use of Early Warning Systems
- Provide public education materials to residents and private sector
- Identify federal and state programs for financial assistance in mitigation projects

FEMA's Hazard Mitigation Grant Program (HMGP), the Pre-Disaster Mitigation Grant (PDM), and TWDB's Flood Mitigation Assistance (FMA) Grant Program all fund localized Flood Risk Reduction Projects. There may be eligibility, benefit cost analysis, and cost-share requirements. The 5% Initiative in the HMGP is used for projects for which it may be difficult to conduct a standard BCA to prove cost-effectiveness, such as emergency notification, public awareness, or sirens. Information about FEMA's HMA grants[1] can be found on our website, as well as on the Texas Department of Public Safety's Emergency Management Forms and Publications[2] website. The State Hazard Mitigation Officer may be contacted for additional information. The North Central Texas Council of Governments has proposed 8 Collaborative Adaptive Sensing of Atmosphere (CASA WX)[3] Radar systems to use for the Urban Test Bed. They are actively looking for public and private stakeholders in a metropolitan area for the next radar deployment.

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1. https://www.fema.gov/hazard-mitigation-assistance
2. https://www.dps.texas.gov/dem/downloadableforms.htm#hmgpgrants
3. https://www.nctcog.org/ep/casawx
4. https://www.twdb.texas.gov/financial/programs/

RiskMAP
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CITY OF ANGUS

KNOW YOUR RISK

2.0
sq. mi.
of the community's land area is in the study watershed

506
Population based on 2017 ACS in the study watershed

13% expected population growth predicted from 2017-2023 in the community

0
policies totaling approximately $0 in coverage

0
documented repetitive loss properties damaged by flood in the study watershed

0
documented severe repetitive loss properties in the study watershed

100%
Of the community's FEMA mapped* 1%-annual-chance storm flood extent areas are in the Richland Watershed

X
Not participating in the National Flood Insurance Program

CNMS Stream Miles in the study watershed
2.4

The are no detailed study stream miles in the study watershed
NA

7
Flood-related presidential disaster declarations in your Discovery study county

*National Flood Hazard Layer (NFHL)

CITY OF ANGUS

TAKE ACTION: Potential Next Step

You **do not** have a Hazard Mitigation Plan.

The hazard mitigation goals identified projects for:

- Join National Flood Insurance Program (NFIP)
- Create and adopt a Hazard Mitigation Plan
- Expand the use of Early Warning Systems
- Provide public education materials to residents and private sector
- Identify federal and state programs for financial assistance in mitigation projects and programs

FEMA's Hazard Mitigation Grant Program (HMGP), the Pre-Disaster Mitigation Grant (PDM), and TWDB's Flood Mitigation Assistance (FMA) Grant Program all fund localized Flood Risk Reduction Projects. The 5% Initiative in the HMGP is used for projects for which it may be difficult to conduct a standard BCA to prove cost-effectiveness, such as emergency notification, public awareness, or sirens. Information about FEMA's HMA grants[1] can be found on our website, as well as on the Texas Department of Public Safety's Emergency Management Forms and Publications[2] website. The State Hazard Mitigation Officer may be contacted for additional information. The National Flood Insurance Program (NFIP) insures structures within the Special Flood Hazard Area, provides post-disaster assistance, and encourages local community regulation. More information about and about joining the NFIP[3] can be found on our website.

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4. https://www.twdb.texas.gov/financial/programs/.

RiskMAP
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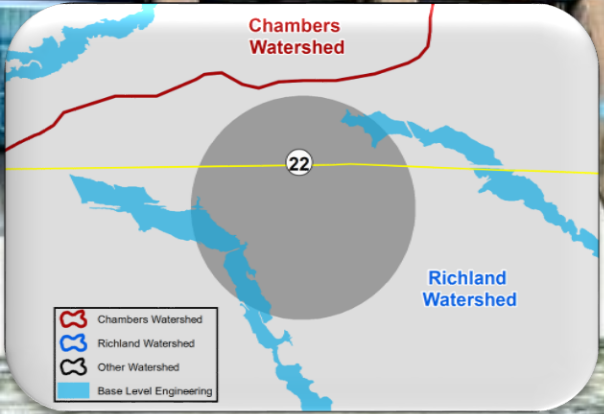
CITY OF BARRY

KNOW YOUR RISK



0.4 sq. mi.
of the community's land area is in the study watershed

268
Population based on 2017 ACS in the study watershed

7% expected population growth predicted from 2017-2023 in the community

0
policies totaling approximately $0 in coverage

0
documented repetitive loss properties damaged by flood in the study watershed

0
documented severe repetitive loss properties in the study watershed

100%
Of the community's FEMA mapped* 1%-annual-chance storm flood extent areas are in the Richland Watershed

Participating in the National Flood Insurance Program

CNMS Stream Miles in the study watershed
0.6

The are no detailed study stream miles in the study watershed
NA

7
Flood-related presidential disaster declarations in your Discovery study county

*National Flood Hazard Layer (NFHL)

CITY OF BARRY

TAKE ACTION: Potential Next Step

You **do not** have a Hazard Mitigation Plan.

The hazard mitigation goals identified projects for:

- Create and adopt a Hazard Mitigation Plan
- Implement storm drainage projects
- Expand the use of Early Warning Systems
- Provide public education materials to residents and private sector
- Identify federal and state programs for financial assistance in mitigation projects and programs

FEMA's Hazard Mitigation Grant Program (HMGP), the Pre-Disaster Mitigation Grant (PDM), and TWDB's Flood Mitigation Assistance (FMA) Grant Program all fund localized Flood Risk Reduction Projects. HMGP and PDM allow for the funding of generators at critical facilities. There may be eligibility, benefit cost analysis, and cost-share requirements. The 5% Initiative in the HMGP is used for projects for which it may be difficult to conduct a standard BCA to prove cost-effectiveness, such as emergency notification, public awareness, or sirens. HMGP also offers funding for post disaster code enforcement, including debris removal strategies. PDM grants are able to fund stream restoration projects. Information about FEMA's HMA grants[1] can be found on our website, as well as on the Texas Department of Public Safety's Emergency Management Forms and Publications[2] website. The State Hazard Mitigation Officer may be contacted for additional information.

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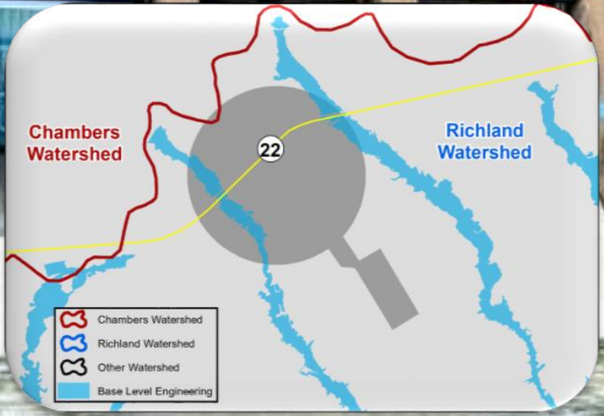
TOWN OF BLOOMING GROVE

KNOW YOUR RISK



0.9
sq. mi.
of the community's land area is in the study watersheds

870
Population based on 2017 ACS in the study watersheds

4% expected population growth predicted from 2017-2023 in the community

0
policies totaling approximately $0 in coverage

0
documented repetitive loss properties damaged by flood in the study watersheds

0
documented severe repetitive loss properties in the study watersheds

100%
Of the community's FEMA mapped* 1%-annual-chance storm flood extent areas are in the Chambers Watershed and Richland Watershed

Participating in the National Flood Insurance Program

CNMS Stream Miles in the study watersheds
0.9

The are no detailed study stream miles in the study watersheds
NA

7
Flood-related presidential disaster declarations in your Discovery study county

*National Flood Hazard Layer (NFHL)

TOWN OF BLOOMING GROVE

TAKE ACTION: Potential Next Step

You **do not** have a Hazard Mitigation Plan.

The hazard mitigation goals identified projects for:

- Create and adopt a Hazard Mitigation Plan
- Implement storm drainage projects
- Expand the use of Early Warning Systems
- Provide public education materials to residents and private sector
- Identify federal and state programs for financial assistance in mitigation projects and programs

FEMA's Hazard Mitigation Grant Program (HMGP), the Pre-Disaster Mitigation Grant (PDM), and TWDB's Flood Mitigation Assistance (FMA) Grant Program all fund localized Flood Risk Reduction Projects. HMGP and PDM allow for the funding of generators at critical facilities. There may be eligibility, benefit cost analysis, and cost-share requirements. The 5% Initiative in the HMGP is used for projects for which it may be difficult to conduct a standard BCA to prove cost-effectiveness, such as emergency notification, public awareness, or sirens. HMGP also offers funding for post disaster code enforcement, including debris removal strategies. PDM grants are able to fund stream restoration projects. Information about FEMA's HMA grants[1] can be found on our website, as well as on the Texas Department of Public Safety's Emergency Management Forms and Publications[2] website. The State Hazard Mitigation Officer may be contacted for additional information.

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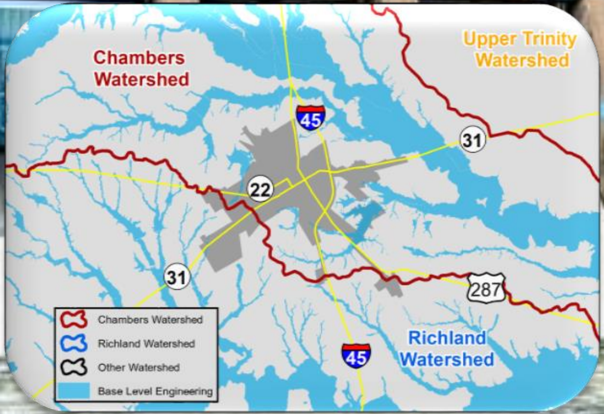
CITY OF CORSICANA

KNOW YOUR RISK



23.5 sq. mi.
of the community's land area is in the study watersheds

23,695
Population based on 2017 ACS in the study watersheds

0% expected population growth predicted from 2017-2023 in the community

120
policies totaling approximately $23,896,100 in coverage

7
documented repetitive loss properties damaged by flood in the study watersheds

0
documented severe repetitive loss properties in the study watersheds

100%
Of the community's FEMA mapped* 1%-annual-chance storm flood extent areas are in the Chambers Watershed and Richland Watershed

Participating in the National Flood Insurance Program

CNMS Stream Miles in the study watersheds
33.4

Percentage of stream miles which are detailed study in the study watersheds
51.4%

7
Flood-related presidential disaster declarations in your Discovery study county

*National Flood Hazard Layer (NFHL)

CITY OF CORSICANA

TAKE ACTION: Potential Next Step

Your Hazard Mitigation Plan is set to expire **July 8, 2020.**

The hazard mitigation goals identified projects for:

- Rehabilitate high hazard critical infrastructure
- Promote and support the CASA WX Radar System
- Expand the use of Early Warning Systems
- Provide public education materials to residents and private sector
- Identify federal and state programs for financial assistance in mitigation projects

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3. https://www.fema.gov/national-flood-insurance-program-community-rating-system
4. https://www.twdb.texas.gov/financial/programs/.

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Increasing Resilience Together

TOWN OF DAWSON

KNOW YOUR RISK

1.8
sq. mi.
of the community's land area is in the study watershed

785
Population based on 2017 ACS in the study watershed

2% expected population decline predicted from 2017-2023 in the community

2
policies totaling approximately $700,000 in coverage

0
documented repetitive loss properties damaged by flood in the study watershed

0
documented severe repetitive loss properties in the study watershed

100%
Of the community's FEMA mapped* 1%-annual-chance storm flood extent areas are in the Richland Watershed

Participating in the National Flood Insurance Program

CNMS Stream Miles in the study watershed
1.5

The are no detailed study stream miles in the study watershed
NA

7
Flood-related presidential disaster declarations in your Discovery study county

*National Flood Hazard Layer (NFHL)

TOWN OF DAWSON

TAKE ACTION: Potential Next Step

You **do not** have a Hazard Mitigation Plan.

The hazard mitigation goals identified projects for:

- Create and adopt a Hazard Mitigation Plan
- Implement storm drainage projects
- Expand the use of Early Warning Systems
- Provide public education materials to residents and private sector
- Identify federal and state programs for financial assistance in mitigation projects and programs

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RiskMAP
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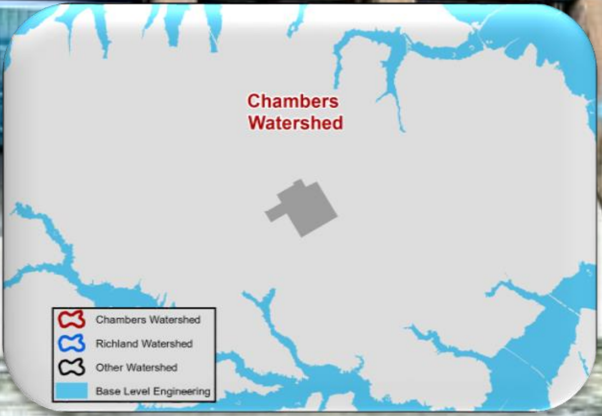
TOWN OF EMHOUSE

KNOW YOUR RISK



0.3
sq. mi.
of the community's land area is in the study watershed

160
Population based on 2017 ACS in the study watershed

12% expected population growth predicted from 2017-2023 in the community

0
policies totaling approximately $0 in coverage

0
documented repetitive loss properties damaged by flood in the study watershed

0
documented severe repetitive loss properties in the study watershed

X
Emhouse does not contain FEMA mapped* 1%-annual-chance storm flood extent areas in the Chambers Watershed

X
Not participating in the National Flood Insurance Program

CNMS Stream Miles in the study watershed
0

The are no detailed study stream miles in the study watershed
NA

7
Flood-related presidential disaster declarations in your Discovery study county

*National Flood Hazard Layer (NFHL)

TOWN OF EMHOUSE

TAKE ACTION: Potential Next Step

You **do not** have a Hazard Mitigation Plan.

The hazard mitigation goals identified projects for:

- Join National Flood Insurance Program (NFIP)
- Create and adopt a Hazard Mitigation Plan
- Expand the use of Early Warning Systems
- Provide public education materials to residents and private sector
- Identify federal and state programs for financial assistance in mitigation projects and programs

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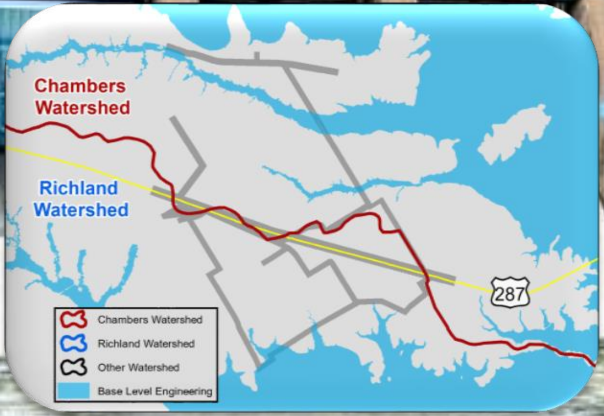
RiskMAP
Increasing Resilience Together

CITY OF EUREKA

KNOW YOUR RISK



2.1 sq. mi. of the community's land area is in the study watersheds

341 Population based on 2017 ACS in the study watersheds

7% expected population growth predicted from 2017-2023 in the community

0 policies totaling approximately $0 in coverage

0 documented repetitive loss properties damaged by flood in the study watersheds

0 documented severe repetitive loss properties in the study watersheds

100% Of the community's FEMA mapped* 1%-annual-chance storm flood extent areas are in the Chambers Watershed and Richland Watershed

Not participating in the National Flood Insurance Program

CNMS Stream Miles in the study watersheds **0**

The are no detailed study stream miles in the study watersheds **NA**

7 Flood-related presidential disaster declarations in your Discovery study county

*National Flood Hazard Layer (NFHL)

CITY OF EUREKA

TAKE ACTION: Potential Next Step

You **do not** have a Hazard Mitigation Plan.

The hazard mitigation goals identified projects for:

- Join National Flood Insurance Program (NFIP)
- Create and adopt a Hazard Mitigation Plan
- Expand the use of Early Warning Systems
- Provide public education materials to residents and private sector
- Identify federal and state programs for financial assistance in mitigation projects and programs

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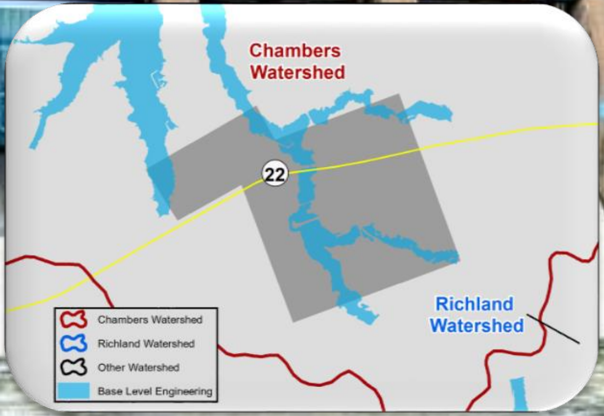
CITY OF FROST

KNOW YOUR RISK



1.2
sq. mi.
of the community's land area is in the study watershed

875
Population based on 2017 ACS in the study watershed

19% expected population growth predicted from 2017-2023 in the community

0
policies totaling approximately $0 in coverage

0
documented repetitive loss properties damaged by flood in the study watershed

0
documented severe repetitive loss properties in the study watershed

100%
Of the community's FEMA mapped* 1%-annual-chance storm flood extent areas are in the Chambers Watershed

Participating in the National Flood Insurance Program

CNMS Stream Miles in the study watershed
2.2

The are no detailed study stream miles in the study watershed
NA

7
Flood-related presidential disaster declarations in your Discovery study county

*National Flood Hazard Layer (NFHL)

CITY OF FROST

TAKE ACTION: Potential Next Step

You **do not** have a Hazard Mitigation Plan.

The hazard mitigation goals identified projects for:

- Create and adopt a Hazard Mitigation Plan
- Implement storm drainage projects
- Expand the use of Early Warning Systems
- Provide public education materials to residents and private sector
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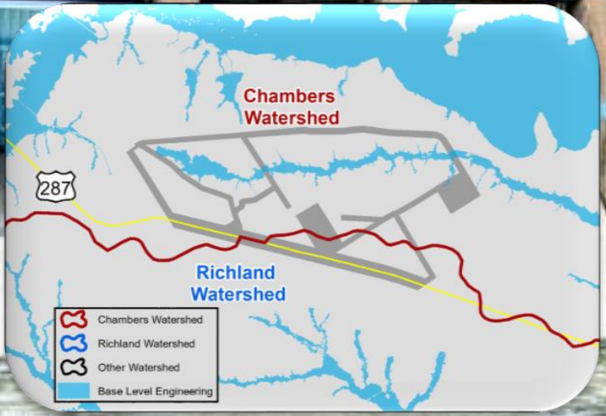
TOWN OF MILDRED

KNOW YOUR RISK



2.3
sq. mi.
of the community's land area is in the study watersheds

413
Population based on 2017 ACS in the study watersheds

8% expected population growth predicted from 2017-2023 in the community

0
policies totaling approximately $0 in coverage

0
documented repetitive loss properties damaged by flood in the study watersheds

0
documented severe repetitive loss properties in the study watersheds

100%
Of the community's FEMA mapped* 1%-annual-chance storm flood extent areas are in the Chambers Watershed and Richland Watershed

Participating in the National Flood Insurance Program

CNMS Stream Miles in the study watersheds
0

The are no detailed study stream miles in the study watersheds
NA

7
Flood-related presidential disaster declarations in your Discovery study county

*National Flood Hazard Layer (NFHL)

TOWN OF MILDRED

TAKE ACTION: Potential Next Step

You **do not** have a Hazard Mitigation Plan.

The hazard mitigation goals identified projects for:

- Create and adopt a Hazard Mitigation Plan
- Implement storm drainage projects
- Expand the use of Early Warning Systems
- Provide public education materials to residents and private sector
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RiskMAP
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TOWN OF MUSTANG

KNOW YOUR RISK

0.1
sq. mi.
of the community's land area is in the study watershed

0
Population based on 2017 ACS in the study watershed

18% expected population growth predicted from 2017-2023 in the community

0
policies totaling approximately $0 in coverage

0
documented repetitive loss properties damaged by flood in the study watershed

0
documented severe repetitive loss properties in the study watershed

100%
Of the community’s FEMA mapped* 1%-annual-chance storm flood extent areas are in the Richland Watershed

X
Not participating in the National Flood Insurance Program

CNMS Stream Miles in the study watershed
0.3

The are no detailed study stream miles in the study watershed
NA

7
Flood-related presidential disaster declarations in your Discovery study county

*National Flood Hazard Layer (NFHL)

TOWN OF MUSTANG

TAKE ACTION: Potential Next Step

You **do not** have a Hazard Mitigation Plan.

The hazard mitigation goals identified projects for:

- Join National Flood Insurance Program (NFIP)
- Create and adopt a Hazard Mitigation Plan
- Expand the use of Early Warning Systems
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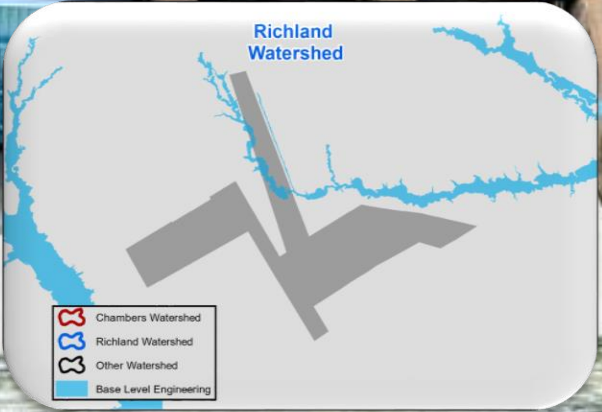
TOWN OF NAVARRO

KNOW YOUR RISK



0.6
sq. mi.
of the community's land area is in the study watershed

162
Population based on 2017 ACS in the study watershed

21% expected population decline predicted from 2017-2023 in the community

0
policies totaling approximately $0 in coverage

0
documented repetitive loss properties damaged by flood in the study watershed

0
documented severe repetitive loss properties in the study watershed

100%
Of the community's FEMA mapped* 1%-annual-chance storm flood extent areas are in the Richland Watershed

X
Not participating in the National Flood Insurance Program

CNMS Stream Miles in the study watershed
0

The are no detailed study stream miles in the study watershed
NA

7
Flood-related presidential disaster declarations in your Discovery study county

*National Flood Hazard Layer (NFHL)

TOWN OF NAVARRO

TAKE ACTION: Potential Next Step

You **do not** have a Hazard Mitigation Plan.

The hazard mitigation goals identified projects for:

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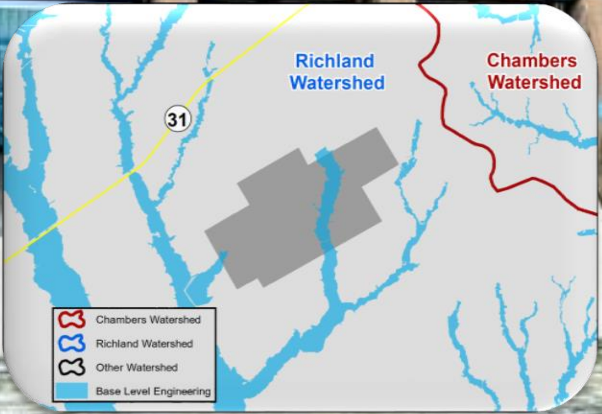
TOWN OF OAK VALLEY

KNOW YOUR RISK



2.0 sq. mi.

of the community's land area is in the study watershed

393

Population based on 2017 ACS in the study watershed

5% expected population growth predicted from 2017-2023 in the community

0

policies totaling approximately $0 in coverage

0

documented repetitive loss properties damaged by flood in the study watershed

0

documented severe repetitive loss properties in the study watershed

100%

Of the community's FEMA mapped* 1%-annual-chance storm flood extent areas are in the Richland Watershed

X

Not participating in the National Flood Insurance Program

CNMS Stream Miles in the study watershed

0

The are no detailed study stream miles in the study watershed

NA

7

Flood-related presidential disaster declarations in your Discovery study county

*National Flood Hazard Layer (NFHL)

TOWN OF OAK VALLEY

TAKE ACTION: Potential Next Step

You **do not** have a Hazard Mitigation Plan.

The hazard mitigation goals identified projects for:

- Join National Flood Insurance Program (NFIP)
- Create and adopt a Hazard Mitigation Plan
- Expand the use of Early Warning Systems
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TOWN OF POWELL

KNOW YOUR RISK

1.3
sq. mi.
of the community's land area is in the study watershed

46
Population based on 2017 ACS in the study watershed

89% expected population decline predicted from 2017-2023 in the community

0
policies totaling approximately $0 in coverage

0
documented repetitive loss properties damaged by flood in the study watershed

0
documented severe repetitive loss properties in the study watershed

X
Powell does not contain FEMA mapped* 1%-annual-chance storm flood extent areas in the Chambers Watershed

Participating in the National Flood Insurance Program

CNMS Stream Miles in the study watershed
0.6

The are no detailed study stream miles in the study watershed
NA

7
Flood-related presidential disaster declarations in your Discovery study county

*National Flood Hazard Layer (NFHL)

TOWN OF POWELL

TAKE ACTION: Potential Next Step

You **do not** have a Hazard Mitigation Plan.

The hazard mitigation goals identified projects for:

- Create and adopt a Hazard Mitigation Plan
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TOWN OF RETREAT

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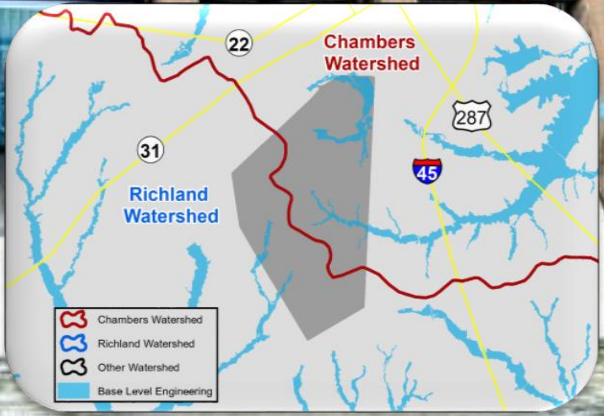

5.0
sq. mi.
of the community's land area is in the study watersheds

453
Population based on 2017 ACS in the study watersheds

12% expected population growth predicted from 2017-2023 in the community

0
policies totaling approximately $0 in coverage

0
documented repetitive loss properties damaged by flood in the study watersheds

0
documented severe repetitive loss properties in the study watersheds

100%
Of the community's FEMA mapped* 1%-annual-chance storm flood extent areas are in the Chambers Watershed and Richland Watershed

Not participating in the National Flood Insurance Program

CNMS Stream Miles in the study watersheds
6.0

The are no detailed study stream miles in the study watersheds
NA

7
Flood-related presidential disaster declarations in your Discovery study county

*National Flood Hazard Layer (NFHL)

TOWN OF RETREAT

TAKE ACTION: Potential Next Step

You **do not** have a Hazard Mitigation Plan.

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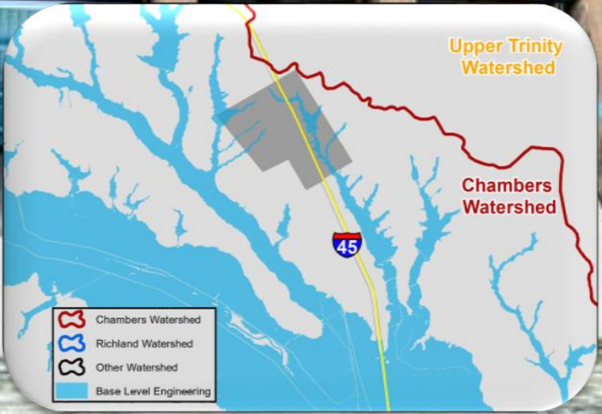
CITY OF RICE

KNOW YOUR RISK



2.6
sq. mi.
of the community's land area is in the study watershed

950
Population based on 2017 ACS in the study watershed

2% expected population growth predicted from 2017-2023 in the community

1
policies totaling approximately $105,000 in coverage

0
documented repetitive loss properties damaged by flood in the study watershed

0
documented severe repetitive loss properties in the study watershed

100%
Of the community's FEMA mapped* 1%-annual-chance storm flood extent areas are in the Chambers Watershed

Participating in the National Flood Insurance Program

CNMS Stream Miles in the study watershed
4.1

The are no detailed study stream miles in the study watershed
NA

7
Flood-related presidential disaster declarations in your Discovery study county

*National Flood Hazard Layer (NFHL)

CITY OF RICE

TAKE ACTION: Potential Next Step

You **do not** have a Hazard Mitigation Plan.

The hazard mitigation goals identified projects for:

- Create and adopt a Hazard Mitigation Plan
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3. https://www.twdb.texas.gov/financial/programs/.

RiskMAP
Increasing Resilience Together

TOWN OF RICHLAND

KNOW YOUR RISK

0.9 sq. mi.
of the community's land area is in the study watershed

213
Population based on 2017 ACS in the study watershed

17% expected population decline predicted from 2017-2023 in the community

0
policies totaling approximately $0 in coverage

0
documented repetitive loss properties damaged by flood in the study watershed

0
documented severe repetitive loss properties in the study watershed

100%
Of the community's FEMA mapped* 1%-annual-chance storm flood extent areas are in the Richland Watershed

Participating in the National Flood Insurance Program

CNMS Stream Miles in the study watershed
1.3

The are no detailed study stream miles in the study watershed
NA

7
Flood-related presidential disaster declarations in your Discovery study county

*National Flood Hazard Layer (NFHL)

TOWN OF RICHLAND

TAKE ACTION: Potential Next Step

You **do not** have a Hazard Mitigation Plan.

The hazard mitigation goals identified projects for:

- Create and adopt a Hazard Mitigation Plan
- Implement storm drainage projects
- Expand the use of Early Warning Systems
- Provide public education materials to residents and private sector
- Identify federal and state programs for financial assistance in mitigation projects and programs

FEMA's Hazard Mitigation Grant Program (HMGP), the Pre-Disaster Mitigation Grant (PDM), and TWDB's Flood Mitigation Assistance (FMA) Grant Program all fund localized Flood Risk Reduction Projects. HMGP and PDM allow for the funding of generators at critical facilities. There may be eligibility, benefit cost analysis, and cost-share requirements. The 5% Initiative in the HMGP is used for projects for which it may be difficult to conduct a standard BCA to prove cost-effectiveness, such as emergency notification, public awareness, or sirens. HMGP also offers funding for post disaster code enforcement, including debris removal strategies. PDM grants are able to fund stream restoration projects. Information about FEMA's HMA grants[1] can be found on our website, as well as on the Texas Department of Public Safety's Emergency Management Forms and Publications[2] website. The State Hazard Mitigation Officer may be contacted for additional information.

Texas Water Development Board's[3] Flood Protection Planning (FPP) Grant, Clean and Drinking Water State Revolving Fund (CWSRF), and Texas Water Development Fund (DFund) provide additional funding or loans for hazard mitigation planning, Emergency Action plans for High Hazard dams, and other planning studies. Both CWSRF and DFund are long term-fixed interest loans which can be used for acquisition or flood-proofing insured structures, building water quality and green infrastructure.

The minimum requirements for floodplain regulations are outlined in 44 Code of Federal Regulations 60.3, and local communities may choose to adopt more restrictive codes. FEMA Regional Office VI offers assistance in developing stricter codes, such as regulating construction or elevational changes in the floodplain.

1. https://www.fema.gov/hazard-mitigation-assistance.
2. https://www.dps.texas.gov/dem/downloadableforms.htm#hmgpgrants.
3. https://www.twdb.texas.gov/financial/programs/.

Appendix II: Base Level Engineering Report

Identify, Interpret, Integrate

Chambers Watershed, TX
Base Level Engineering (BLE) Results

Contract #HSFE60-15-D-0003, Task Order #HSFE60-15-J-0002
March 2017

Prepared for:

DHS/FEMA (Federal Emergency Management Agency)
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1.0	December 2015	Initial First Order Approximation Draft	AECOM
1.1	February 2016	Revised to reflect Base Level Engineering effort	AECOM
1.2	March 2017	Revised to add Base Level Engineering in detailed studied areas	AECOM

APPROVALS

This document requires the approval of the following persons:

Role	Name	Phone Extension	Title (CLIN/RMC)	Review Date	Approved Date
Project Manager	April Smith	512.457.7818	Project Manager	March 13, 2017	March 15, 2017

CLIENT DISTRIBUTION

Name	Title/Organization	Location
FEMA's MIP	Region VI	See path above

Table of Contents

List of Figures

List of Tables

Executive Summary

FEMA Region VI contracted Compass to complete a Base Level Engineering (BLE) analysis for the Chambers Watershed in East Central Texas, to support FEMA's Discovery process and validation of effective Zone A Special Flood Hazard Area (SFHA). The BLE process involves using best available data and incorporating automated techniques with traditional model development procedures to produce regulatory quality flood hazard boundaries for the 1-percent annual chance event as well as estimates of flood hazard boundaries for multiple recurrence intervals.

The source digital terrain data used for surface model development in support of hydrologic and hydraulic (H&H) analysis as well as mapping activities were leveraged from Texas Natural Resources Information System (TNRIS) and supplemented with USGS National Elevation Dataset (NED) as appropriate. The TNRIS terrain dataset was 2013 1-meter gridded DEM data derived from Light Detection and Ranging (LiDAR) data, while the USGS NED 1/3 Arc Second DEM was approximately 10-meter equivalent.

Flood discharges for this study were calculated using both USGS regression equations and gage analysis, where stream gages with sufficient records exist. Regression Equations obtained from the Scientific Investigations Report (SIR) 2009-5087, Regression Equations for Estimation of Annual Peak-Streamflow Frequency for Undeveloped Watersheds in Texas Using an L-moment-Based, PRESS-Minimized, Residual-Adjusted Approach (2009) were used while PeakFQ version 7.1 was used to perform Flood Frequency Analysis (FFA) for the two gages in the Chambers watershed.

The Hydrologic Engineering Center's River Analysis System (HEC-RAS) program version 4.1 was used to compute water surface elevations on a stream by stream basis. All hydraulic models were computed using 1-D steady state analysis.

The stream mile network that was validated for Chambers Watershed was compiled using FEMA's CNMS inventory in conjunction with the National Hydrography Dataset (NHD) 24K High Resolution. Table ES-1 lists the stream miles identified by each source for this BLE validation analysis.

Table ES- 1. Summary of Stream Miles

Source	Chambers Stream Miles
CNMS	1,180
Total	**1,180**

The full inventory of Zone A studies (1,180 miles) in the Chambers Watershed were classified in CNMS. Total miles validated in CNMS are summarized in Table ES-2 and illustrated in Figure ES-1 below. This figure also presents the pass/fail HUC-12 results as determined by the CNMS validation.

Table ES- 2: Zone A Validation Results

Validation Status	Status Type	Total Miles
VALID	NVUE COMPLIANT	260.65
UNVERIFIED	TO BE STUDIED	919.36

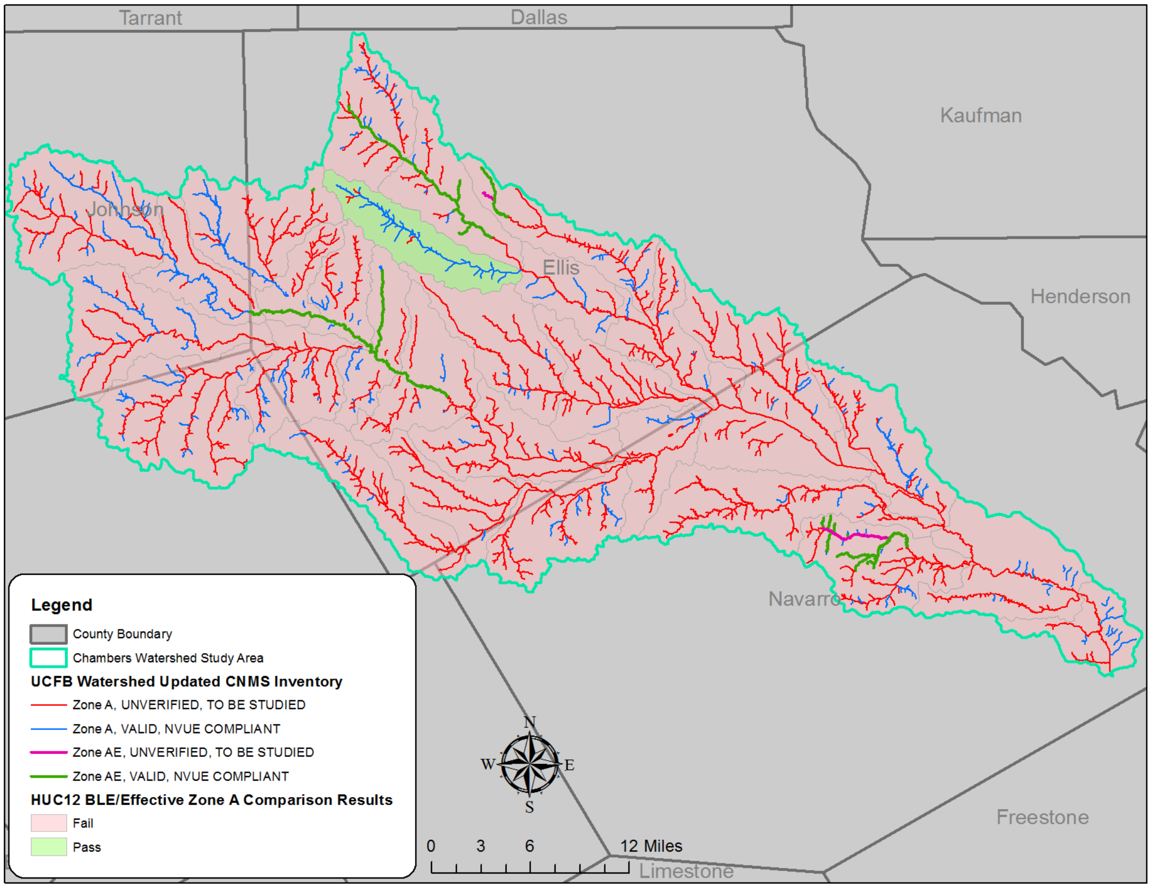


Figure ES-1. Chambers Watershed CNMS Validation Results

An overall risk for each HUC-12 watershed was calculated using the National Flood Risk Percentages Dataset and its proportional area. The weighted risk was multiplied by the percentage of points in the watershed that failed the CNMS comparison to effective to determine the priority score. Figure ES-2 below shows the range of the Chambers HUC-8 priority scores which can be used to initiate discussions during the Discovery phase. Lower Waxahachie Creek HUC-12 was determined to have the highest priority score and the most need while South Prong Creek – Lake Waxahachie HUC-12 has the lowest score.

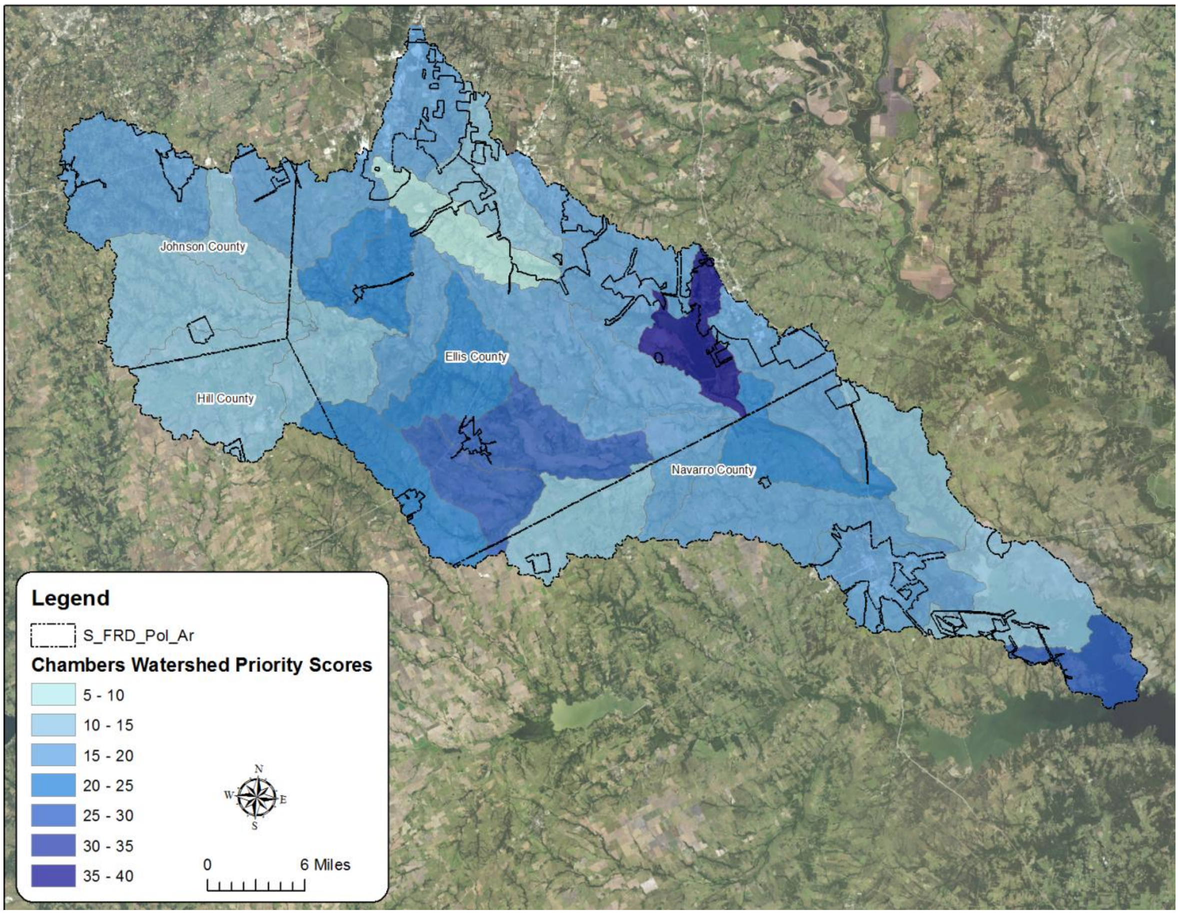


Figure ES-2. Ranking of Chambers Watershed HUC-12s

Base Level Engineering (BLE) Methodology

Recent innovations and efficiencies in floodplain mapping have allowed the U.S. Department of Homeland Security's Federal Emergency Management Agency (FEMA) to develop a process called Base Level Engineering (BLE), which can be used to address current program challenges, including the validation of Zone A studies and the availability of flood risk data in the early stages of a Flood Risk Project. The BLE process involves using best available data and incorporating automated techniques with traditional model development procedures to produce regulatory quality flood hazard boundaries for the 1-percent annual chance event as well as estimates of flood hazard boundaries for multiple recurrence intervals. The cost for developing the data and estimates resulting from the BLE process are lower than standard flood production costs. The BLE results may be used for eventual production of regulatory and non-regulatory products.

As described in Title 42 of the Code of Federal Regulations, Chapter III, Section 4101(e), once every five years, FEMA must evaluate whether the information on Flood Insurance Rate Maps (FIRMs) reflects the current risks in floodprone areas. FEMA makes this determination of flood hazard data validity by examining flood study attributes and change characteristics, as specified in the Validation Checklist of the Coordinated Needs Management Strategy (CNMS) Technical Reference. The CNMS Validation Checklist provides a series of critical and secondary checks to determine the validity of flood hazard areas studied by detailed methods (e.g., Zone AE, AH, or AO). While the critical and secondary elements in CNMS provide a comprehensive method of evaluating the validity of Zone AE studies, a cost-effective approach for evaluating Zone A studies has been lacking.

In addition to the need for Zone A validation guidance, FEMA standards require flood risk data to be provided in the early stages of a Flood Risk Project. FEMA Program Standard SID #29 requires that during Discovery, data must be identified that illustrates potential changes in flood elevation and mapping that may result from the proposed project scope. If available data does not clearly illustrate the likely changes, an analysis is required that estimates the likely changes. This data and any associated analyses should be shared and results should be discussed with stakeholders.

An important goal of the BLE process is the scalability of the results. Scalability means that the results of a BLE analysis can not only be used for CNMS evaluations of Zone A studies, but can also be leveraged throughout the Risk MAP program. The data resulting from a BLE analysis can be updated as needed and used for the eventual production of regulatory and non-regulatory products, outreach and risk communication, and MT-1 processing. Leveraging this data outside the Risk MAP program may also be valuable to external stakeholders.

FEMA Region VI contracted Compass to complete a BLE analysis for the Chambers Watershed in East Central Texas, to support FEMA's Discovery process and validation of effective Zone A Special Flood Hazard Area (SFHA). The study extents include portions of Ellis, Hill, Johnson and Navarro Counties and include the following communities: Cities of Alvarado, Bardwell, Blooming Grove, Burleson, Cedar Hill, Corsicana, Ennis, Eureka, Frost, Garrett, Grandview, Italy, Itasca, Keene, Maypearl, Midlothian, Milford, Retreat, Rice, Venus, and Waxahachie and the Towns of Alma, Emhouse, Mildred, and Powell. The study area consisted of four HUC-10 basins: North Fork Chambers Creek, Upper Chambers Creek, Lower Chambers Creek, and Waxahachie Creek. Figure 1 shows the orientation of the Chambers Creek HUC-10 basins with respect to the counties.

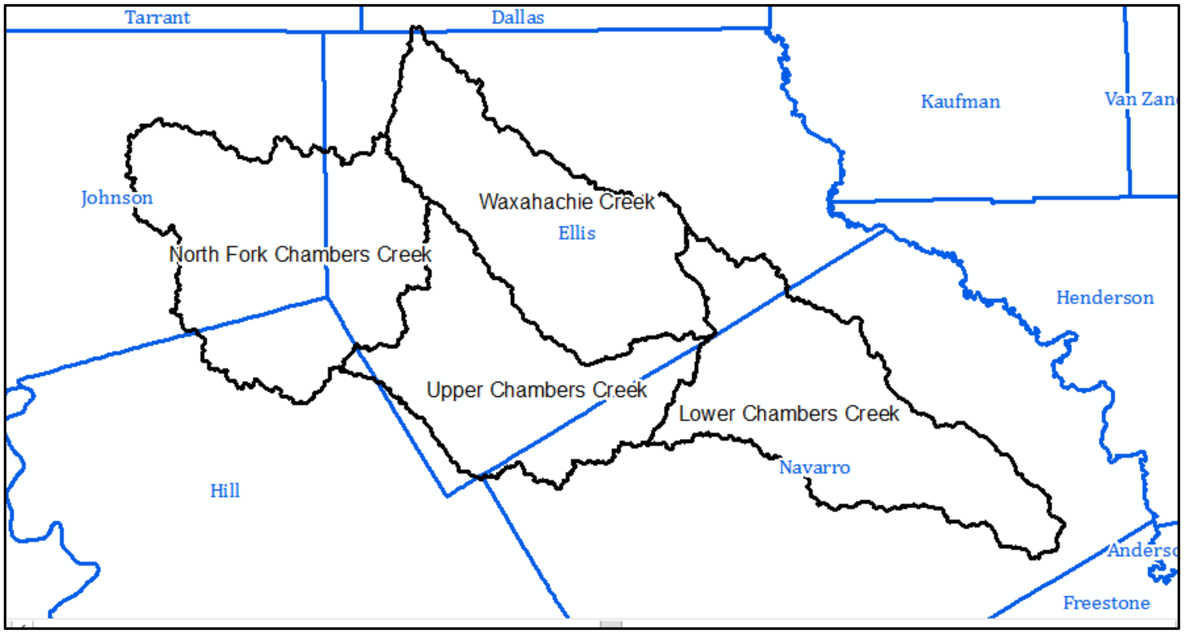


Figure 1. Chambers Watershed HUC-10 Basins

Compass studied approximately 1,200 miles of stream reaches within the Chambers Watershed with a minimum drainage area tolerance of one square mile. The selection and extent of stream reaches studied was based upon the number of stream miles with minimum drainage area of one square mile and not the number of effective Zone A stream miles. Study reaches were extended above this one square mile threshold as appropriate to ensure all effective Zone A floodplain received an updated analysis. Topographic data available from the United States Geologic Survey (USGS) was used to determine the hydrologic and hydraulic characteristics of the watershed. The following sections will summarize the BLE process and will discuss the results along with their recommended use.

1.1 Topographic Data

The source digital terrain data used for surface model development in support of hydrologic and hydraulic (H&H) analysis as well as mapping activities were leveraged from Texas Natural Resources Information System (TNRIS) and supplemented with USGS National Elevation Dataset (NED) as appropriate. The leveraged TNRIS DEM data consisted of 2013 1-meter gridded DEM data derived from Light Detection and Ranging (LiDAR) data. The USGS NED 1/3 Arc Second DEM (approximately 10-meter equivalent) was used to provide a buffer along the northeastern ridge line and around the southern extent of the Chambers-Chambers Reservoir as a buffer to the HUC-10 watersheds. Figure 2 shows the extent of the TNRIS LiDAR data.

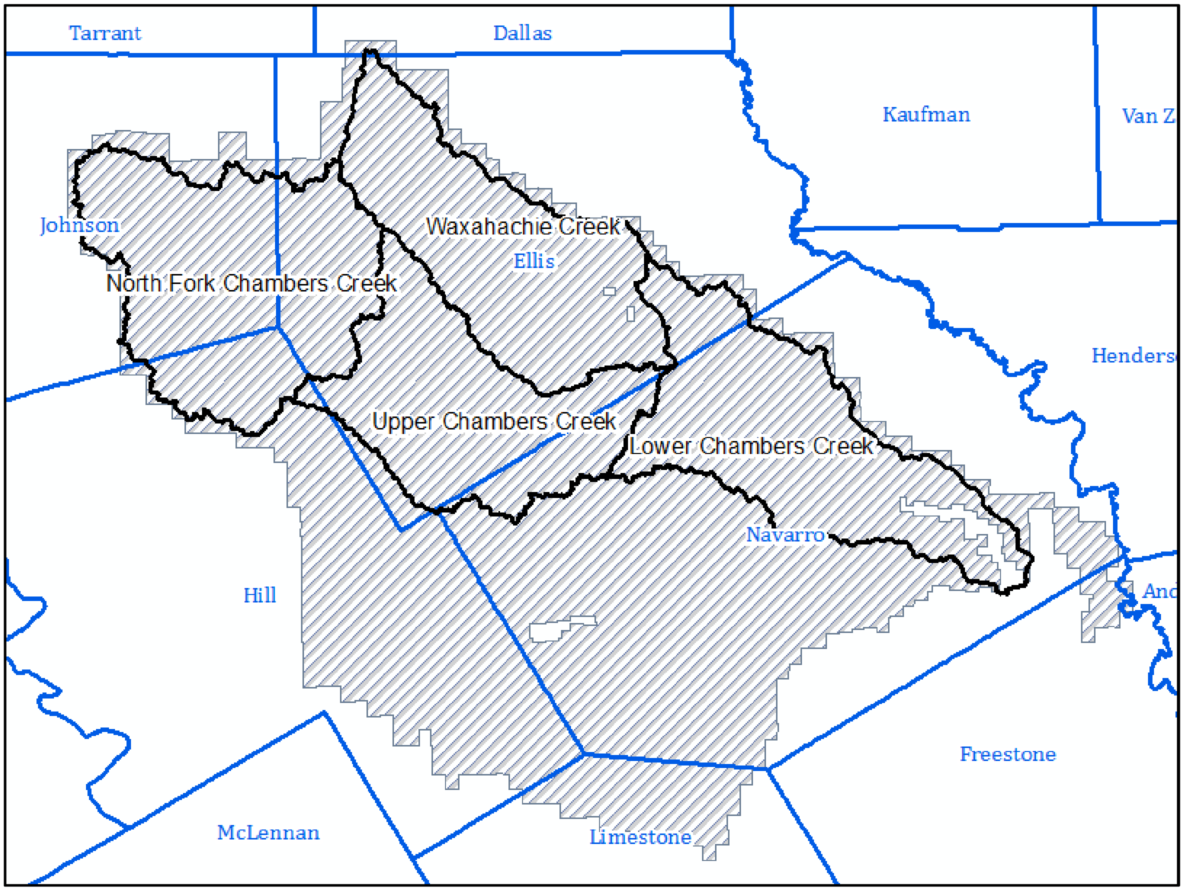


Figure 2. Extent of LiDAR Data

A new composite surface of the combined source topographic datasets, a seamless Triangular Irregular Network (TIN), was constructed using the WISE (Watershed Information System) Terrain Analyst tools. The TNRIS DEM data were used as the primary data source for the TIN while the 10-meter DEM was the secondary data source where TNRIS data did not exist for adequate buffer of the project area. A 10-foot DEM was sampled from the composite TIN and was used as the primary source for cross section takeoffs supporting hydraulic analyses. This 10-foot DEM was also used for visual QC and to support floodplain mapping tasks. A 50-foot DEM was sampled from the TIN for hydro enforcement to support hydrology tasks including flow vector and basin delineation.

Root Mean Square Error (RMSE) was calculated on the leveraged LiDAR-derivative DEM data used in this BLE analysis. The vertical accuracy of the source DEMs was calculated using QC checkpoints for the entire Chambers/Chambers project area from original LiDAR QC reports acquired with the TNRIS data. The entire project area tested at 3.77 centimeters (cm) RMSEz, well within the 12.5 cm FEMA requirement for leveraged topographic data.

In addition to the quantitative assessment of the source digital terrain, a qualitative visual inspection of the composite DEM was performed using a hillshade derived from the 10-foot DEM. The visual inspection indicated no unusual or non-terrestrial features were observed in the composite DEM assuring the surface files used for H&H and floodplain mapping activities are sufficient for BLE analysis.

1.2 Hydrology

Flood discharges for this study were calculated using both USGS regression equations and gage analysis, where stream gages with sufficient records exist. Scientific Investigations Report (SIR) 2009-5087, Regression Equations for Estimation of Annual Peak-Streamflow Frequency for Undeveloped Watersheds in Texas Using an L-moment-Based, PRESS-Minimized, Residual-Adjusted Approach (2009) contains the most recent regression equations for Texas and was used as the basis for regression calculations.

The WISE computer program was used to delineate drainage basins in shapefile format using the 50-foot resolution DEM. WISE was used to calculate the main-channel slope for each basin. The basin shapefile attribution was automated by WISE with drainage area and main-channel slope.

In order to perform the regression analysis and attribute each basin with appropriate discharge values, a script was written in Python and run in ESRI's ArcCatalog. This script required input of drainage area and main-channel slope (from WISE), as well as mean annual precipitation and OmegaEM.

PeakFQ version 7.1 was used to perform Flood Frequency Analysis (FFA) for two gages in the Chambers watershed.

Table 1 shows the published equations that were used for this study. In these equations, Qi represents peak streamflow for i-recurrence interval (annual chance exceedance (a.c.e.)) in cubic feet per second, P represents mean annual precipitation in inches, S represents dimensionless main-channel slope, Ω represents the OmegaEM parameter, and A is cumulative drainage area in square miles.

Table 1. Summary of Regression Equations (SIR 2009-5087)

Recurrence Interval	Equation[1]
$Q_{10\%}$	$P^{1.203}S^{0.403} \times 10^{[0.918\ \Omega\ +13.62-11.97A^{\wedge}(-0.0289)]}$
$Q_{4\%}$	$P^{1.140}S^{0.446} \times 10^{[0.945\ \Omega\ +11.79-9.819A^{\wedge}(-0.0374)]}$
$Q_{2\%}$	$P^{1.105}S^{0.476} \times 10^{[0.961\ \Omega\ +11.17-8.997A^{\wedge}(-0.0424)]}$
$Q_{1\%}$	$P^{1.071}S^{0.507} \times 10^{[0.969\ \Omega\ +10.82-8.448A^{\wedge}(-0.0467)]}$
$Q_{0.2\%}$	$P^{0.988}S^{0.569} \times 10^{[0.976\ \Omega\ +10.40-7.605A^{\wedge}(-0.0554)]}$

[1] Variables:
- Q_i peak flow for i recurrence interval (a.c.e.), in cubic feet per second;
- P, Mean Annual Precipitation in Inches;
- S, Main-channel slope (dimensionless);
- Ω, OmegaEM parameter;
- A, Cumulative Drainage Area in square miles

Discharges for the 1-percent plus and 1-percent minus a.c.e. were calculated as well. These values were computed by multiplying the $Q_{1\%}$ discharges by 0.30log10, which is the mean residual standard error for the $Q_{1\%}$ equation.

The mean annual precipitation values were determined based on a shapefile coverage obtained from the Texas Water Development Board and available for download from the following location: http://www.twdb.texas.gov/mapping/gisdata/doc/Precipitation_Shapefile.zip

The annual precipitation values reflect data for the climatological period 1981-2010 as recorded by the Natural Resources Conservation Service (NRCS).

Main channel slope was calculated in WISE. An automated routine was used to determine the longest flowpath from the upstream of a reach to the outlet of the sub-basin of interest based on flowpaths developed from the 50-foot DEM. Once the length of the flowpath was delineated, elevations for the endpoints were determined based on the TIN developed from the LiDAR. The slope was calculated by dividing the fall by the reach distance and the result was reported in foot/foot.

From USGS SIR 2009-5087, the OmegaEM parameter is a generalized terrain and climate index that expresses relative differences in peak-streamflow potential. A shapefile was developed and populated with OmegaEM values based on Figure 2 in SIR 2009-5087. This shapefile was used, along with a python script in ArcCatalog, to determine OmegaEM values on a sub-basin basis. For sub-basins that are split, the dominant OmegaEM value for the sub-basin was used.

Drainage area for each sub-basin was determined based on automated basin delineations performed in WISE. Basin break points were set by the user with a sub-basin target of one square mile in size. This criterion was adjusted for streams with larger drainage areas in order to avoid excessive and unnecessary discharge breaks. Break points were also set just upstream of stream confluences. Cumulative drainage area was determined based on these automated delineations performed by WISE in combination with a stream connectivity routine that defined the stream reach segments with upstream and downstream neighbors.

As discussed in previously, a Python script in ArcCatalog was used to compute discharges for each sub-basin. The sub-basin shapefile was attributed with the computed discharges as part of the automated script. From the sub-watershed basin shapefile the discharges were incorporated into the HEC-RAS models using an automated routine in WISE. Discharges, as well as water surface elevation results, were associated with the hydraulic cross sections prior to generation of floodplain boundaries and grid mapping. Those results are available in GIS format as part of this BLE submittal package.

The peak discharges on Chambers Watershed are attenuated by the combined effect of several flood control reservoirs in the headwaters of the sub-basin. These reservoirs are on the main stem as well as several tributary streams. As a result of the peak attenuation, the USGS regression equations likely over predict the a.c.e. flows for Chambers Creek as well as study segments on tributaries to Chambers Creek that are downstream of flood control impoundments.

Two USGS stream gages in the Chambers HUC-8 watershed listed in Table 2 were used to determine the a.c.e. flows for Chambers Creek. The record for the period since the beginning of regulation in 1962 was examined in order to determine the a.c.e. flows under the existing regulated conditions.

Table 2. USGS Stream Gages Used in Analysis

Gage ID	Flooding Source and Location	Computed Drainage Area (mi^2)	Published Drainage Area (mi^2)	Period of Record
08064100	Chambers Creek near Rice, TX	803	807	1984 - 2014
08064500	Chambers Creek near Corsicana, TX	959	963	1913, 1939-1984

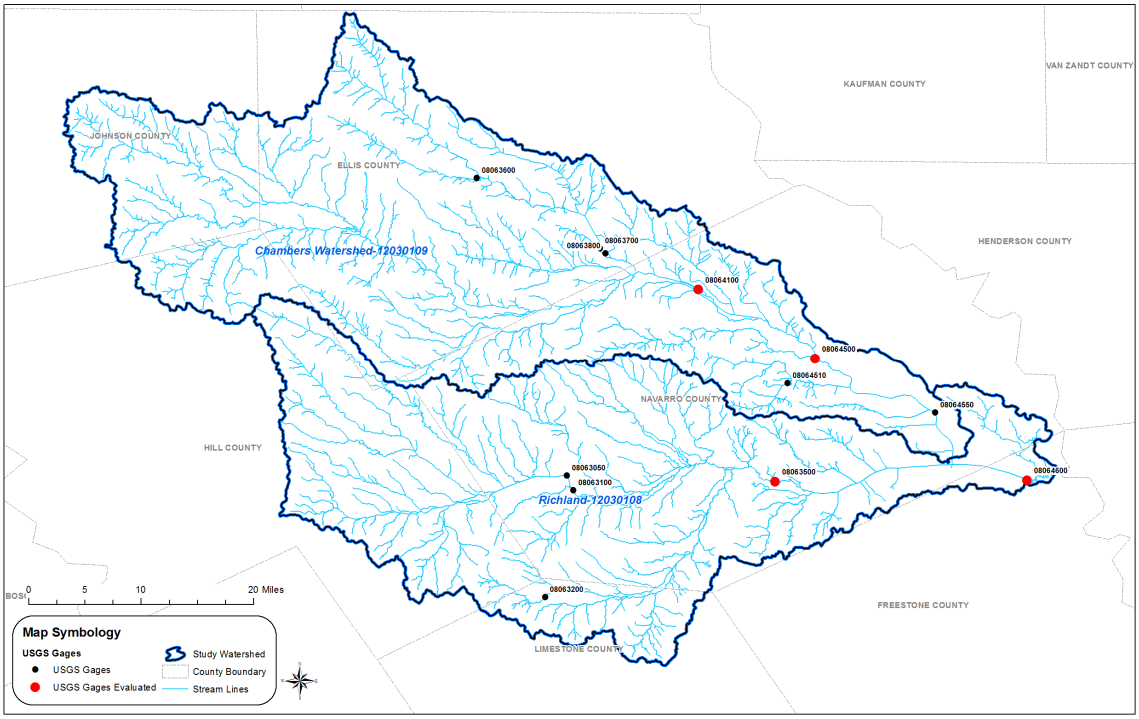


Figure 3. USGS Gage Stations within Chambers and Richland Watersheds

The two stream gages on Chambers Creek, near Rice (08064100) and near Corsicana (08064500) are at similar drainage areas and have a combined period of record of 54 years (1961-2014) that spans the entire regulated period.

Flood Frequency Analyses (FFA) were performed following Bulletin 17B guidelines for the 2 gages on Chambers Creek (08064100, 08064500).

Similar to the regression analysis results, the discharges used on these streams are associated with the hydraulic cross sections in the GIS shapefiles. For the portion of Chambers Creek downstream of the confluence with Waxahachie Creek, the computed discharges for the gages are used with no adjustment. Computed discharges for gage 08064100 are used upstream of the confluence of Tupelo Branch with discharges from 08064500 used downstream of this confluence. For the portion of Chambers Creek upstream of the confluence with Waxahachie Creek, gage computations were disregarded. The discharges for this reach were adopted from the effective FIS for Ellis County and since the discharges reported in the FIS are higher than those computed at the downstream gages, a constant discharge value was used for the entire reach.

In addition to the gages listed above, there are several stage only gages which were used for reference only as a reasonability check on lake elevations. No gage analysis was performed for Gage ID 08063800, Waxahachie Creek near Bardwell, TX. This gage is located just downstream of Bardwell Lake which is regulated.

It should be noted that throughout the watershed there are a significant number of flood control dams on tributaries to Chambers Creek and Waxahachie Creek. Hydrologic results were not adjusted to take into account the impact of these structures.

1.3 Hydraulics

The hydraulic approach for BLE analysis for the Chambers watershed consisted of using the terrain model described in section 1.1 in combination with hydrology input computed as described in section 1.2 to establish water surface elevations using 1-D steady state analysis. The Hydrologic Engineering Center's River Analysis System (HEC-RAS) program version 4.1 was chosen as the computer model to compute water surface elevations on a stream by stream basis. The WISE computer program was used to establish model stream orientation, initial hydraulic cross section layout and stationing, assign n-values to cross sections, and to develop all input files for the HEC-RAS program. ESRI's ArcMap program was used to review and refine cross section layout orientation.

First pass cross section layout was performed using an automated routine in WISE based on the drainage area at the cross section location. A first draft model was created based on this initial cross section layout and draft boundaries were developed. At this stage, a second pass inspection for cross section placement occurred. Significant refinement occurred during this step. To improve the hydraulic models, additional cross sections were added as needed to better define the BLE floodplain boundary. Cross sections were extended in locations where overtopping occurred. Orientation of cross sections was refined to improve on the perpendicular orientation to flow. Additional cross sections were added at floodplain constrictions and at downstream portions of tributaries to ensure a proper tie-in with receiving streams. Cross sections were adjusted to remove sections that intersected hydraulic crossings in the floodplain. For some of the largest studied streams, cross sections were laid out manually in order to have more reasonable spacing and better capture the constrictions in the floodplain.

Cross sections were not drawn on top of roadways or railroads. Cross sections were placed at the upstream and downstream face of major roads and railroads. Major roads are those designated in the Texas DOT road coverage as On System Highways. The road coverage can be acquired in shapefile format from the TNRIS website at the following link: https://tnris.org/data-catalog/entry/txdot-roadways/. Ineffective flow stations were placed in the hydraulic models as appropriate to account for flow constrictions at crossings as well as at locations deemed by the engineer to be ineffective at conveying flow downstream.

Cross sections were drawn on dam tops for significant dams with well defined spillways in order to better represent ponded water upstream of the structures. It was assumed in doing this that the vast majority of the flow during a flood event would pass the spillway and that the hydraulic model would reasonably estimate flow across the spillway as represented in the hydraulic cross section. This was the method used for the Chambers/Chambers Reservoir as flood elevations at the desired frequencies were not available. The elevations used in the modeling were checked against known elevations from past flooding events and effective Zone A boundaries and the results were determined reasonable.

Significant effort was made to start all tributaries below the receiving water surface elevations but this was not always achieved, particularly in wide, flat floodplains where small tributaries ran parallel to large streams or where road crossings or dams interfered with cross section alignments.

There are levees in this watershed along Chambers Creek both upstream and downstream of the confluence with Waxahachie Creek as well as levees on Waxahachie Creek. These levees are not certified under NFIP and the reaches with levees were modeled using the natural valley approach.

The relationship between drainage area and assigned channel geometry is shown in Table 3. These default values for dimensions and spacing are subject to change based on the details noted above as well as the judgment of the responsible engineer.

Table 3. Cross Section Default Parameters

Drainage area (upper limit)	XS Spacing	Channel Top Width	Channel Bottom Width	Channel Depth
1.0	500	4	3.5	0.5
2.0	500	6	5	0.5
4.0	500	11	10	0.5
8.0	500	18	17	0.5
10.0	500	20	19	0.5
15.0	600	26	25	0.5
20.0	600	32	31	0.5
25.0	600	38	36	0.5
30.0	600	43	41	0.5
40.0	600	52	50	0.5
50.0	600	60	57	1
75.0	750	68	65	1
100.0	750	76	73	1
150.0	1000	91	88	1
250.0	1000	122	119	2
500.0	1500	198	195	2
1000.0	2500	351	346	3
2000.0	4000	657	652	3
5000.0	4000	1575	1565	3
>5000.0	4000	2000	1990	4

Manning's roughness coefficients (n-values) were determined using the 2011 National Land Cover Data (NLCD) dataset in combination with n-values from Chow (1959) and Calenda, et al. (2005). The association between the n-values and the NLCD Classification is shown in Table 4. Manning's n-value takeoffs were performed by WISE and the n-values were adjusted in some locations based on engineering judgment. N-values within channel banks were limited by the automated routine to a range of 0.030 to 0.070.

Table 4. Manning's "n" Roughness Based on 2001 NLCD Classification (Moore, 2011)

NLCD Classification	Minimum	Normal	Maximum	Source
Open Water	.025	.03	.033	Chow 1959
Developed, Open Space	.01	.013	.016	Calenda, et al. 2005
Developed, Low Intensity	.038	.05	.063	Calenda, et al. 2005
Developed, Medium Intensity	.056	.075	.094	Calenda, et al. 2005
Developed, High Intensity	.075	.1	.125	Calenda, et al. 2005
Barren Land	.025	.03	.035	Chow 1959
Deciduous Forest	.1	.12	.16	Chow 1959
Evergreen Forest	.1	.12	.16	Chow 1959
Mixed Forest	.1	.12	.16	Chow 1959
Scrub/Shrub	.035	.05	.07	Chow 1959
Grassland/Herbaceous	.025	.03	.035	Chow 1959

NLCD Classification	Minimum	Normal	Maximum	Source
Pasture/Hay	.03	.04	.05	Chow 1959
Cultivated Crops	.025	.035	.045	Chow 1959
Woody Wetlands	.08	.1	.12	Chow 1959
Emergent Herbaceous Wetland	.075	.1	.15	Chow 1959

The boundary condition used for the majority of the study streams was normal depth with a default value of 0.005 ft/ft. For streams with names in the National Flood Hazard Layer (NFHL) and streams with large drainage areas (generally greater than 8square miles), the normal depth slope was calculated based on the HEC-RAS profile invert.

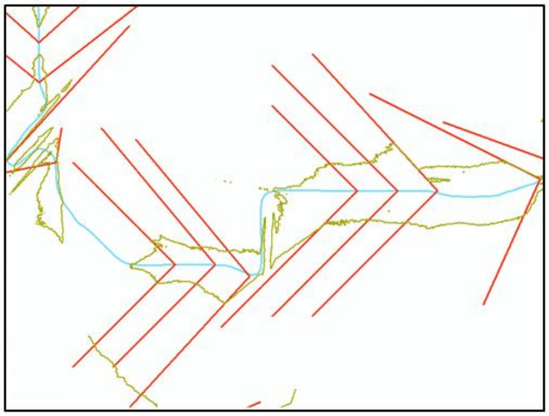
Stage data was available for the Navarro-Mills Dam from USGS Gage 0863050. A statistical analysis using a Log-Pearson III (LP3) distribution was performed to determine reasonable stage elevations for each of the modeled return periods.

1.4 Quality Control

Following the initial BLE analysis in each watershed, the flood hazard area delineations created by the BLE process were reviewed for areas where the results were not ideal.

Typical manual editing resulting from reasonability checks included adding cross-sections, adjusting orientation of cross sections, trimming cross sections and reduction of the default "V" angle of cross sections. It is estimated that 50 percent of cross-sections were adjusted in some work areas while other areas did not require as much editing. Other examples of manual editing included adding cross-sections at confluence areas, modification to improve perpendicular orientation at the channel, adjustment of discharge breaks to better represent flow addition points, revisions to dam spillways and dam tops, and revisions to n-values.

A major component of the QC process was an automated check that identified locations where the 1-percent a.c.e profile was crossed by another frequency or by the 1-percent plus or 1-percent minus profile. Significant effort was made to reasonably resolve all of these instances. Another automated check identified locations where there was a drawdown of greater than 0.5 feet on the 1-percent a.c.e. water surface profile. This check is particularly useful for identifying errors in the model such as a channel that is too wide, a poorly placed cross section, or a need for additional cross sections. Again, significant effort was made to reasonable resolve these drawdown situations.



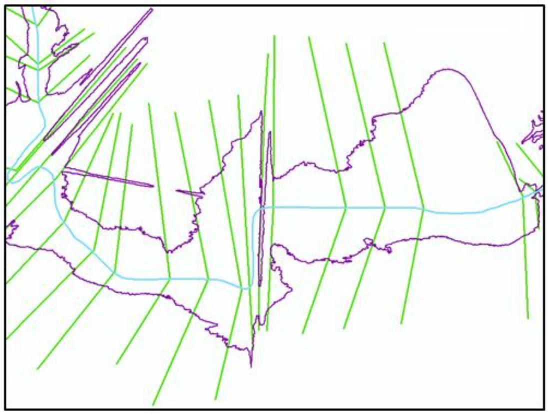


Figure 4. Default "V" angle cross-sections automated by WISE (left). Manually edited cross-sections to more accurately capture terrain (right). Resulting flood boundaries shown in gold (left) or purple (right) for clarity.

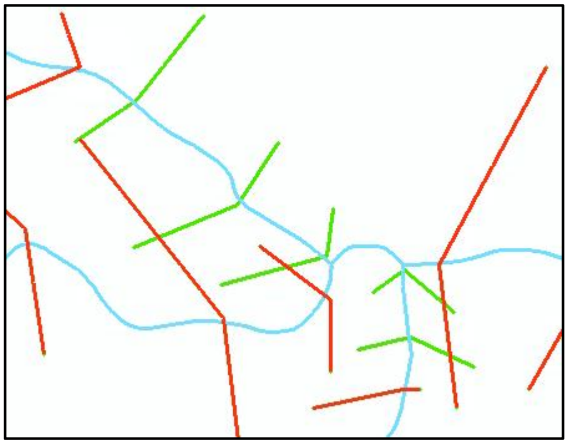


Figure 5. Manually added cross-sections (green) to improve accuracy of tie-ins at confluences.

1.5 One-percent Special Flood Hazard Area Delineation

The 1-percent and 0.2-percent boundaries were mapped using a routine that develops water surface elevation grids based on the 10-foot cell size DEM developed from the TNRIS LiDAR. This product was converted to a polygon for cleaning. The cleaning routine involved manual inspection of the polygons to identify and remove areas of disconnected flooding. In general, areas with a size of less than 5,000 square feet were removed and all others were investigated to determine whether they should be considered as potentially part of the special flood hazard area (SFHA). This investigation was aided by the ground DEM and aerial imagery. Manual adjustments to the polygons were made to account for spillways on dams which could not be accurately modeled using HEC-RAS as well as disconnected areas along the flooding source that should reasonably be connected.

Following the removal of disconnected flooding areas and other boundary adjustments, the small islands in the floodplain were filled. Islands with a size between roughly 5,000 and 30,000 square feet were inspected and, in general, islands that were less than 10,000 square feet were filled.

Once the island filling process was complete, the water surface raster mapping routine was run and set to conform to the polygon boundary. This ensures that the water surface raster and the flood plain boundary are consistent with each other. The depth raster product was created at the end of the process by performing a raster subtraction with the water surface elevation raster and the ground DEM.

Challenges

Challenges encountered during BLE analyses will vary based on available data on which to run the analysis. The Chambers Watershed analysis presented challenges as summarized in the following paragraphs.

As noted in Section 1.2 above, there are a significant number of flood control dams on tributaries to Chambers Creek. Hydrologic results from regression calculations were not adjusted to take into account the impact of these structures. Further investigation should be conducted when upgrading these models.

As noted in Section 1.3 above, significant effort was made to start all tributaries below the receiving water surface elevations but this was not always achieved, particularly in wide, flat floodplains where small tributaries ran parallel to large streams or where road crossings or dams interfered with cross section alignments.

As noted in Section 1.4 above, multiple streamlines did not extend far enough to fully capture effective flood hazard data. The streamlines generated in the development of the one square mile basins were extended in order to more closely match the effective areas and CNMS streams.

Results and Recommendations

The BLE results for the Chambers Watershed produced an SFHA that compares reasonably well with the effective SFHA in most cases, and provides an additional estimated SFHA in areas that do not currently have an SFHA mapped. These results provide context for flood risk communication as part of the Discovery process, and should be verified through community work map meetings before being applied to a regulatory product.

A map showing the BLE results are included as Appendix A.

3.1 Validation of Effective Zone A SFHA

The full inventory of Zone A studies in Chambers watershed contains 1,180 miles. The following is a summary of the results of the CNMS validation assessment for the effective Zone A studies in the study area. Initial Assessment checks A1-A3 were evaluated for the CNMS inventory of Zone A studies.

INITIAL ASSESSMENT A1 – SIGNIFICANT TOPOGRAPHY UPDATE CHECK

This check involves determining whether a topographic data source is available that is significantly better than what was used for the effective Zone A modeling and mapping. For the study area in Chambers TX, the effective Zone A topographic data leveraged a variety of sources, but primarily based upon USGS 24K map products. The topography listed in Section1.1 above represents a significant improvement from the assumed effective Zone A topographic source.

INITIAL ASSESSMENT A2 – CHECK FOR SIGNIFICANT HYDROLOGY CHANGES

This check involves first determining whether new regression equations have become available from the USGS since the date of the effective Zone A study. If newer regression equations exist for the area of interest, then an engineer must determine whether these regression equations would significantly affect the 1-percent-annual-chance flow. Scientific Investigations Report 2009-5087, Regression Equations for Estimation of Annual Peak-Streamflow Frequency for Undeveloped Watersheds in Texas Using an L-moment-Based, PRESS-Minimized, Residual-Adjusted Approach (2009) contains the most recent regression equations for Texas. The Regression Equations used for the effective Zone A studies for Ellis, Navarro and Hill Counties were developed using the USGS Water Resources Investigations Report 96-4307, "Regional Equations for Estimation of Peak-Streamflow Frequency for Natural Basins in Texas". However, the equations used for the effective Zone A studies in Johnson County are unknown. The newer Regression Equations will not significantly impact the 1-percent annual chance flow and therefore A-2 was passed.

INITIAL ASSESSMENT A3 – CHECK FOR SIGNIFICANT DEVELOPMENT

This check involves using the National Urban Change Indicator (NUCI) dataset to assess increased urbanization in the watershed of the Zone A study. If the percentage of urban area within the HUC-12 watershed containing the effective Zone A study is 15% or more, and has increased by 50% or more since the effective analysis, the study would fail this check. Although the NUCI data provide year-to-year changes in urbanization, the NLCD also is needed to establish a baseline of urban land cover for this analysis. The check for significant development in this watershed was completed by evaluating percentage of urban change at the HUC-12 level. Of the 30 HUC-12 polygons within the study area, none showed an increase in urbanization of 50% or more since the effective study.

Table 5. Zone A Initial Assessment Results

Assessment Check	Pass / Fail	Notes
A1 – Topography	Fail	2013 LiDAR significantly better than effective USGS topo source.
A2 – Hydrology	Pass	Latest regression equations for TX are dated 2009. Ellis, Navarro and Hill Counties used regression equations from 1997 while the source for Johnson County is unknown.
A3 – Development	Pass	No increase of 50% or more since effective study

VALIDATION CHECK A4 – CHECK OF STUDIES BACKED BY TECHNICAL DATA

Zone A studies that pass all initial assessment checks described above may be categorized as "Valid" in the CNMS Inventory only if the effective Zone A study is supported by modeling or sound engineering judgment and all regulatory products are in agreement. If the effective Zone A study passes all initial assessment checks, but is not supported by modeling, or if the original engineering method used is unsupported or undocumented, a comparison of the BLE results and effective Zone A's is performed. Due to lack of complete documentation of the original engineering methods in Ellis, Hill and Navarro Counties A4 for streams within these counties have been marked as Fail in CNMS. Streams within Johnson County have been marked as Pass in FEMA's CNMS database since they were supported by sound engineering judgment.

VALIDATION CHECK A5 – COMPARISON OF BLE AND EFFECTIVE ZONE A

The BLE /effective Zone A comparison method leverages the existing Floodplain Boundary Standard (FBS) certification procedures described in FEMA SID 113, but with a slight modification. This modified FBS comparison approach uses the 1-percent plus and 1-percent minus flood profiles and horizontal and vertical tolerances described in the *First Order Approximation—Methodology, Validation, and Scalability Guidance Procedures (Version 1.5).* For the comparison of BLE and effective Zone A in the Texas study area, the following vertical and horizontal tolerances were used to conduct the modified FBS procedure. One point was placed every 200 feet along the floodplain boundaries for comparison.

Vertical Tolerance: +/- 10 feet (one-half contour interval of assumed effective topographic source).
Horizontal Tolerance: +/-75 feet (standard horizontal tolerance for BLE comparison testing).

Of the 570 modeled BLE streams in the study area, 339 were found to correspond (within the tolerance limits) with effective Zone A flood zones. Comparison results for these streams were grouped at the HUC-12 level and are summarized in Table 7 below. Streams where the percentage of passing FBS sample points is greater than or equal to 85% are marked as "Pass", otherwise marked as "Fail".

VALIDATION RESULTS

Based on the validation assessments and BLE comparison results described above, the CNMS inventory of Zone A studies in the Chambers Watershed study area has been updated, with 919.36 miles categorized as UNVERIFIED – TO BE STUDIED, and 260.65 miles categorized as VALID

– NVUE COMPLIANT. Total miles in each of these categories are summarized in Table 6 and illustrated in Figure 3 below.

Table 6. Zone A Validation Results

Validation Status	Status Type	Total Miles
VALID	NVUE COMPLIANT	260.65
UNVERIFIED	TO BE STUDIED	919.36

Table 7. BLE Comparison Results

HUC-12 Watershed		Total FBS points	Fail	Pass	%Pass	BLE Comparison Pass? (>85%)	Priority Score
Watershed Name	Watershed Number						
Chambers	All Streams	47,799	11,941	35,858	75.0%	Fail	
Headwaters North Fork Chambers Creek	120301090101	3,682	771	2,911	79.1%	Fail	15.6
Upper North Fork Chambers Creek	120301090102	1,637	302	1,335	81.6%	Fail	14.8
Armstrong Creek-Cottonwood Creek	120301090103	2,015	412	1,603	79.6%	Fail	16.4
Middle North Fork Chambers Creek	120301090104	600	162	438	73.0%	Fail	21.7
Lower North Fork Chambers Creek	120301090105	637	170	467	73.3%	Fail	21.6
Upper South Fork Chambers Creek	120301090106	2,713	461	2,252	83.0%	Fail	11.0
Island Creek	120301090107	3,228	763	2,465	76.4%	Fail	12.0
Lower South Fork Chambers Creek	120301090108	1,217	220	997	81.9%	Fail	13.2
Greathouse Branch-Chambers Creek	120301090201	541	125	416	76.9%	Fail	18.5
Baker Branch-Chambers Creek	120301090202	1,184	310	874	73.8%	Fail	21.1
Houston Creek-Chambers Creek	120301090203	1,904	569	1,335	70.1%	Fail	25.8
Upper Mill Creek	120301090204	1,765	499	1,266	71.7%	Fail	21.6
Middle Mill Creek	120301090205	1,565	543	1,022	65.3%	Fail	27.3
Lower Mill Creek	120301090206	2,029	563	1,466	72.3%	Fail	12.8
Cryer Creek-Chambers Creek	120301090207	624	177	447	71.6%	Fail	17.9
Headwaters Waxahachie Creek	120301090301	1,819	420	1,399	76.9%	Fail	17.1
Upper Waxahachie Creek	120301090302	863	165	698	80.9%	Fail	13.5
South Prong Creek-Lake Waxahachie	120301090303	1,355	132	1,223	90.3%	Pass	7.5
Middle Waxahachie Creek	120301090304	956	244	712	74.5%	Fail	20.4

HUC-12 Watershed		Total FBS points	Fail	Pass	%Pass	BLE Comparison Pass? (>85%)	Priority Score
Watershed Name	Watershed Number						
Mustang Creek-Bardwell Lake	120301090305	1,507	339	1,168	77.5%	Fail	18.6
Lower Waxahachie Creek	120301090306	1,604	777	827	51.6%	Fail	39.1
Upper Big Onion Creek	120301090307	1,699	375	1,324	77.9%	Fail	18.2
Lower Big Onion Creek	120301090308	1,930	447	1,483	76.8%	Fail	19.6
Cummins Creek	120301090401	2,573	778	1,795	69.8%	Fail	20.5
Oak Branch-Chambers Creek	120301090402	841	272	569	67.7%	Fail	23.2
Tupelo Branch-Chambers Creek	120301090403	1,794	416	1,378	76.8%	Fail	12.6
Briar Creek	120301090404	2,276	733	1,543	67.8%	Fail	20.1
Elm Creek-Post Oak Creek	120301090405	1,975	505	1,470	74.4%	Fail	19.8
Cedar Creek-Chambers Creek	120301090406	1,070	207	863	80.7%	Fail	13.1
Long Arm Branch-Chambers Creek	120301090407	196	84	112	57.1%	Fail	28.6

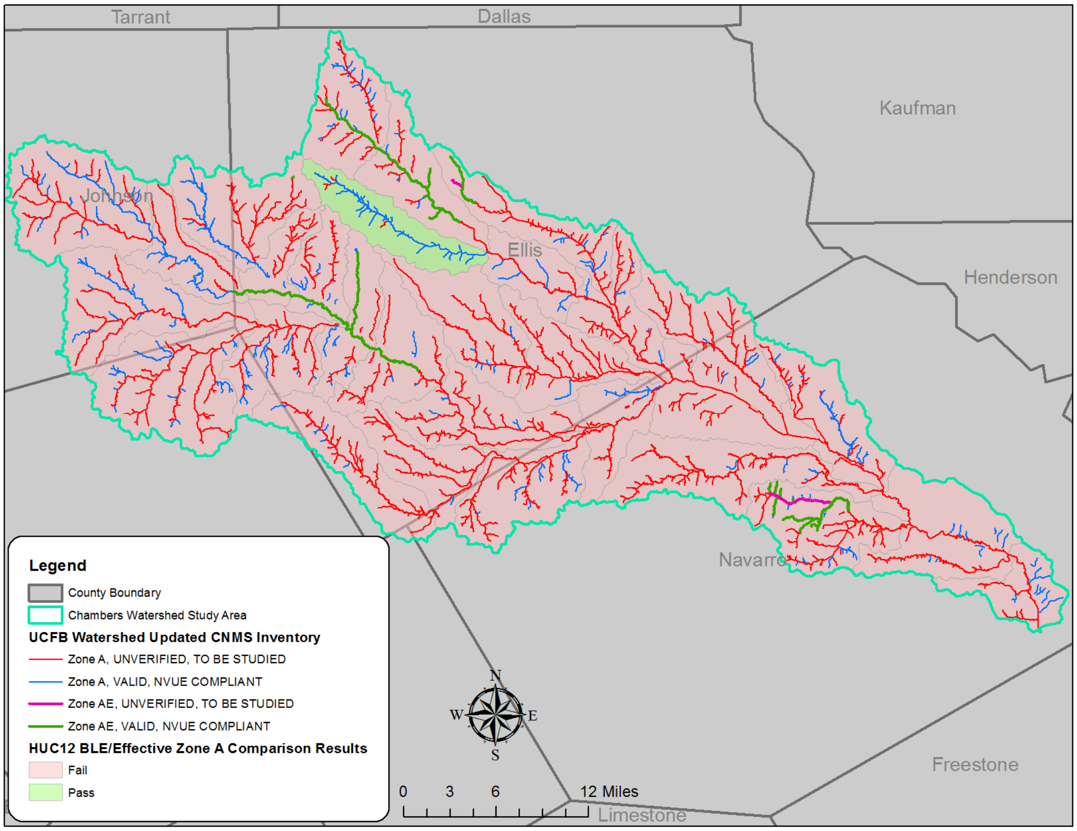


Figure 6. Chambers Watershed CNMS Validation Results

An overall risk for each HUC-12 watershed was calculated using the National Flood Risk Percentages Dataset and its proportional area. The weighted risk was multiplied by the percentage of points in the watershed that failed the CNMS comparison to effective to determine the priority score. The range of the Richland HUC-8 priority scores can be used to initiate discussions during the Discovery phase. Lower Waxahachie Creek HUC-12 was determined to have the highest priority score and the most need while South Prong Creek – Lake Waxahachie HUC-12 has the lowest score.

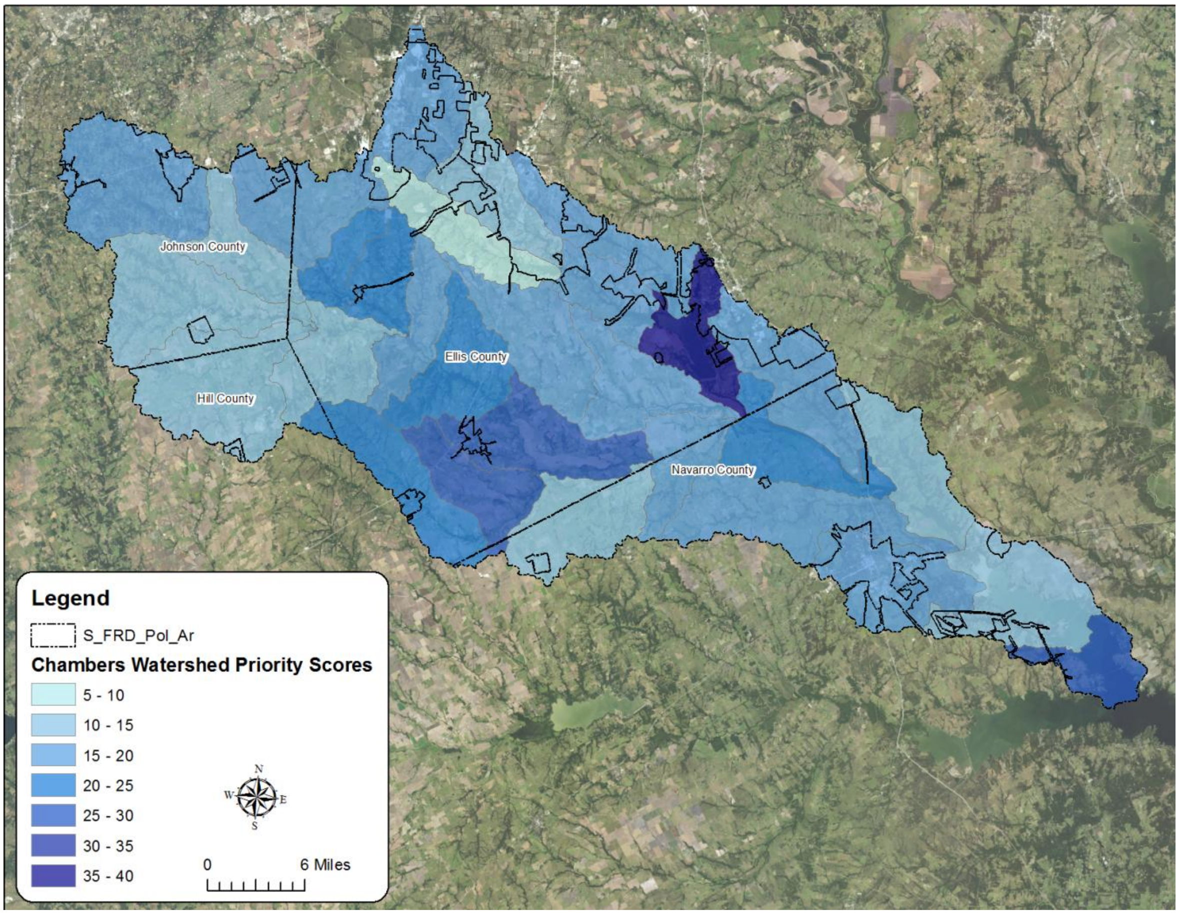


Figure 7. Ranking of Chambers Watershed HUC-12s

3.2 Flood Risk Analysis

A flood risk analysis was performed for this project. The initial 2010 AAL study was based upon 2000 census data, for this project a new Basic Hazus analysis was performed to establish a base level of flood losses. Those results are stored in the L_RA_AAL table. The updated 1-percent-annual-chance grid (known as 'refined' grid) was used to update the flood losses. The refined grid loss results are stored in the L_RA_Refined table. Both tables are combined to populate the L_RA_Composite table.

Hazus version 3.2 was used for the basic and refined loss analysis. The losses are reported via census blocks. It is important to note that Hazus version 3.2 uses dasymetric census blocks. Dasymetric mapping removes undeveloped areas (such as areas covered by other bodies of water, wetlands, or forests) from the Census blocks, changing their shape and reducing their size in these areas. For more information on dasymetric data visit FEMA's Media Library for the Hazus-MH Data Inventories: Dasymetric vs. Homogenous, or Hazus 3.0 Dasymetric Data Overview.

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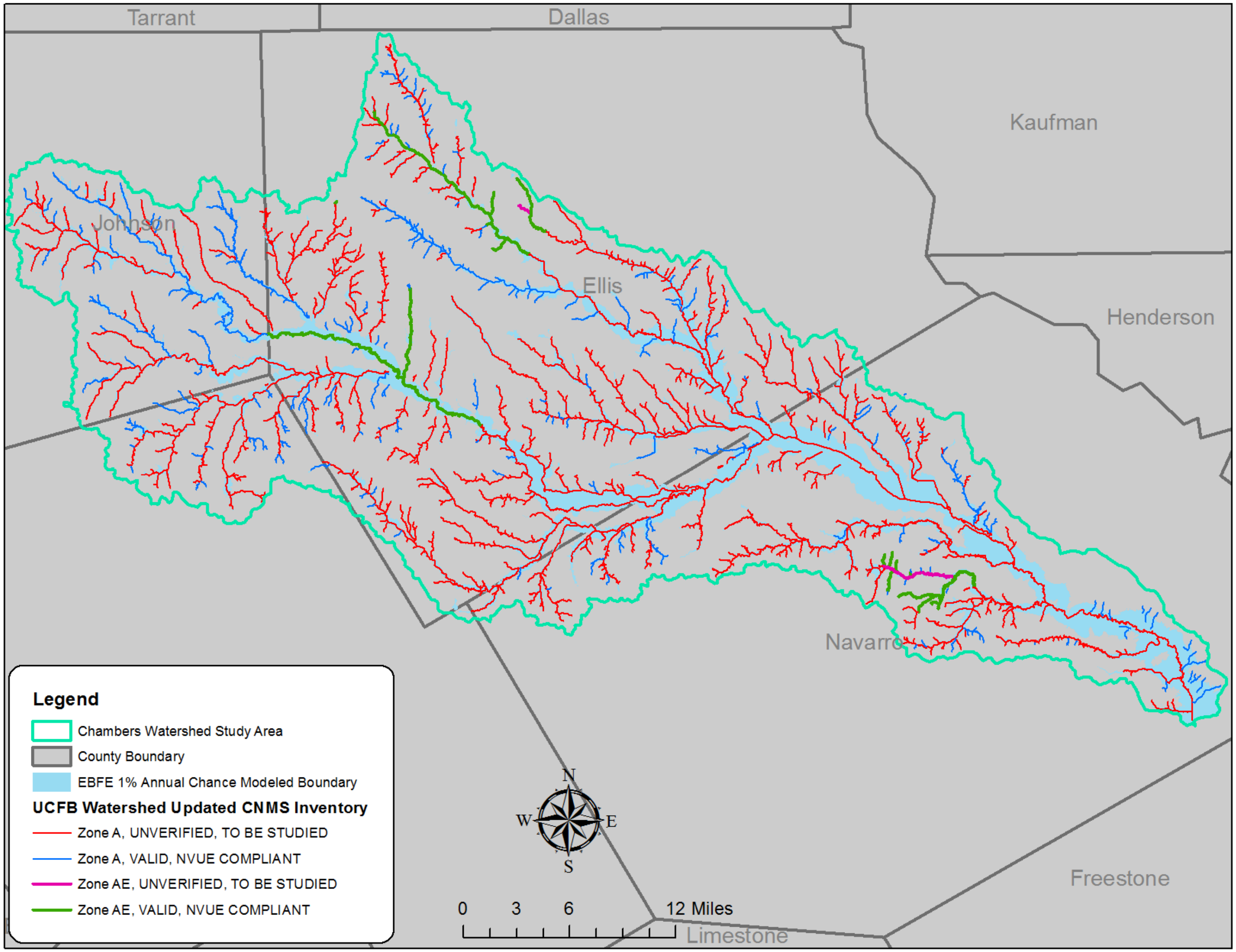
Appendix A BLE Maps



Richland Watershed, TX
Base Level Engineering (BLE) Results

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Prepared for:

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1.1	February 2016	Revised to reflect Base Level Engineering effort	AECOM

APPROVALS

This document requires the approval of the following persons:

Role	Name	Phone Extension	Title (CLIN/RMC)	Review Date	Approved Date

CLIENT DISTRIBUTION

Name	Title/Organization	Location
FEMA's MIP	Region VI	See path above

Table of Contents

Executive Summary

The U.S. Department of Homeland Security's Federal Emergency Management Agency (FEMA) Region VI contracted Compass to complete a Base Level Engineering (BLE) analysis for the Richland Watershed in North Eastern Texas, to support FEMA's Discovery process and validation of effective Zone A Special Flood Hazard Area (SFHA). The BLE process involves using best available data and incorporating automated techniques with traditional model development procedures to produce regulatory quality flood hazard boundaries for the 1-percent annual chance event as well as estimates of flood hazard boundaries for multiple recurrence intervals.

The source digital terrain data used for surface model development in support of hydrologic and hydraulic (H&H) analysis as well as mapping activities were leveraged from Texas Natural Resources Information System (TNRIS) and supplemented with USGS National Elevation Dataset (NED) as appropriate. The TNRIS terrain dataset was 2013 1-meter gridded DEM data derived from Light Detection and Ranging (LiDAR) data, while the USGS NED 1/3 Arc Second DEM was approximately 10-meter equivalent.

Flood discharges for this study were calculated using both USGS regression equations and gage analysis, where stream gages with sufficient records exist. Regression Equations obtained from the Scientific Investigations Report (SIR) 2009-5087, Regression Equations for Estimation of Annual Peak-Streamflow Frequency for Undeveloped Watersheds in Texas Using an L-moment-Based, PRESS-Minimized, Residual-Adjusted Approach (2009) were used while PeakFQ version 7.1 was used to perform Flood Frequency Analysis (FFA) for the three gages in the Richland Watershed.

The Hydrologic Engineering Center's River Analysis System (HEC-RAS) program version 4.1 was used to compute water surface elevations on a stream by stream basis. All hydraulic models were computed using 1-D steady state analysis.

The stream mile network for Richland Watershed was compiled using FEMA's Coordinated Needs Management Strategy (CNMS) inventory in conjunction with the National Hydrography Dataset (NHD) 24K High Resolution. Table ES-1 lists the stream miles identified by each source for this BLE validation analysis.

Table ES-1. Summary of Stream Miles

Source	Richland Stream Miles
CNMS	1,035.5
NHD High	10.0
Total	**1,045.5**

Of the 1,045.5 stream miles in the study area, only 1,035.5 were evaluated. The 10 stream miles added to the inventory from NHD were not compared as no effective floodplain exists. Based on the validation assessment, CNMS has been updated to reflect 1,008.6 miles of UNVERIFIED – TO BE STUDIED and 26.9 miles of VALID – NVUE COMPLIANT.

Total miles in each of these categories are summarized in Table ES-2 and illustrated in Figure ES-1 below.

Table ES-2: Zone A Validation Results

Validation Status	Status Type	Total Miles
VALID	NVUE COMPLIANT	26.9
UNVERIFIED	TO BE STUDIED	1008.6

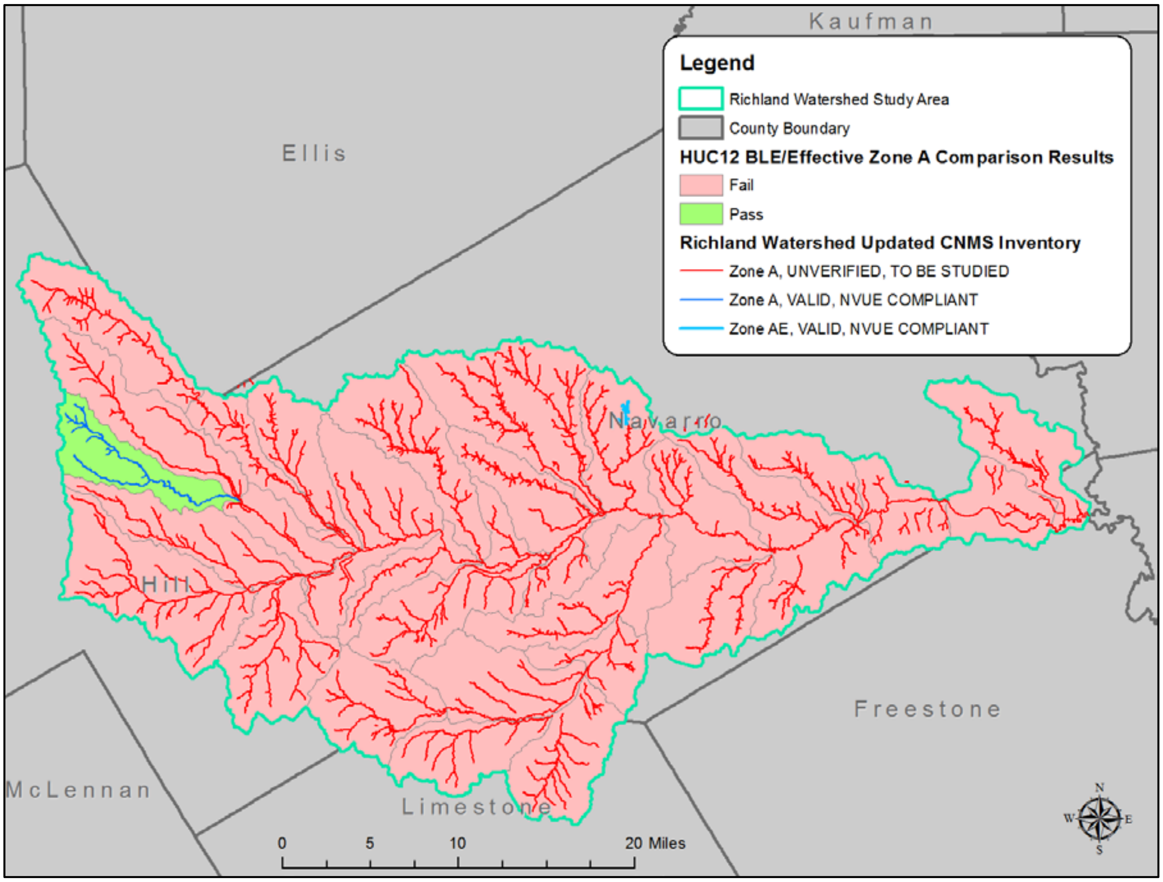

Figure ES-1. Richland Watershed CNMS Validation Results

An overall risk for each HUC-12 watershed was calculated using the National Flood Risk Percentages Dataset and its proportional area. The weighted risk was multiplied by the percentage of points in the watershed that failed the CNMS comparison to effective to determine the priority score. Figure ES-2 below shows the range of the Richland HUC-8 priority scores which can be used to initiate discussions during the Discovery phase. Alligator Creek – Pin Oak Creek HUC-12 was determined to have the highest priority score and the most need while Grove Creek – Pecan Creek HUC-12 has the lowest score.

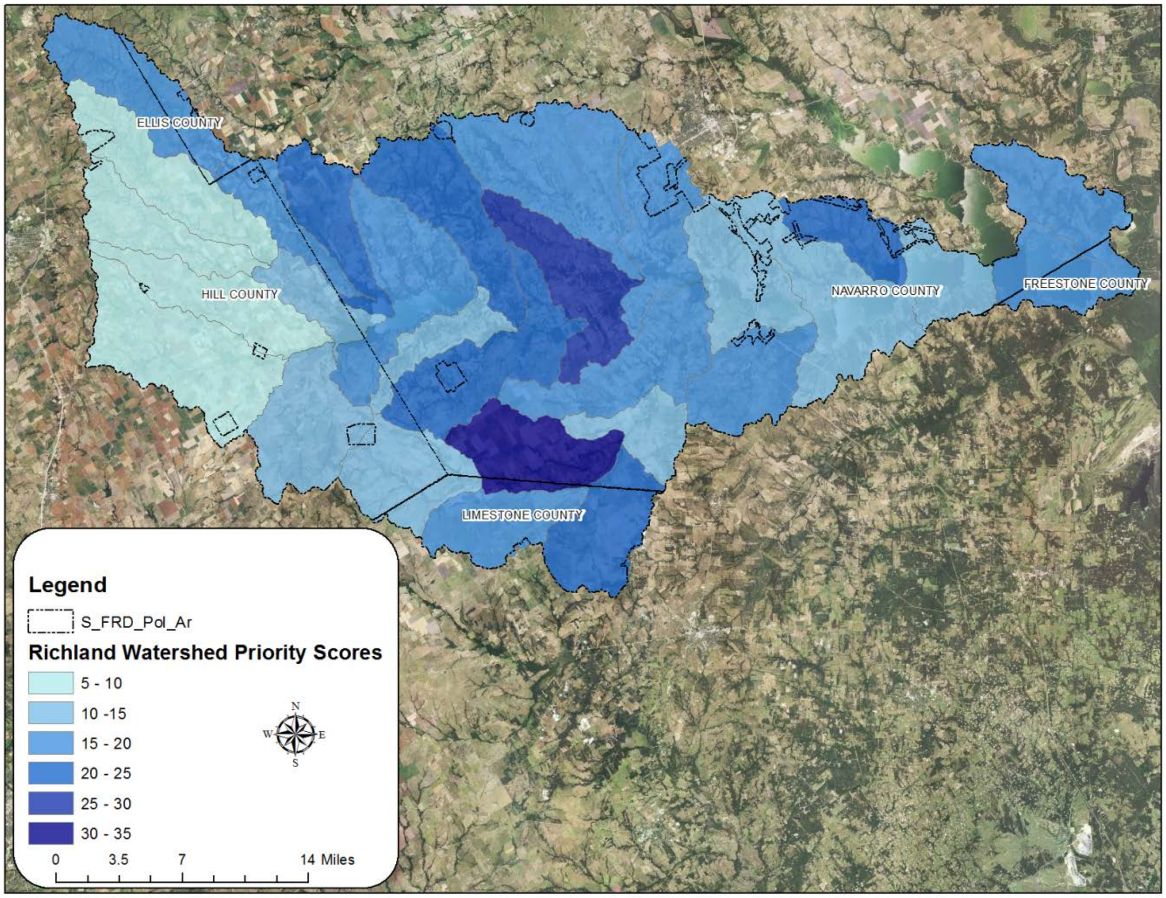

Figure ES-2. Ranking of Richland Watershed HUC-12s

Base Level Engineering (BLE) Methodology

Recent innovations and efficiencies in floodplain mapping have allowed the U.S. Department of Homeland Security's Federal Emergency Management Agency (FEMA) to develop a process called Base Level Engineering (BLE), which can be used to address current program challenges, including the validation of Zone A studies and the availability of flood risk data in the early stages of a Flood Risk Project. The BLE process involves using best available data and incorporating automated techniques with traditional model development procedures to produce regulatory quality flood hazard boundaries for the 1-percent annual chance event as well as estimates of flood hazard boundaries for multiple recurrence intervals. The cost for developing the data and estimates resulting from the BLE process are lower than standard flood production costs. The BLE results may be used for eventual production of regulatory and non-regulatory products.

As described in Title 42 of the Code of Federal Regulations, Chapter III, Section 4101(e), once every five years, FEMA must evaluate whether the information on Flood Insurance Rate Maps (FIRMs) reflects the current risks in floodprone areas. FEMA makes this determination of flood hazard data validity by examining flood study attributes and change characteristics, as specified in the Validation Checklist of the Coordinated Needs Management Strategy (CNMS) Technical Reference. The CNMS Validation Checklist provides a series of critical and secondary checks to determine the validity of flood hazard areas studied by detailed methods (e.g., Zone AE, AH, or AO). While the critical and secondary elements in CNMS provide a comprehensive method of evaluating the validity of Zone AE studies, a cost-effective approach for evaluating Zone A studies has been lacking.

In addition to the need for Zone A validation guidance, FEMA standards require flood risk data to be provided in the early stages of a Flood Risk Project. FEMA Program Standard SID #29 requires that during Discovery, data must be identified that illustrates potential changes in flood elevation and mapping that may result from the proposed project scope. If available data does not clearly illustrate the likely changes, an analysis is required that estimates the likely changes. This data and any associated analyses should be shared and results should be discussed with stakeholders.

An important goal of the BLE process is the scalability of the results. Scalability means that the results of a BLE analysis can not only be used for CNMS evaluations of Zone A studies, but can also be leveraged throughout the Risk MAP program. The data resulting from a BLE analysis can be updated as needed and used for the eventual production of regulatory and non-regulatory products, outreach and risk communication, and MT-1 processing. Leveraging this data outside the Risk MAP program may also be valuable to external stakeholders.

The BLE process produces a model backed Zone A study that is suitable to replace the effective Zone A products. As implied by the nomenclature, the Base Level study is the first tier in the three tiers of engineering analysis available to FEMA for flood studies. The second tier is Limited Detail Study (LDS). LDS involves a more rigorous level of detail from an engineering standpoint and includes field visits to assess hydraulic crossings for incorporation into the hydraulic analysis. The highest tier of study is Detailed Study. This involves the most rigorous review of the engineering and FIRM products. In addition, Detailed Study incorporates the use of traditional survey techniques to better capture detail on hydraulic crossings and the dimensions of the stream channel. Table 1 outlines the additional effort involved when moving from one study level/tier to the next. The cost of a flood study on a per mile basis increases by approximately one order of magnitude for each tier.

FEMA Region VI contracted Compass to complete a BLE analysis for the Richland Watershed in North Eastern Texas, to support FEMA's Discovery process and validation of effective Zone A Special Flood Hazard Area (SFHA). The study extents include portions of Ellis, Hill, Navarro, Limestone, and Freestone Counties and include the following communities: Cities of Angus, Blooming Grove, Bynum, Carl's Corner, Coolidge, Corsicana, Dawson, Eureka, Hubbard, Malone, Milford, Retreat, Richland and the Towns of Barry, Mertens, Mildred, Mustang, Navarro, Oak Valley, Penelope, and Tehuacana. The study area consisted of four HUC-10 basins: Alligator Creek, Navarro Mills Lake, Pin Oak Creek, and Post Oak Creek. Figure 1 shows the orientation of the Richland Creek HUC-10 basins with respect to the counties.

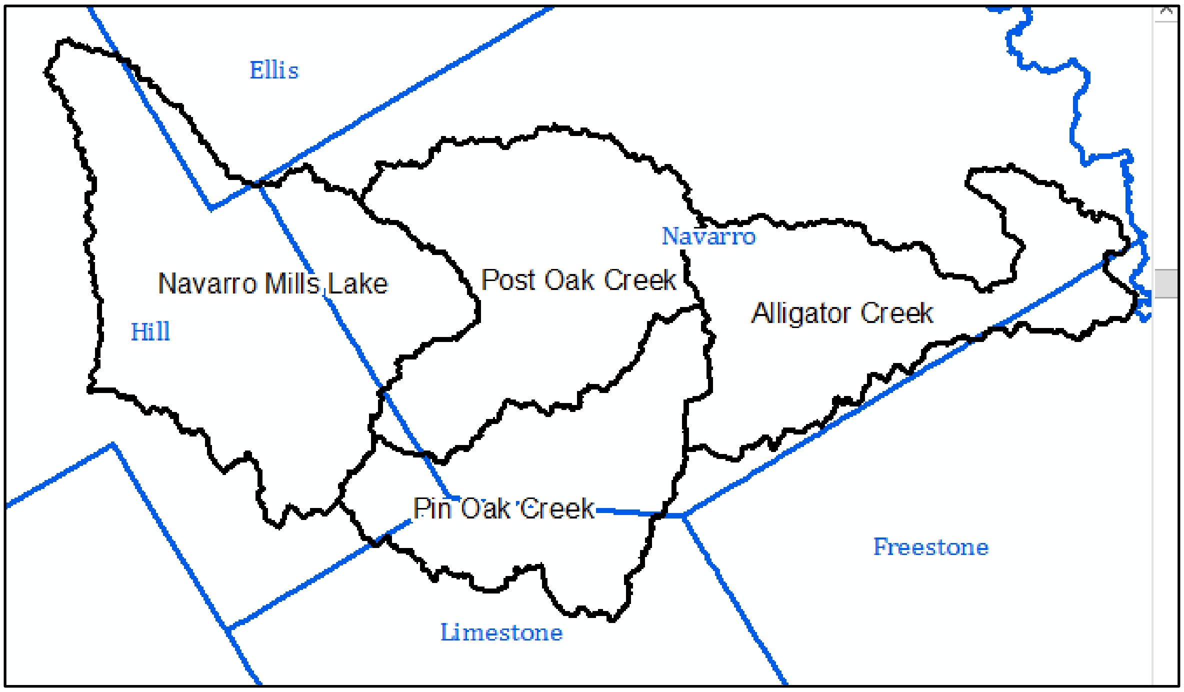

Figure 1. Richland Creek HUC-10 Basins

Compass studied approximately 1,036 miles of stream reaches within the Richland Watershed with a minimum drainage area tolerance of one square mile. The selection and extent of stream reaches studied was based upon the number of stream miles with minimum drainage area of one square mile and not the number of effective Zone A stream miles. Study reaches were extended above this one square mile threshold as appropriate to ensure all effective Zone A floodplain received an updated analysis. Topographic data available from the United States Geologic Survey (USGS) was used to determine the hydrologic and hydraulic characteristics of the watershed. The following sections will summarize the BLE process and will discuss the results along with their recommended use.

1.1 Topographic Data

The source digital terrain data used for surface model development in support of hydrologic and hydraulic (H&H) analysis as well as mapping activities were leveraged from Texas Natural Resources Information System (TNRIS) and supplemented with USGS National Elevation Dataset (NED) as appropriate. The leveraged TNRIS DEM data consisted of 2013 1-meter gridded DEM data derived from Light Detection and Ranging (LiDAR) data. The USGS NED 1/3 Arc Second DEM (approximately 10-meter equivalent) was used to provide a buffer along the northeastern ridge line and around the southern extent of the Richland-Chambers Reservoir as a buffer to the HUC-10 watersheds. Figure 2 shows the extent of the TNRIS LiDAR data.

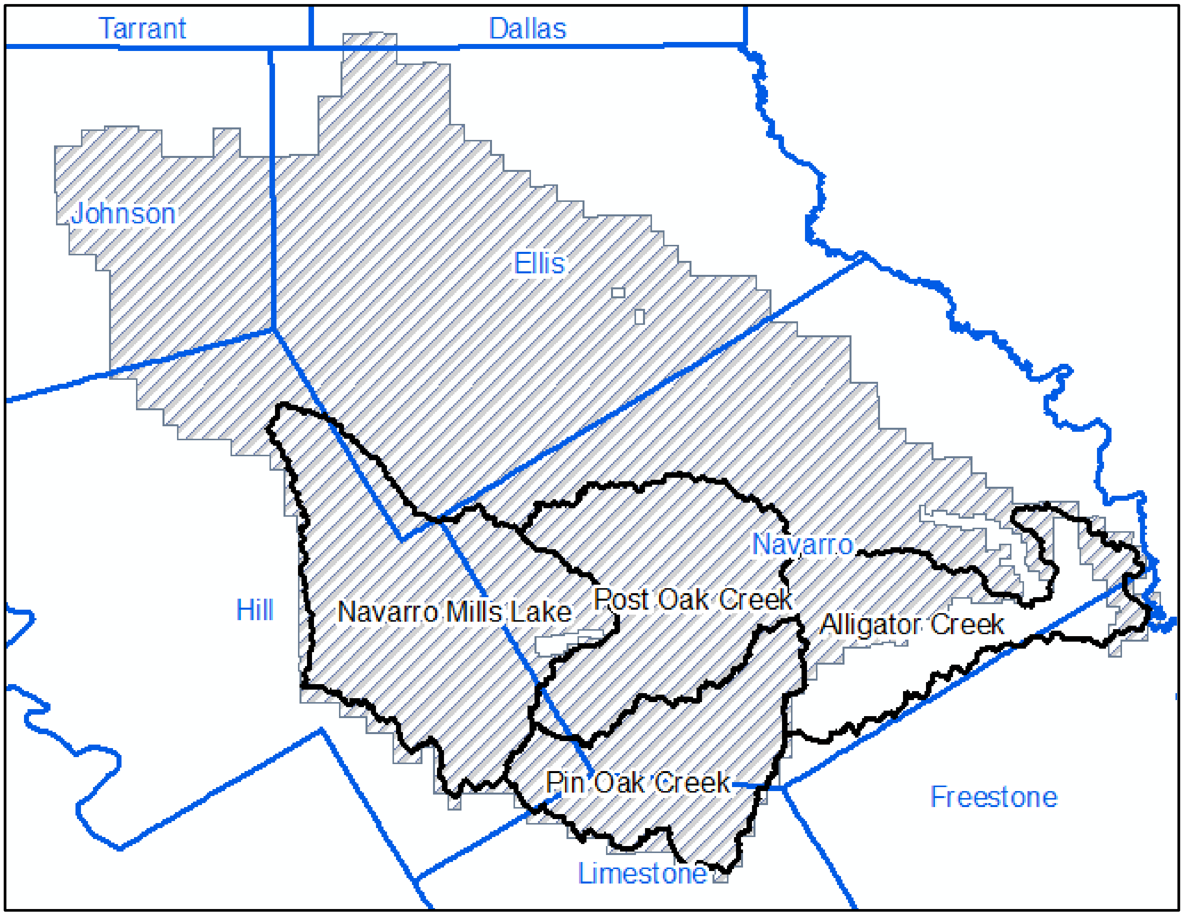

Figure 2. Extent of LiDAR Data

A new composite surface of the combined source topographic datasets, a seamless Triangular Irregular Network (TIN), was constructed using the WISE (Watershed Information System) Terrain Analyst tools. The TNRIS DEM data were used as the primary data source for the TIN while the 10-meter DEM was the secondary data source where TNRIS data did not exist for adequate buffer of the project area. A 10-foot DEM was sampled from the composite TIN and was used as the primary source for cross section takeoffs supporting hydraulic analyses. This 10-foot DEM was also used for visual QC and to support floodplain mapping tasks. A 50-foot DEM was sampled from the TIN for hydro enforcement to support hydrology tasks including flow vector and basin delineation.

Root Mean Square Error (RMSE) was calculated on the leveraged LiDAR-derivative DEM data used in this BLE analysis. The vertical accuracy of the source DEMs was calculated using QC checkpoints for the entire Richland/Chambers project area from original LiDAR QC reports acquired with the

TNRIS data. The entire project area tested at 3.77 centimeters (cm) RMSEz, well within the 12.5 cm FEMA requirement for leveraged topographic data.

In addition to the quantitative assessment of the source digital terrain, a qualitative visual inspection of the composite DEM was performed using a hillshade derived from the 10-foot DEM. The visual inspection indicated no unusual or non-terrestrial features were observed in the composite DEM assuring the surface files used for H&H and floodplain mapping activities are sufficient for BLE analysis.

1.2 Hydrology

Flood discharges for this study were calculated using both USGS regression equations and gage analysis, where stream gages with sufficient records exist. Scientific Investigations Report (SIR) 2009-5087, Regression Equations for Estimation of Annual Peak-Streamflow Frequency for Undeveloped Watersheds in Texas Using an L-moment-Based, PRESS-Minimized, Residual-Adjusted Approach (2009) contains the most recent regression equations for Texas and was used as the basis for regression calculations.

The WISE computer program was used to delineate drainage basins in shapefile format using the 50-foot resolution DEM. WISE was used to calculate the main-channel slope for each basin. The basin shapefile attribution was automated by WISE with drainage area and main-channel slope.

In order to perform the regression analysis and attribute each basin with appropriate discharge values, a script was written in Python and run in ESRI's ArcCatalog. This script required input of drainage area and main-channel slope (from WISE), as well as mean annual precipitation and OmegaEM.

PeakFQ version 7.1 was used to perform Flood Frequency Analysis (FFA) for three gages in the Richland Watershed.

Table 1 shows the published equations that were used for this study. In these equations, Qi represents peak streamflow for i-recurrence interval (annual chance exceedance (a.c.e.)) in cubic feet per second, P represents mean annual precipitation in inches, S represents dimensionless main-channel slope, Ω represents the OmegaEM parameter, and A is cumulative drainage area in square miles.

Table 1. Summary of Regression Equations (SIR 2009-5087)

Recurrence Interval	Equation[1]
$Q_{10\%}$	$P^{1.203}S^{0.403} \times 10^{[0.918\ \Omega\ +13.62-11.97A\wedge(-0.0289)]}$
$Q_{4\%}$	$P^{1.140}S^{0.446} \times 10^{[0.945\ \Omega\ +11.79-9.819A\wedge(-0.0374)]}$
$Q_{2\%}$	$P^{1.105}S^{0.476} \times 10^{[0.961\ \Omega\ +11.17-8.997A\wedge(-0.0424)]}$
$Q_{1\%}$	$P^{1.071}S^{0.507} \times 10^{[0.969\ \Omega\ +10.82-8.448A\wedge(-0.0467)]}$
$Q_{0.2\%}$	$P^{0.988}S^{0.569} \times 10^{[0.976\ \Omega\ +10.40-7.605A\wedge(-0.0554)]}$

[1] Variables:

Q_i peak flow for i recurrence interval (a.c.e.), in cubic feet per second;
P, Mean Annual Precipitation in Inches;
S, Main-channel slope (dimensionless);
Ω, OmegaEM parameter;
A, Cumulative Drainage Area in square miles

Discharges for the 1-percent plus and 1-percent minus a.c.e. were calculated as well. These values were computed by multiplying the $Q_{1\%}$ discharges by 0.30log10, which is the mean residual standard error for the $Q_{1\%}$ equation.

The mean annual precipitation values were determined based on a shapefile coverage obtained from the Texas Water Development Board and available for download from the following location: http://www.twdb.texas.gov/mapping/gisdata/doc/Precipitation_Shapefile.zip

The annual precipitation values reflect data for the climatological period 1981-2010 as recorded by the Natural Resources Conservation Service (NRCS).

Main channel slope was calculated in WISE. An automated routine was used to determine the longest flowpath from the upstream of a reach to the outlet of the sub-basin of interest based on flowpaths developed from the 50-foot DEM. Once the length of the flowpath was delineated, elevations for the endpoints were determined based on the TIN developed from the LiDAR. The slope was calculated by dividing the fall by the reach distance and the result was reported in foot/foot.

From USGS SIR 2009-5087, the OmegaEM parameter is a generalized terrain and climate index that expresses relative differences in peak-streamflow potential. A shapefile was developed and populated with OmegaEM values based on Figure 2 in SIR 2009-5087. This shapefile was used, along with a python script in ArcCatalog, to determine OmegaEM values on a sub-basin basis. For sub-basins that are split, the dominant OmegaEM value for the sub-basin was used.

Drainage area for each sub-basin was determined based on automated basin delineations performed in WISE. Basin break points were set by the user with a sub-basin target of one square mile in size. This criterion was adjusted for streams with larger drainage areas in order to avoid excessive and unnecessary discharge breaks. Break points were also set just upstream of stream confluences. Cumulative drainage area was determined based on these automated delineations performed by WISE in combination with a stream connectivity routine that defined the stream reach segments with upstream and downstream neighbors.

As discussed in previously, a Python script in ArcCatalog was used to compute discharges for each sub-basin. The sub-basin shapefile was attributed with the computed discharges as part of the automated script. From the sub-watershed basin shapefile the discharges were incorporated into the HEC-RAS models using an automated routine in WISE. Discharges, as well as water surface elevation results, were associated with the hydraulic cross sections prior to generation of floodplain boundaries and grid mapping. Those results are available in GIS format as part of this BLE submittal package.

While BLE analysis was not performed in areas with effective discharge data available, it was possible to compare the hydrologic results at transition points between effective and BLE study. The only such location in the Richland watershed is on Harris Branch of Richland Creek. The comparison at this location shows the regression discharge to be approximately 15% lower than the effective discharge.

The peak discharges on Richland Creek are attenuated by the combined effect of several flood control reservoirs in the headwaters of the sub-basin. These reservoirs are on the main stem as well as several tributary streams. As a result of the peak attenuation, the USGS regression equations likely over predict the a.c.e. flows for Richland Creek as well as study segments on tributaries to Richland Creek that are downstream of flood control impoundments.

Three USGS stream gages in the Richland and Chambers HUC-8 watersheds listed in Table 2 were used to determine the a.c.e. flows for Richland Creek. The record for the period since the beginning of regulation in 1962 was examined in order to determine the a.c.e. flows under the existing regulated conditions.

Table 2: USGS Stream Gages Used in Analysis

Gage ID	Flooding Source and Location	Computed Drainage Area (mi^2)	Published Drainage Area (mi^2)	Period of Record
08063500	Richland Creek near Richland, TX	731	734	1962-1989
08064100	Chambers Creek near Rice, TX	803	807	1984 - 2014
08064500	Chambers Creek near Corsicana, TX	959	963	1913, 1939-1984

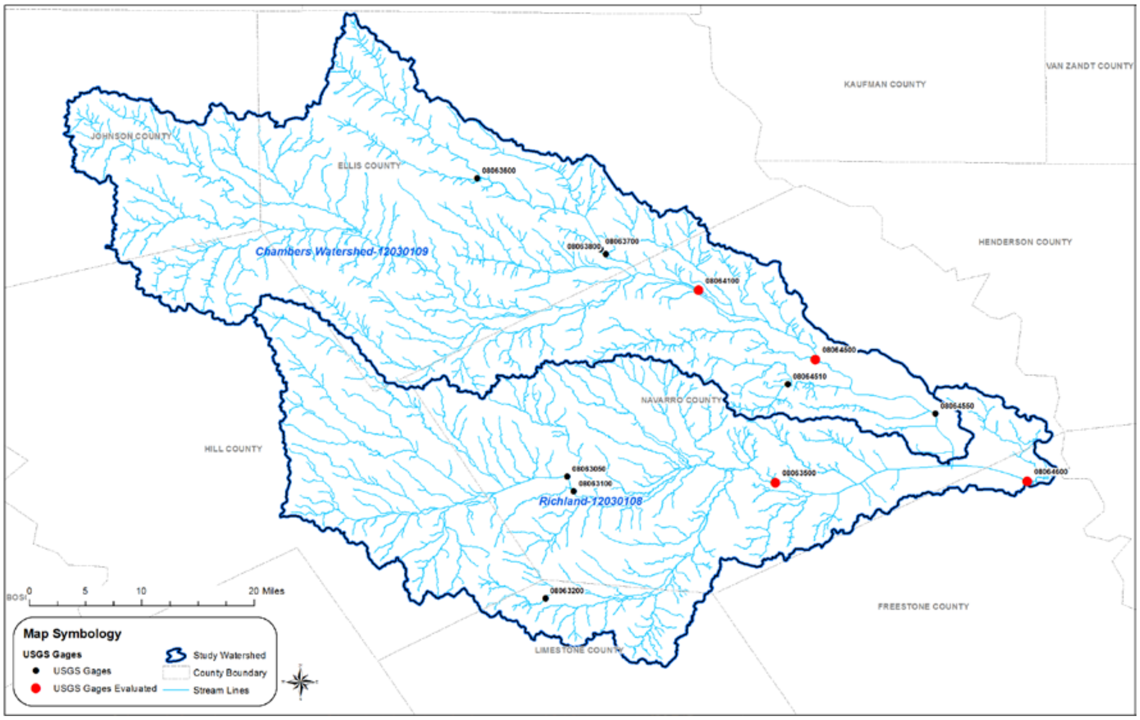

Figure 3. USGS Gage Stations within Chambers and Richland Watersheds

The gage on Richland Creek near Richland (08063500) has a post-regulation period of record of 28 years (1962-1989). The two stream gages on Chambers Creek, near Rice (08064100) and near Corsicana (08064500) are at similar drainage areas and have a combined period of record of 54 years (1961-2014) that spans the entire regulated period.

Flood Frequency Analyses (FFA) were performed following Bulletin 17B guidelines for the Richland Creek near Richland gage (08063500) and for the 2 gages on Chambers Creek (08064100, 08064500). The FFAs for each of the Chambers Creek gages used combined period of record, which was developed using drainage area transposition. The peak discharges resulting from the FFA of the Chambers Creek gage near Rice (08064100) were transposed to the Richland Creek near Richland gage (08063500) location; the transposed peak discharges were used instead of the at-site (08063500) FFA results because the combined period of record at the Chambers Creek near Rice gage (08064100) is nearly twice the period at the 08063500 gage.

The study reach on Richland Creek includes Richland Reservoir, which impounds 1,950 square miles and results in additional peak attenuation. The a.c.e. flows for Richland Creek just above the reservoir were determined by averaging the results of the flows transposed by drainage area from each of the two Chambers Creek gages (08064100, 08064500). The flows downstream of Richlands Reservoir were determined by using a plot of the observed inflows and outflows for the Reservoir. The inflows were determined by summing the concurrent observed annual peak flows from Richland Creek near Richland (08063500) and Chambers Creek near Corsicana (08064500). The summed flows represent the total inflow from Chambers Creek and Richland Creek above the confluence of Chambers Creek with Richland Creek. The summed flows were adjusted by drainage area transposition to the drainage area at the gage on Richland Creek below Richlands Reservoir (08064600). The outflows used were observed flows at the gage below Richland Reservoir (08064600). A least-squares best fit line was developed in order to approximate the relation between inflow and outflow of the Richlands reservoir. This linear relation was used to convert the a.c.e. flows out of Richland Reservoir, based on the previously estimated inflows to the Reservoir.

Stage only gages and gages with insufficient periods of record were not used for hydrologic computations.

Similar to the regression analysis results, the discharges used on these streams are associated with the hydraulic cross sections in the GIS shapefiles. In addition to the gages listed above, there are several stage only gages which were used for reference only as a reasonability check on lake elevations.

Again, it should be noted that throughout the watershed there are a significant number of flood control dams on tributaries to Richland Creek. Hydrologic results from regression calculations were not adjusted to take into account the impact of these structures.

1.3 Hydraulics

The hydraulic approach for BLE analysis for the Richland watershed consisted of using the terrain model described in section 1.1 in combination with hydrology input computed as described in section 1.2 to establish water surface elevations using 1-D steady state analysis. The Hydrologic Engineering Center's River Analysis System (HEC-RAS) program version 4.1 was chosen as the computer model to compute water surface elevations on a stream by stream basis. The WISE computer program was used to establish model stream orientation, initial hydraulic cross section layout and stationing, assign n-values to cross sections, and to develop all input files for the HEC-RAS program. ESRI's ArcMap program was used to review and refine cross section layout orientation.

First pass cross section layout was performed using an automated routine in WISE based on the drainage area at the cross section location. A first draft model was created based on this initial cross section layout and draft boundaries were developed. At this stage, a second pass inspection for cross section placement occurred. Significant refinement occurred during this step. To improve the hydraulic models, additional cross sections were added as needed to better define the BLE floodplain boundary. Cross sections were extended in locations where overtopping occurred. Orientation of cross sections was refined to improve on the perpendicular orientation to flow. Additional cross sections were added at floodplain constrictions and at downstream portions of tributaries to ensure a proper tie-in with receiving streams. Cross sections were adjusted to remove sections that intersected hydraulic crossings in the floodplain.

Cross sections were not drawn on top of roadways or railroads. Cross sections were placed at the upstream and downstream face of major roads and railroads. Major roads are those designated in the Texas DOT road coverage as On System Highways. The road coverage can be acquired in shapefile format from the TNRIS website at the following link: https://tnris.org/data-catalog/entry/txdot-roadways/. Ineffective flow stations were placed in the hydraulic models as appropriate to account for flow constrictions at crossings as well as at locations deemed by the engineer to be ineffective at conveying flow downstream.

Cross sections were drawn on dam tops for significant dams with well defined spillways in order to better represent ponded water upstream of the structures. It was assumed in doing this that the vast majority of the flow during a flood event would pass the spillway and that the hydraulic model would reasonably estimate flow across the spillway as represented in the hydraulic cross section. This was the method used for the Richland/Chambers Reservoir as flood elevations at the desired frequencies were not available. The elevations used in the modeling were checked against known elevations from past flooding events and effective Zone A boundaries and the result was determined reasonable.

For some of the largest studied streams, cross sections were laid out manually in order to have more reasonable spacing and better capture the constrictions in the floodplain.

Significant effort was made to start all tributaries below the receiving water surface elevations but this was not always achieved, particularly in wide, flat floodplains where small tributaries ran parallel to large streams or where road crossings or dams interfered with cross section alignments.

There are no certified levees within the study area, therefore the levees that do exist were disregarded for this effort. For a flooding source with levees on both sides, this approach may result in under prediction of flooding elevations. Similarly, flooding elevations and extents may be under predicted on the overbank opposite of a levee when the flooding source has a levee on one side. Other scenarios are possible as well depending on locations and extents of levee failures.

The relationship between drainage area and assigned channel geometry is shown in Table 3. These default values for dimensions and spacing are subject to change based on the details noted above as well as the judgment of the responsible engineer.

Table 3: Cross Section Default Parameters

Drainage area (upper limit)	XS Spacing	Channel Top Width	Channel Bottom Width	Channel Depth
1.0	500	4	3.5	0.5
2.0	500	6	5	0.5
4.0	500	11	10	0.5
8.0	500	18	17	0.5
10.0	500	20	19	0.5
15.0	600	26	25	0.5
20.0	600	32	31	0.5
25.0	600	38	36	0.5
30.0	600	43	41	0.5
40.0	600	52	50	0.5
50.0	600	60	57	1
75.0	750	68	65	1
100.0	750	76	73	1
150.0	1000	91	88	1
250.0	1000	122	119	2
500.0	1500	198	195	2
1000.0	2500	351	346	3
2000.0	4000	657	652	3

Drainage area (upper limit)	XS Spacing	Channel Top Width	Channel Bottom Width	Channel Depth
5000.0	4000	1575	1565	3
>5000.0	4000	2000	1990	4

Manning's roughness coefficients (n-values) were determined using the 2011 National Land Cover Data (NLCD) dataset in combination with n-values from Chow (1959) and Calenda, et al. (2005). The association between the n-values and the NLCD Classification is shown in Table 4. Manning's n-value takeoffs were performed by WISE and the n-values were adjusted in some locations based on engineering judgment. N-values within channel banks were limited by the automated routine to a range of 0.030 to 0.070.

Table 4: Manning's "n" Roughness Based on 2001 NLCD Classification (Moore, 2011)

NLCD Classification	Minimum	Normal	Maximum	Source
Open Water	.025	.03	.033	Chow 1959
Developed, Open Space	.01	.013	.016	Calenda, et al. 2005
Developed, Low Intensity	.038	.05	.063	Calenda, et al. 2005
Developed, Medium Intensity	.056	.075	.094	Calenda, et al. 2005
Developed, High Intensity	.075	.1	.125	Calenda, et al. 2005
Barren Land	.025	.03	.035	Chow 1959
Deciduous Forest	.1	.12	.16	Chow 1959
Evergreen Forest	.1	.12	.16	Chow 1959
Mixed Forest	.1	.12	.16	Chow 1959
Scrub/Shrub	.035	.05	.07	Chow 1959
Grassland/Herbaceous	.025	.03	.035	Chow 1959
Pasture/Hay	.03	.04	.05	Chow 1959
Cultivated Crops	.025	.035	.045	Chow 1959
Woody Wetlands	.08	.1	.12	Chow 1959
Emergent Herbaceous Wetland	.075	.1	.15	Chow 1959

The boundary condition used for the majority of the study streams was normal depth with a default value of 0.005 ft/ft. For streams with names in the National Flood Hazard Layer (NFHL) and streams with large drainage areas (generally greater than 8 square miles), the normal depth slope was calculated based on the HEC-RAS profile invert. For studies that have a known downstream water surface elevation from an effective study, those known water elevations were used as the starting condition.

Stage data was available for the Navarro-Mills Dam from USGS Gage 0863050. A statistical analysis using a Log-Pearson III (LP3) distribution was performed to determine reasonable stage elevations for each of the modeled return periods.

1.4 Quality Control

Following the initial BLE analysis in each watershed, the flood hazard area delineations created by the BLE process were reviewed for areas where the results were not ideal.

QC results indicated that some of the model should be extended to cover the scope of effective flood hazard data. Those streams were extended farther upstream to match the extents of the SFHA data.

Typical manual editing resulting from reasonability checks included adding cross-sections, adjusting orientation of cross sections, trimming cross sections and reduction of the default "V" angle of cross sections. It is estimated that 50 percent of cross-sections were adjusted in some work areas while other areas did not require as much editing. Other examples of manual editing included adding cross-sections at confluence areas, modification to improve perpendicular orientation at the channel, adjustment of discharge breaks to better represent flow addition points, revisions to dam spillways and dam tops, and revisions to n-values.

A major component of the QC process was an automated check that identified locations where the 1-percent a.c.e profile was crossed by another frequency or by the 1-percent plus or 1-percent minus profile. Significant effort was made to reasonably resolve all of these instances. Another automated check identified locations where there was a drawdown of greater than 0.5 feet on the 1-percent a.c.e. water surface profile. This check is particularly useful for identifying errors in the model such as a channel that is too wide, a poorly placed cross section, or a need for additional cross sections. Again, significant effort was made to reasonable resolve these drawdown situations.

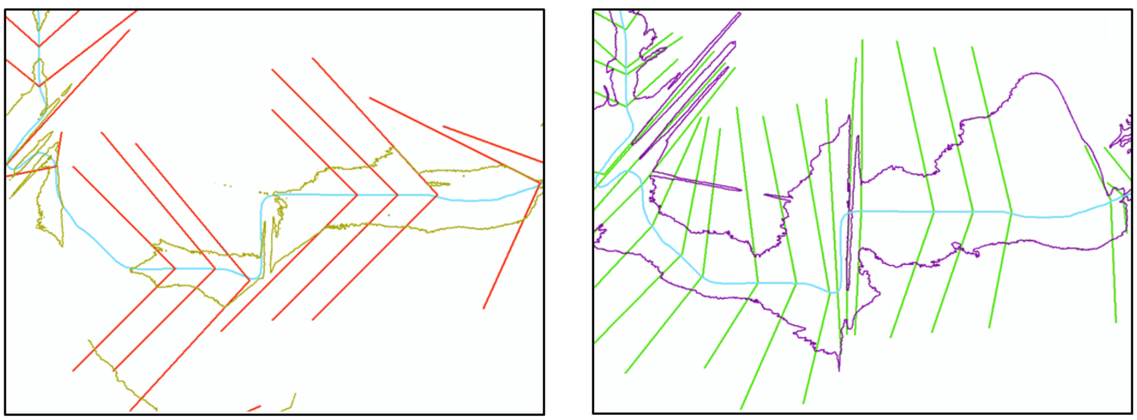

Figure 4: Default "V" angle cross-sections automated by WISE (left). Manually edited cross-sections to more accurately capture terrain (right). Resulting flood boundaries shown in gold (left) or purple (right) for clarity.

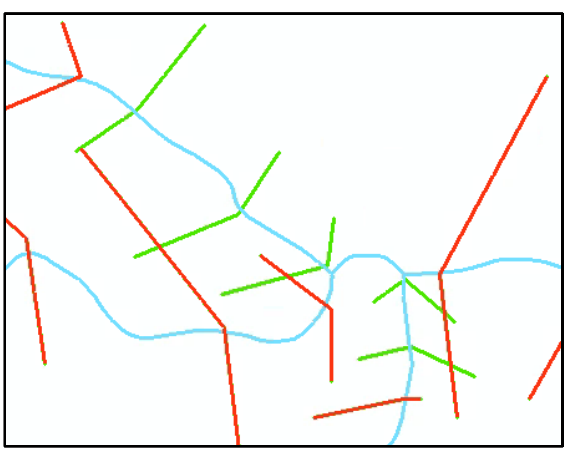

Figure 5: Manually added cross-sections (green) to improve accuracy of tie-ins at confluences.

1.5 One-percent Special Flood Hazard Area Delineation

The 1-percent and 0.2-percent boundaries were mapped using a routine that develops water surface elevation grids based on the 10-foot cell size DEM developed from the TNRIS LiDAR. This product was converted to a polygon for cleaning. The cleaning routine involved manual inspection of the polygons to identify and remove areas of disconnected flooding. In general, areas with a size of less than 5,000 square feet were removed and all others were investigated to determine whether they should be considered as potentially part of the special flood hazard area (SFHA). This investigation was aided by the ground DEM and aerial imagery. Manual adjustments to the polygons were made to account for spillways on dams which could not be accurately modeled using HEC-RAS as well as disconnected areas along the flooding source that should reasonably be connected.

Following the removal of disconnected flooding areas and other boundary adjustments, the small islands in the floodplain were filled. Islands with a size between roughly 5,000 and 30,000 square feet were inspected and, in general, islands that were less than 10,000 square feet were filled.

Once the island filling process was complete, the water surface raster mapping routine was run and set to conform to the polygon boundary. This ensures that the water surface raster and the flood plain boundary are consistent with each other. The depth raster product was created at the end of the process by performing a raster subtraction with the water surface elevation raster and the ground DEM.

Challenges

Challenges encountered during BLE analyses will vary based on available data on which to run the analysis. The Richland Watershed analysis presented challenges as summarized in the following paragraphs.

As noted in Section 1.2 above, there are a significant number of flood control dams on tributaries to Richland Creek. Hydrologic results from regression calculations were not adjusted to take into account the impact of these structures. Further investigation should be conducted when upgrading these models.

As noted in Section 1.3 above, significant effort was made to start all tributaries below the receiving water surface elevations but this was not always achieved, particularly in wide, flat floodplains where small tributaries ran parallel to large streams or where road crossings or dams interfered with cross section alignments.

As noted in Section 1.4 above, multiple streamlines did not extend far enough to fully capture effective flood hazard data. The streamlines generated in the development of the one square mile basins were extended in order to more closely match the effective areas and CNMS streams.

Results and Recommendations

The BLE results for the Richland Watershed produced an SFHA that compares reasonably well with the effective SFHA in most cases, and provides an additional estimated SFHA in areas that do not currently have an SFHA mapped. These results provide context for flood risk communication as part of the Discovery process, and should be verified through community work map meetings before being applied to a regulatory product.

Maps showing the BLE results are included as Appendix B.

3.1 Validation of Effective Zone A SFHA

The full inventory of Zone A studies (1,035.5 miles) in the Richland Watershed were classified in CNMS with a validation status of "UNKNOWN" and status type of "TO BE ASSESSED." The following is a summary of the results of the CNMS validation assessment for the effective Zone A studies in the study area. Initial Assessment checks A1-A3 were evaluated for the CNMS inventory of Zone A studies.

INITIAL ASSESSMENT A1 – SIGNIFICANT TOPOGRAPHY UPDATE CHECK

This check involves determining whether a topographic data source is available that is significantly better than what was used for the effective Zone A modeling and mapping. For the study area in Texas, the effective Zone A topographic data leveraged a variety of sources, but primarily based upon USGS 24K map products. The TNRIS 2013 1-meter gridded DEM data derived from LiDAR within the study area represents a significant improvement from the assumed effective Zone A topographic source. Since the LiDAR data available now is a better source than what effective SFHAs were based on, this initial assessment failed.

INITIAL ASSESSMENT A2 – CHECK FOR SIGNIFICANT HYDROLOGY CHANGES

This check involves first determining whether new regression equations have become available from the USGS since the date of the effective Zone A study. If newer regression equations exist for the area of interest, then an engineer must determine whether these regression equations would significantly affect the 1-percent annual chance flow. Scientific Investigations Report 2009-5087, Regression Equations for Estimation of Annual Peak-Streamflow Frequency for Undeveloped Watersheds in Texas Using an L-moment-Based, PRESS-Minimized, Residual-Adjusted Approach (2009) contains the most recent regression equations for Texas. The Regression Equations used for the effective Zone A studies for Ellis, Navarro and Hill Counties were developed using the USGS Water Resources Investigations Report 96-4307, "Regional Equations for Estimation of Peak-Streamflow Frequency for Natural Basins in Texas". However, the equations used for the effective Zone A studies in Limestone and Freestone Counties are unknown. The newer Regression Equations will not significantly impact the 1-percent annual chance flow and therefore A-2 was passed.

INITIAL ASSESSMENT A3 – CHECK FOR SIGNIFICANT DEVELOPMENT

This check involves using the National Urban Change Indicator (NUCI) dataset to assess increased urbanization in the watershed of the Zone A study. If the percentage of urban area within the HUC-12 watershed containing the effective Zone A study is 15% or more, and has increased by 50% or more since the effective analysis, the study would fail this check. Although the NUCI data provide year-to-year changes in urbanization, the NLCD also is needed to establish a baseline of urban land cover for this analysis. The check for significant development in the Texas study area was completed by evaluating percentage of urban change at the HUC-12 level. Of the 29 HUC-12 polygons within the study area, none currently meet the threshold of 15% or more urban cover, and therefore all effective Zone A's pass this check.

Table 5: Zone A Initial Assessment Results

Assessment Check	Pass / Fail	Notes
A1 – Topography	Fail	TNRIS 2013 LiDAR significantly better than effective USGS topo source.
A2 – Hydrology	Pass	Latest regression equations for TX are dated 2009. Ellis, Navarro and Hill Counties used regression equations from 1997 while Limestone and Freestone Counties source are unknown.
A3- Development	Pass	Less than 15% urbanization in all subwatersheds within the study area.

VALIDATION CHECK A4 – CHECK OF STUDIES BACKED BY TECHNICAL DATA

Zone A studies that pass all initial assessment checks described above may be categorized as "Valid" in the CNMS Inventory only if the effective Zone A study is supported by modeling or sound engineering judgment and all regulatory products are in agreement. If the effective Zone A study passes all initial assessment checks, but is not supported by modeling, or if the original engineering method used is unsupported or undocumented, a comparison of the BLE results and effective Zone A's is performed. Due to lack of complete documentation of the original engineering methods in Limestone and Freestone Counties, check A4 for streams within these counties have been marked as unknown in CNMS. Streams within Ellis, Navarro and Hill Counties have been marked as "Unverified" in FEMA's CNMS database since they were supported by sound engineering judgment.

VALIDATION CHECK A5 – COMPARISON OF BLE AND EFFECTIVE ZONE A

The BLE /effective Zone A comparison method leverages the existing Floodplain Boundary Standard (FBS) certification procedures described in FEMA SID 113, but with a slight modification. This modified FBS comparison approach uses the 1-percent plus and 1-percent minus flood profiles and horizontal and vertical tolerances described in the *First Order Approximation—Methodology, Validation, and Scalability Guidance Procedures (Version 1.5).* For the comparison of BLE and effective Zone A in the Texas study area, the following vertical and horizontal tolerances were used to conduct the modified FBS procedure. One point was placed every 200 feet along the floodplain boundaries for comparison.

Vertical Tolerance: +/- 5 feet (one-half contour interval of assumed effective topographic source).
Horizontal Tolerance: +/-75 feet (standard horizontal tolerance for BLE comparison testing).

Of the 294 modeled BLE streams in the study area, 288 were found to correspond (within the tolerance limits) with effective Zone A flood zones. Comparison results for these streams were grouped at the HUC-12 level and are summarized in Table 9 below. Streams where the percentage of passing FBS sample points is greater than or equal to 85% are marked as "Pass", otherwise marked as "Fail". Of the 288 stream reaches evaluated, comprising 1,035.5 miles of the

CNMS Inventory of Zone A studies, only one of the HUC-12s (120301080105), comprising 26.9 stream miles, passed the comparison check. Note that the 10 stream miles added to the inventory from NHD were not compared as no effective floodplain exists.

VALIDATION RESULTS

Based on the validation assessments and BLE comparison results described above, the CNMS inventory of Zone A studies in the Richland Watershed study area has been updated, with 1,008.6 miles categorized as UNVERIFIED – TO BE STUDIED, and 26.9 miles categorized as VALID – NVUE COMPLIANT. Total miles in each of these categories are summarized in Table 5 and illustrated in Figure 3 below.

Table 6: Zone A Validation Results

Validation Status	Status Type	Total Miles
VALID	NVUE COMPLIANT	26.9
UNVERIFIED	TO BE STUDIED	1008.6

Table 7: BLE Comparison Results

HUC-12 Watershed		Total FBS points	Fail	Pass	%Pass	BLE Comparison Pass? (>85%)	Priority Score
Watershed Name	Watershed Number						
Richland	All Streams	44,353	10,801	33,552	75.6%	Fail	
Grove Creek-Pecan Creek	120301080105	1,696	166	1,530	90.2%	Pass	4.9
Cottonwood Creek-White Rock Creek	120301080104	2,356	356	2,000	84.9%	Fail	7.6
Bynum Creek	120301080108	1,557	261	1,296	83.2%	Fail	8.4
Jones Branch-Richland Creek	120301080405	461	79	382	82.9%	Fail	13.7
Little Pin Oak Creek-Richland Creek	120301080401	1,348	240	1,108	82.2%	Fail	11.8
Town of Union High-Pin Oak Creek	120301080305	423	78	345	81.6%	Fail	14.7
Grape Creek-Richland Creek	120301080403	1,938	362	1,576	81.3%	Fail	14.9
Mesquite Creek-Little Pin Oak Creek	120301080402	900	170	730	81.1%	Fail	15.1
Headwaters Ash Creek	120301080106	2,276	454	1,822	80.1%	Fail	9.9
Board Creek-Pin Oak Creek	120301080306	787	167	620	78.8%	Fail	16.9
North Fork Pin Oak Creek	120301080301	1,876	406	1,470	78.4%	Fail	12.6
Cottonwood Creek-Ash Creek	120301080107	4,497	988	3,509	78.0%	Fail	11.4
Munger Branch	120301080302	2,486	570	1,916	77.1%	Fail	18.3
Treadwell Branch-Richland Creek	120301080201	933	222	711	76.2%	Fail	13.1

HUC-12 Watershed		Total FBS points	Fail	Pass	%Pass	BLE Comparison Pass? (>85%)	Priority Score
Watershed Name	Watershed Number						
Tom Harris Branch-Navarro Mills Lake	120301080110	2,034	494	1,540	75.7%	Fail	17.0
Cedar Creek-Richland Creek	120301080206	1,593	400	1,193	74.9%	Fail	15.4
Ash Creek-Navarro Mills Lake	120301080109	1,187	307	880	74.1%	Fail	13.7
Rush Creek	120301080205	2,526	680	1,846	73.1%	Fail	15.1
Crab Creek	120301080404	724	208	516	71.3%	Fail	22.9
Yonker Pin Slough-Richland Creek	120301080407	769	223	546	71.0%	Fail	15.9
Hog Pen Slough-Richland Creek	120301080406	418	125	293	70.1%	Fail	15.9
Post Oak Creek	120301080202	1,459	446	1,013	69.4%	Fail	21.8
Headwaters Richland Creek	120301080101	1,081	331	750	69.4%	Fail	18.4
Battle Creek-Richland Creek	120301080203	1,827	564	1,263	69.1%	Fail	20.5
Melton Branch-Richland Creek	120301080204	1,373	432	941	68.5%	Fail	25.2
Hackberry Creek-Navarro Mills Lake	120301080103	810	274	536	66.2%	Fail	20.2
Town of Mertens-Richland Creek	120301080102	1,297	444	853	65.8%	Fail	19.1
Elm Creek-Pin Oak Creek	120301080303	3,006	1,064	1,942	64.6%	Fail	22.9
Alligator Creek-Pin Oak Creek	120301080304	715	290	425	59.4%	Fail	32.1

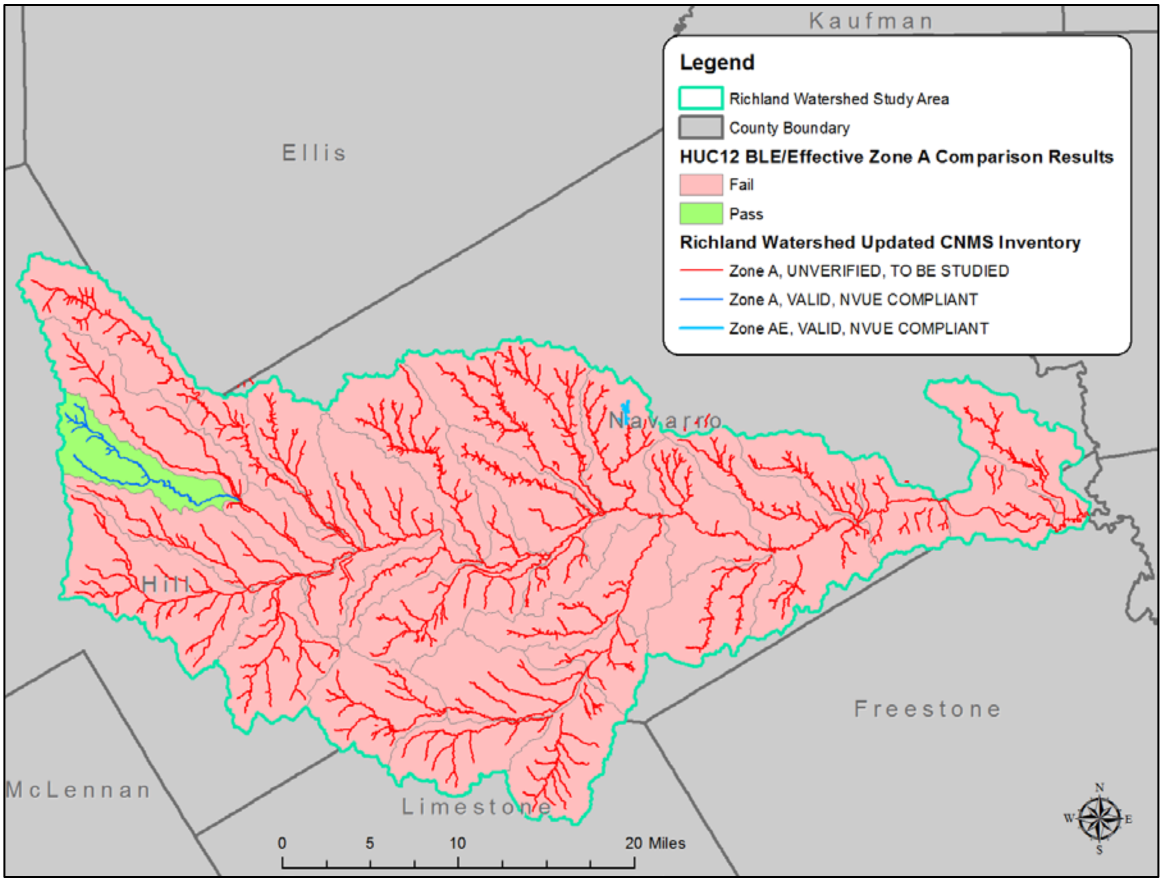

Figure 6. Richland Watershed CNMS Validation Results

An overall risk for each HUC-12 watershed was calculated using the National Flood Risk Percentages Dataset and its proportional area. The weighted risk was multiplied by the percentage of points in the watershed that failed the CNMS comparison to effective to determine the priority score. The range of the Richland HUC-8 priority scores can be used to initiate discussions during the Discovery phase. Alligator Creek – Pin Oak Creek HUC-12 was determined to have the highest priority score and the most need while Grove Creek – Pecan Creek HUC-12 has the lowest score. Priority scores are identified above in Table 7.

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Appendix A Summary of Peak Qs

Table A-1. Summary of Hydrology

Stream Name	Drainage Area (sq. mi)	1% Peak Q (cfs)	1%- Peak Q (cfs)	1%+ Peak Q (cfs)
Alligator Creek	1.17	1,623	813	3,238
Alligator Creek	2.08	1,775	889	3,541
Alligator Creek	2.09	2,487	1,247	4,963
Alligator Creek	2.54	2,077	1,041	4,144
Alligator Creek	3.01	3,248	1,628	6,481
Alligator Creek	3.54	2,686	1,346	5,359
Alligator Creek	4.00	3,822	1,916	7,626
Alligator Creek	4.54	3,172	1,590	6,328
Alligator Creek	4.65	4,093	2,052	8,168
Alligator Creek	5.07	4,517	2,264	9,012
Alligator Creek	5.51	3,527	1,768	7,038
Alligator Creek	5.93	3,626	1,818	7,236
Alligator Creek	6.49	5,679	2,846	11,331
Alligator Creek	10.10	5,605	2,809	11,183
Alligator Creek	11.58	6,192	3,104	12,355
Alligator Creek	12.67	6,687	3,352	13,343
Alligator Creek	13.67	7,182	3,599	14,329
Alligator Creek	13.88	7,185	3,601	14,336
Alligator Creek	16.43	8,051	4,035	16,064
Alligator Creek	17.38	8,433	4,227	16,827
Alligator Creek	18.34	11,443	5,735	22,832
Alligator Creek	18.53	11,481	5,754	22,908
Alligator Creek	26.84	15,037	7,536	30,002
Alligator Creek	28.18	15,166	7,601	30,260
Alligator Creek	28.73	15,561	7,799	31,049
Alligator Creek	29.73	15,747	7,892	31,419
Alligator Creek	30.08	15,801	7,920	31,528
Alligator003	1.01	728	365	1,453
Alligator004	0.19	380	191	759
Alligator004	0.37	741	371	1,479
Alligator004	0.71	1,163	583	2,320
Alligator004	1.74	2,014	1,009	4,018
Alligator004	3.72	4,642	2,326	9,261
Alligator004	5.96	6,781	3,398	13,529
Alligator004	10.13	9,829	4,926	19,612

Stream Name	Drainage Area (sq. mi)	1% Peak Q (cfs)	1%- Peak Q (cfs)	1%+ Peak Q (cfs)
Alligator005	0.18	373	187	743
Alligator006	0.22	419	210	835
Alligator007	0.19	338	169	674
Alligator007	0.55	837	420	1,670
Alligator008	0.10	205	103	408
Alligator009	0.53	791	396	1,578
Alligator009	1.00	1,330	667	2,654
Alligator009	1.23	2,037	1,021	4,065
Alligator010	0.25	449	225	896
Alligator011	0.40	605	303	1,207
Alligator011	0.60	1,127	565	2,249
Alligator011	0.94	1,666	835	3,323
Alligator011	1.56	2,471	1,238	4,930
Alligator011	2.21	3,194	1,601	6,373
Alligator012	0.09	196	98	391
Alligator013	0.18	342	172	683
Alligator014	0.41	871	437	1,738
Alligator015	0.54	1,223	613	2,441
Alligator016	1.09	1,341	672	2,675
Alligator016	1.76	1,825	915	3,641
Alligator016	2.75	3,610	1,809	7,203
Alligator016	3.64	4,333	2,172	8,645
Alligator016	3.83	4,553	2,282	9,084
Alligator017	0.67	1,274	639	2,542
Alligator018	1.89	2,539	1,272	5,065
Alligator018	2.72	3,436	1,722	6,856
Alligator019	0.82	1,472	738	2,938
Alligator020	1.76	2,548	1,277	5,084
Alligator020	2.28	3,093	1,550	6,171
Alligator020	3.27	3,999	2,004	7,979
Alligator020	3.54	3,885	1,947	7,751
Alligator022	2.43	3,764	1,887	7,510
Alligator022	2.71	4,023	2,016	8,026
Alligator022	5.12	6,409	3,212	12,789
Alligator023	1.58	3,197	1,602	6,379
Alligator025	0.75	1,266	635	2,526
Alligator026	0.23	571	286	1,140
Alligator027	2.01	3,691	1,850	7,364

Stream Name	Drainage Area (sq. mi)	1% Peak Q (cfs)	1%- Peak Q (cfs)	1%+ Peak Q (cfs)
Alligator027	2.25	4,133	2,071	8,247
Alligator028	0.63	1,021	512	2,038
Alligator029	1.98	2,488	1,247	4,965
Alligator029	2.92	3,439	1,724	6,862
Alligator029	3.04	3,640	1,824	7,263
Alligator031	0.38	976	489	1,947
Alligator032	0.36	770	386	1,536
Alligator033	0.21	608	305	1,213
Alligator034	0.16	426	213	850
Alligator035	1.00	1,887	946	3,765
Alligator035	1.09	1,997	1,001	3,984
Alligator037	1.17	1,959	982	3,908
Alligator037	3.03	3,556	1,782	7,095
Alligator037	3.36	3,778	1,893	7,537
Alligator037	7.72	6,909	3,463	13,786
Alligator037	8.69	7,376	3,697	14,717
Alligator037	8.94	7,282	3,650	14,530
Alligator037	9.66	7,607	3,813	15,179
Alligator037	9.83	7,727	3,873	15,418
Alligator038	1.09	2,004	1,004	3,998
Alligator039	1.93	2,501	1,254	4,991
Alligator039	2.13	2,700	1,353	5,387
Alligator039	3.34	3,939	1,974	7,860
Alligator040	1.16	1,597	800	3,186
Alligator041	0.59	945	474	1,885
Alligator043	2.07	2,988	1,498	5,962
Alligator043	3.06	4,053	2,031	8,087
Alligator043	3.63	4,437	2,224	8,852
Alligator043	5.80	6,538	3,277	13,046
Alligator043	7.68	8,156	4,088	16,274
Alligator043	9.40	8,461	4,241	16,882
Alligator044	0.95	1,977	991	3,944
Alligator045	1.00	1,618	811	3,228
Alligator045	1.09	1,759	881	3,509
Alligator045	1.79	2,665	1,336	5,318
Alligator045	2.15	3,020	1,514	6,026
Alligator046	0.61	1,216	610	2,427
Alligator047	1.17	1,964	985	3,920

Stream Name	Drainage Area (sq. mi)	1% Peak Q (cfs)	1%- Peak Q (cfs)	1%+ Peak Q (cfs)
Alligator047	1.87	2,750	1,378	5,488
Alligator048	0.44	1,007	505	2,009
Alligator049	1.01	1,798	901	3,588
Alligator049	1.03	1,840	922	3,672
Alligator052	0.43	589	295	1,175
Alligator052	1.02	1,140	571	2,275
Alligator052	1.16	1,167	585	2,329
Alligator052	2.10	1,971	988	3,932
Alligator052	2.41	2,208	1,107	4,406
Alligator053	0.28	368	185	735
Alligator054	0.90	945	474	1,886
Alligator055	0.40	506	253	1,009
Alligator055	1.00	1,171	587	2,337
Alligator056	0.24	343	172	685
Alligator057	1.22	1,681	842	3,354
Alligator058	0.58	1,117	560	2,229
Alligator059	0.82	1,422	713	2,837
Alligator059	1.96	2,878	1,442	5,742
Alligator060	0.57	1,032	517	2,059
Alligator061	1.11	1,847	926	3,685
Alligator061	1.26	1,920	962	3,831
Alligator062	1.02	1,719	862	3,430
Alligator062	1.62	2,260	1,133	4,510
Alligator063	0.18	381	191	759
Alligator065	1.73	3,064	1,536	6,114
Alligator065	2.46	3,638	1,824	7,260
Alligator066	1.04	2,084	1,044	4,158
Alligator066	1.49	2,539	1,272	5,065
Alligator069	1.02	1,024	513	2,044
Alligator069	1.36	1,292	648	2,578
Alligator069	1.71	1,581	792	3,154
Alligator069	1.95	1,758	881	3,508
Alligator069	2.95	2,489	1,247	4,966
Alligator069	3.34	2,734	1,370	5,455
Alligator070	0.19	248	125	496
Alligator071	0.18	290	145	579
Alligator073	0.75	1,006	504	2,007
Alligator073	1.00	1,298	650	2,589

Stream Name	Drainage Area (sq. mi)	1% Peak Q (cfs)	1%- Peak Q (cfs)	1%+ Peak Q (cfs)
Alligator073	1.01	1,296	650	2,586
Alligator074	0.20	356	179	711
Alligator075	0.20	614	308	1,226
Alligator076	1.03	1,312	657	2,617
Alligator076	1.23	1,435	719	2,864
Alligator077	0.83	1,080	541	2,155
Alligator078	1.73	1,928	967	3,848
Alligator079	1.02	1,339	671	2,672
Alligator079	1.47	2,101	1,053	4,191
Alligator081	1.28	1,565	784	3,122
Alligator082	0.30	809	406	1,615
Alligator082	0.60	1,403	703	2,799
Alligator082	1.71	3,211	1,609	6,406
Alligator084	0.13	422	212	843
Alligator104	1.57	1,203	603	2,401
Alligator105	1.16	1,158	580	2,310
Alligator106	1.09	860	431	1,716
Alligator107	0.34	460	230	918
Alligator108	1.55	1,366	685	2,725
Alligator109	1.98	1,687	845	3,365
Alligator109	2.56	2,128	1,066	4,246
Alligator109	3.27	2,495	1,251	4,979
Alligator109	3.74	2,688	1,347	5,363
Alligator109	7.81	5,948	2,981	11,867
Alligator110	0.51	755	378	1,506
Alligator111	2.63	2,544	1,275	5,076
Alligator111	3.61	2,955	1,481	5,896
Alligator111	3.73	3,028	1,518	6,041
Alligator112	0.36	693	347	1,382
Alligator112	0.70	1,251	627	2,496
Alligator112	0.71	1,254	629	2,503
Alligator113	0.15	361	181	721
Alligator114	1.89	1,311	657	2,617
Alligator114	2.41	1,749	877	3,490
Ash Creek	1.02	1,502	753	2,996
Ash Creek	1.91	2,407	1,206	4,803
Ash Creek	4.44	4,755	2,383	9,487
Ash Creek	9.12	10,321	5,173	20,593

Stream Name	Drainage Area (sq. mi)	1% Peak Q (cfs)	1%- Peak Q (cfs)	1%+ Peak Q (cfs)
Ash Creek	9.73	10,577	5,301	21,103
Ash Creek	11.90	11,943	5,986	23,829
Ash Creek	22.11	19,056	9,551	38,022
Ash Creek	22.38	18,991	9,518	37,892
Ash Creek	23.88	19,390	9,718	38,688
Ash Creek	25.34	19,947	9,997	39,800
Ash Creek	27.50	20,843	10,446	41,588
Ash Creek	28.88	20,956	10,503	41,812
Ash Creek	39.81	26,475	13,269	52,824
Ash Creek	42.51	27,386	13,726	54,642
Ash Creek	51.36	31,105	15,589	62,062
Ash Creek	52.32	31,450	15,763	62,752
Ash Creek	54.68	31,648	15,861	63,145
Ash Creek	55.21	31,258	15,666	62,368
Ash Creek	77.27	41,321	20,710	82,446
Ash Creek	78.63	41,530	20,814	82,863
Ash Creek	112.27	52,626	26,375	105,002
Ash Creek	114.44	51,108	25,615	101,973
Ash Creek	120.08	53,284	26,705	106,316
Ash Creek	125.25	54,997	27,564	109,734
Ash Creek	212.56	80,568	40,380	160,754
Battle Creek	3.74	4,783	2,397	9,544
Battle Creek	8.28	8,687	4,354	17,334
Battle Creek	10.57	10,365	5,195	20,681
Battle Creek	12.50	11,826	5,927	23,596
Battle Creek	15.85	13,545	6,788	27,025
Battle Creek	18.55	14,836	7,435	29,601
Battle Creek	23.76	17,091	8,566	34,101
Briar Creek	0.61	806	404	1,607
Briar Creek	3.74	3,196	1,602	6,377
Briar Creek	5.79	4,440	2,225	8,860
Briar Creek	9.21	6,043	3,029	12,057
Briar Creek	10.07	5,994	3,004	11,959
Briar Creek	11.43	6,634	3,325	13,237
Briar Creek	22.30	10,005	5,014	19,962
Briar Creek	26.01	14,401	7,218	28,735
Briar Creek	54.02	27,047	13,556	53,966
Broad Creek	1.02	1,444	724	2,882

Stream Name	Drainage Area (sq. mi)	1% Peak Q (cfs)	1%- Peak Q (cfs)	1%+ Peak Q (cfs)
Broad Creek	1.96	2,512	1,259	5,013
Broad Creek	2.90	3,368	1,688	6,719
Broad Creek	3.69	3,993	2,001	7,968
Broad Creek	4.68	4,736	2,374	9,450
Broad Creek	5.67	5,435	2,724	10,843
Broad Creek	6.64	5,837	2,926	11,647
Broad Creek	8.70	6,779	3,397	13,525
Broad Creek	9.79	7,642	3,830	15,249
Broad Creek	11.24	8,281	4,150	16,522
Broad Creek	12.23	8,847	4,434	17,652
Broad Creek	13.29	9,390	4,706	18,735
Broad Creek	13.61	9,488	4,755	18,930
Broad Creek	17.82	11,406	5,716	22,758
Broad Creek	18.40	11,314	5,670	22,574
Broad Creek	20.24	12,111	6,070	24,164
Broad Creek	21.33	12,621	6,325	25,182
Bynum Creek	1.00	1,500	752	2,992
Bynum Creek	1.68	2,082	1,044	4,154
Bynum Creek	3.15	4,309	2,160	8,597
Bynum Creek	4.15	4,328	2,169	8,636
Bynum Creek	4.49	5,639	2,826	11,252
Bynum Creek	5.48	6,564	3,290	13,098
Bynum Creek	6.33	7,292	3,655	14,550
Bynum Creek	8.17	8,665	4,343	17,288
Bynum Creek	11.49	11,153	5,590	22,254
Bynum Creek	12.75	11,984	6,006	23,911
Bynum Creek	13.71	12,601	6,315	25,142
Bynum Creek	14.71	13,058	6,544	26,054
Bynum Creek	15.64	13,348	6,690	26,632
Bynum Creek	15.98	13,410	6,721	26,756
Bynum Creek	20.11	15,195	7,616	30,319
Bynum Creek	20.91	15,587	7,812	31,099
Bynum Creek	22.06	15,988	8,013	31,901
Carroll Branch	2.51	2,402	1,204	4,792
Carroll Branch	4.49	3,452	1,730	6,888
Cedar Creek	0.50	633	317	1,262
Cedar Creek	2.22	2,072	1,038	4,133
Cedar Creek	4.83	3,674	1,841	7,330

Stream Name	Drainage Area (sq. mi)	1% Peak Q (cfs)	1%- Peak Q (cfs)	1%+ Peak Q (cfs)
Cedar Creek	6.96	4,721	2,366	9,420
Cedar Creek	9.30	5,722	2,868	11,418
Cedar Creek	23.04	13,049	6,540	26,036
Cedar Creek	26.62	14,558	7,296	29,046
Chambers Creek AC	1074.92	136,912	68,619	273,175
Cottonwood Creek 3	1.00	1,248	625	2,490
Cottonwood Creek 3	1.81	2,035	1,020	4,061
Cottonwood Creek 3	3.81	3,614	1,811	7,211
Cottonwood Creek 3	4.75	4,187	2,098	8,353
Cottonwood Creek 3	5.68	4,567	2,289	9,112
Cottonwood Creek 3	6.67	4,963	2,487	9,902
Cottonwood Creek 3	7.67	5,563	2,788	11,100
Cottonwood Creek 3	7.92	5,690	2,852	11,353
Cottonwood Creek 5	1.07	2,401	1,203	4,790
Cottonwood Creek 5	1.68	2,957	1,482	5,900
Cottonwood Creek 5	2.65	4,136	2,073	8,253
Cottonwood Creek 5	3.63	5,061	2,537	10,098
Cottonwood Creek 5	4.17	5,464	2,739	10,903
Cottonwood Creek 5	11.78	10,681	5,353	21,312
Cottonwood Creek 5	13.75	11,736	5,882	23,416
Cottonwood Creek 5	14.59	12,079	6,054	24,101
Cottonwood Creek 5	15.08	12,165	6,097	24,273
Cottonwood Creek 5	26.44	17,903	8,973	35,722
Cottonwood Creek 5	33.05	21,059	10,554	42,018
Crab Creek	2.00	2,136	1,071	4,263
Crab Creek	2.10	2,182	1,093	4,353
Crab Creek	3.25	3,050	1,529	6,086
Crab Creek	6.68	4,805	2,408	9,587
Crab Creek	6.94	6,692	3,354	13,353
Crab Creek	8.33	7,655	3,837	15,274
Crab Creek	9.17	8,233	4,126	16,426
Crab Creek	9.36	8,156	4,088	16,273
Crab Creek	12.51	9,328	4,675	18,611
Crab Creek	13.03	8,744	4,382	17,446
Crab Creek	14.64	10,032	5,028	20,017
Elm Creek	1.01	1,839	922	3,669
Elm Creek	1.72	2,591	1,298	5,169
Elm Creek	3.10	3,940	1,975	7,862

Stream Name	Drainage Area (sq. mi)	1% Peak Q (cfs)	1%- Peak Q (cfs)	1%+ Peak Q (cfs)
Elm Creek	3.72	4,528	2,270	9,035
Elm Creek	5.57	6,080	3,047	12,131
Elm Creek	7.88	7,752	3,885	15,466
Elm Creek	10.68	12,464	6,247	24,869
Elm Creek	12.25	13,426	6,729	26,789
Elm Creek	13.68	14,495	7,265	28,922
Elm Creek	15.28	15,212	7,624	30,351
Elm Creek	16.89	15,920	7,979	31,765
Elm Creek	20.05	17,737	8,890	35,390
Elm Creek	23.11	18,759	9,402	37,429
Elm Creek Limestone	0.29	598	300	1,193
Elm Creek Limestone	1.03	1,820	912	3,632
Elm Creek Limestone	1.66	2,556	1,281	5,099
Elm Creek Limestone	2.58	3,638	1,824	7,260
Four Mile Creek	1.01	1,327	665	2,649
Four Mile Creek	2.00	2,348	1,177	4,685
Four Mile Creek	2.95	3,119	1,563	6,224
Four Mile Creek	3.89	3,943	1,976	7,866
Four Mile Creek	4.83	4,508	2,259	8,995
Four Mile Creek	5.28	4,721	2,366	9,420
Four Mile Creek	6.28	5,411	2,712	10,797
Four Mile Creek	7.36	5,523	2,768	11,019
Gas Creek	2.00	1,720	862	3,433
Gas Creek	4.16	3,107	1,557	6,200
Grape Creek	1.00	1,042	522	2,079
Grape Creek	1.99	1,808	906	3,608
Grape Creek	2.98	2,442	1,224	4,873
Grape Creek	3.34	2,620	1,313	5,228
Grape Creek	5.98	4,119	2,064	8,218
Grape Creek	7.05	6,307	3,161	12,584
Grape Creek	8.81	7,263	3,640	14,491
Grape Creek	9.81	7,785	3,902	15,534
Grape Creek	10.62	8,310	4,165	16,581
Grape Creek	11.60	8,483	4,252	16,926
Grape Creek	11.93	8,552	4,286	17,063
Grape Creek	12.52	8,918	4,470	17,794
Grape Creek	13.52	8,871	4,446	17,700
Grape Creek	15.84	10,071	5,047	20,094

Stream Name	Drainage Area (sq. mi)	1% Peak Q (cfs)	1%- Peak Q (cfs)	1%+ Peak Q (cfs)
Grape Creek	17.25	10,770	5,398	21,490
Grape Creek	18.95	11,229	5,628	22,405
Grove Creek	1.00	1,740	872	3,472
Grove Creek	1.95	2,798	1,402	5,583
Grove Creek	2.94	3,875	1,942	7,732
Grove Creek	3.79	4,621	2,316	9,219
Grove Creek	4.77	5,439	2,726	10,852
Grove Creek	5.67	5,258	2,635	10,490
Grove Creek	6.37	7,867	3,943	15,697
Grove Creek	18.38	13,088	6,559	26,114
Grove Creek	20.24	17,629	8,836	35,175
Grove Creek	20.94	13,549	6,790	27,033
Grove Creek	22.98	18,372	9,208	36,656
Grove Creek	23.53	18,367	9,205	36,646
Grove Creek	24.47	14,249	7,141	28,431
Grove Creek	25.28	19,618	9,832	39,142
Grove Creek	25.79	19,314	9,680	38,537
Hackberry Creek	1.13	1,259	631	2,512
Hackberry Creek	2.13	1,986	995	3,962
Hackberry Creek	2.85	2,501	1,254	4,990
Hackberry Creek	3.82	3,155	1,581	6,295
Hackberry Creek	4.42	3,413	1,711	6,811
Hackberry Creek	5.39	3,833	1,921	7,648
Hackberry Creek	6.12	3,997	2,003	7,975
Hackberry Creek	7.12	4,438	2,224	8,855
Hackberry Creek	7.77	4,361	2,186	8,701
Hackberry Creek	8.61	4,820	2,416	9,617
Hackberry Creek	13.46	6,856	3,436	13,680
Hackberry Creek	15.57	7,474	3,746	14,913
Hackberry Creek	16.57	7,744	3,881	15,451
Hackberry Creek	16.70	10,785	5,405	21,518
Hackberry Creek	17.67	11,239	5,633	22,424
Hackberry Creek	18.12	11,050	5,538	22,048
Hackberry Creek 2	1.07	2,091	1,048	4,172
Hackberry Creek 2	2.00	3,073	1,540	6,132
Harris Branch of Richland Creek Tributary 1	0.41	644	323	1,286
Harris Branch of Richland Creek Tributary 2	0.78	965	483	1,925

Stream Name	Drainage Area (sq. mi)	1% Peak Q (cfs)	1%- Peak Q (cfs)	1%+ Peak Q (cfs)
Harris Branch of Richland Creek Tributary 3	0.12	234	117	468
Harris Branch of Richland Creek Tributary 5	0.73	966	484	1,928
Hughes Branch	4.63	4,529	2,270	9,037
Hughes Branch	6.43	5,953	2,984	11,878
Larkin Hill Creek	1.69	2,659	1,333	5,306
Larkin Hill Creek	1.92	2,939	1,473	5,864
Little Cottonwood Creek	1.00	1,786	895	3,563
Little Cottonwood Creek	1.91	2,716	1,361	5,419
Little Cottonwood Creek	2.90	3,947	1,978	7,875
Little Cottonwood Creek	3.53	4,199	2,105	8,379
Little Cottonwood Creek	4.53	5,126	2,569	10,228
Little Cottonwood Creek	4.83	5,114	2,563	10,203
Little Cottonwood Creek	5.78	5,860	2,937	11,693
Little Cottonwood Creek	6.38	6,298	3,156	12,566
Little Harris Branch	0.46	675	338	1,346
Little Pen Oak Creek	1.04	1,979	992	3,949
Little Pen Oak Creek	1.68	2,954	1,480	5,894
Little Pen Oak Creek	2.59	4,155	2,083	8,291
Little Pen Oak Creek	3.49	5,125	2,569	10,226
Little Pen Oak Creek	4.00	5,642	2,828	11,258
Little Pen Oak Creek	4.45	6,026	3,020	12,024
Little Pen Oak Creek	5.00	6,465	3,240	12,899
Little Pen Oak Creek	10.72	11,771	5,899	23,485
Little Pen Oak Creek	13.96	13,547	6,789	27,029
Little Pen Oak Creek	14.02	13,456	6,744	26,848
Little Pen Oak Creek	14.88	13,630	6,831	27,196
Little Pen Oak Creek	15.84	13,682	6,857	27,300
Little Pen Oak Creek	19.84	15,429	7,733	30,786
Little Pen Oak Creek	27.49	19,530	9,788	38,968
Little Pen Oak Creek	37.34	23,925	11,991	47,737
Melton Branch	4.61	3,683	1,846	7,349
Melton Branch	12.49	6,858	3,437	13,683
Melton Branch	14.14	9,554	4,788	19,063
Melton Branch	25.12	15,613	7,825	31,152
Mesquite Creek	1.72	2,688	1,347	5,363
Mesquite Creek	2.37	3,566	1,787	7,116
Mesquite Creek	2.54	3,553	1,781	7,089

Stream Name	Drainage Area (sq. mi)	1% Peak Q (cfs)	1%- Peak Q (cfs)	1%+ Peak Q (cfs)
Mesquite Creek	2.91	4,066	2,038	8,113
Mesquite Creek	3.25	4,213	2,112	8,406
Mesquite Creek	3.74	4,735	2,373	9,448
Mesquite Creek	4.21	5,116	2,564	10,207
Mesquite Creek	4.58	5,382	2,697	10,739
Mesquite Creek	6.58	6,764	3,390	13,496
Mesquite Creek	7.58	7,181	3,599	14,328
Mesquite Creek	7.61	7,293	3,655	14,551
Mesquite Creek	7.62	7,268	3,642	14,501
Munger Branch	1.39	2,279	1,142	4,547
Munger Branch	2.20	3,134	1,571	6,253
Munger Branch	3.19	4,101	2,055	8,182
Munger Branch	4.21	4,772	2,392	9,521
Munger Branch	7.45	7,135	3,576	14,236
Munger Branch	14.08	11,526	5,777	22,998
Munger Branch	17.89	13,051	6,541	26,040
Munger Branch	21.76	14,387	7,211	28,706
Munger Branch	24.59	15,453	7,745	30,834
Munger Branch	25.75	15,662	7,850	31,250
Munger Branch	26.75	16,096	8,067	32,115
Munger Branch	50.14	25,746	12,903	51,370
Munger Branch	51.25	25,495	12,778	50,869
Munger Branch	53.41	25,814	12,938	51,505
Munger Branch	56.42	26,760	13,412	53,393
Navarro-Mills Stream002	1.41	2,119	1,062	4,229
Navarro-Mills Stream002	1.54	2,216	1,111	4,421
Navarro-Mills Stream003	1.57	2,202	1,103	4,393
Navarro-Mills Stream003	1.84	2,456	1,231	4,900
Navarro-Mills Stream003	2.71	3,414	1,711	6,811
Navarro-Mills Stream003	3.67	4,246	2,128	8,472
Navarro-Mills Stream004	1.02	1,679	841	3,350
Navarro-Mills Stream004	1.47	2,610	1,308	5,207
Navarro-Mills Stream005	1.09	1,615	809	3,222
Navarro-Mills Stream005	2.09	2,667	1,337	5,322
Navarro-Mills Stream005	2.21	2,738	1,372	5,463
Navarro-Mills Stream005	4.77	5,060	2,536	10,097
Navarro-Mills Stream005	5.76	5,971	2,992	11,913
Navarro-Mills Stream005	6.51	6,304	3,159	12,578

Stream Name	Drainage Area (sq. mi)	1% Peak Q (cfs)	1%- Peak Q (cfs)	1%+ Peak Q (cfs)
Navarro-Mills Stream005	9.36	10,389	5,207	20,728
Navarro-Mills Stream006	1.05	1,609	807	3,211
Navarro-Mills Stream006	1.85	2,405	1,206	4,799
Navarro-Mills Stream007	1.20	1,778	891	3,548
Navarro-Mills Stream007	2.12	2,715	1,361	5,417
Navarro-Mills Stream007	2.77	4,124	2,067	8,229
Navarro-Mills Stream008	1.00	1,570	787	3,132
Navarro-Mills Stream008	1.27	2,027	1,016	4,045
Navarro-Mills Stream009	1.70	2,782	1,395	5,552
Navarro-Mills Stream009	2.01	3,012	1,509	6,009
Navarro-Mills Stream011	1.02	1,561	782	3,115
Navarro-Mills Stream011	1.74	2,381	1,193	4,751
Navarro-Mills Stream011	2.74	3,224	1,616	6,433
Navarro-Mills Stream011	5.98	6,015	3,015	12,001
Navarro-Mills Stream011	10.57	9,873	4,948	19,700
Navarro-Mills Stream012	1.07	1,833	919	3,658
Navarro-Mills Stream012	2.07	2,911	1,459	5,809
Navarro-Mills Stream012	2.91	3,675	1,842	7,333
Navarro-Mills Stream012	3.86	4,313	2,162	8,606
Navarro-Mills Stream012	4.58	4,900	2,456	9,776
Navarro-Mills Stream013	1.36	2,183	1,094	4,356
Navarro-Mills Stream013	2.15	2,846	1,426	5,679
Navarro-Mills Stream013	2.38	3,159	1,583	6,302
Navarro-Mills Stream014	1.01	1,642	823	3,277
Navarro-Mills Stream014	1.97	2,911	1,459	5,809
Navarro-Mills Stream014	2.39	3,244	1,626	6,473
Navarro-Mills Stream014	4.75	5,328	2,670	10,630
Navarro-Mills Stream014	5.76	6,150	3,082	12,271
Navarro-Mills Stream014	8.79	8,316	4,168	16,593
Navarro-Mills Stream015	1.02	1,860	932	3,712
Navarro-Mills Stream015	1.72	2,629	1,318	5,246
Navarro-Mills Stream016	1.03	2,306	1,156	4,600
Navarro-Mills Stream016	1.70	3,073	1,540	6,131
Navarro-Mills Stream017	1.02	1,337	670	2,668
Navarro-Mills Stream017	1.13	1,499	751	2,991
Navarro-Mills Stream019	1.00	1,331	667	2,656
Navarro-Mills Stream019	1.13	1,480	742	2,953
Navarro-Mills Stream020	1.02	1,733	869	3,459

Stream Name	Drainage Area (sq. mi)	1% Peak Q (cfs)	1%- Peak Q (cfs)	1%+ Peak Q (cfs)
Navarro-Mills Stream020	1.22	2,050	1,027	4,089
Navarro-Mills Stream021	1.16	1,971	988	3,933
Navarro-Mills Stream021	1.83	2,536	1,271	5,060
Navarro-Mills Stream021	2.83	3,694	1,851	7,370
Navarro-Mills Stream021	3.00	3,828	1,918	7,638
Navarro-Mills Stream022	1.00	1,739	871	3,469
Navarro-Mills Stream022	1.18	1,887	946	3,766
Navarro-Mills Stream023	1.08	1,515	759	3,023
Navarro-Mills Stream023	2.08	2,643	1,325	5,274
Navarro-Mills Stream023	3.08	3,462	1,735	6,908
Navarro-Mills Stream023	3.25	3,600	1,804	7,182
Navarro-Mills Stream025	1.06	1,865	935	3,721
Navarro-Mills Stream025	2.01	2,914	1,461	5,815
Navarro-Mills Stream025	3.76	4,617	2,314	9,213
Navarro-Mills Stream025	5.10	5,745	2,879	11,463
Navarro-Mills Stream025	6.61	6,914	3,465	13,795
Navarro-Mills Stream026	1.02	1,836	920	3,663
Navarro-Mills Stream026	1.05	1,878	941	3,747
Navarro-Mills Stream028	1.03	1,999	1,002	3,988
Navarro-Mills Stream028	1.54	2,771	1,389	5,530
Navarro-Mills Stream030	1.02	2,224	1,115	4,438
Navarro-Mills Stream030	1.91	3,140	1,574	6,266
Navarro-Mills Stream034	1.00	2,286	1,146	4,561
Navarro-Mills Stream034	2.00	3,398	1,703	6,780
Navarro-Mills Stream034	2.19	3,508	1,758	7,000
Navarro-Mills Stream034	5.30	6,738	3,377	13,444
Navarro-Mills Stream035	1.04	2,108	1,056	4,206
Navarro-Mills Stream035	2.16	3,714	1,861	7,410
Navarro-Mills Stream036	1.06	2,201	1,103	4,391
Navarro-Mills Stream036	2.04	3,545	1,777	7,073
Navarro-Mills Stream036	3.01	4,391	2,201	8,760
Navarro-Mills Stream036	4.95	6,532	3,274	13,032
Navarro-Mills Stream038	1.10	2,122	1,063	4,234
Navarro-Mills Stream038	1.55	2,616	1,311	5,219
Navarro-Mills Stream039	1.00	1,848	926	3,686
Navarro-Mills Stream039	1.18	2,065	1,035	4,121
Navarro-Mills Stream040	1.18	2,303	1,154	4,595
Navarro-Mills Stream040	1.63	2,795	1,401	5,577

Stream Name	Drainage Area (sq. mi)	1% Peak Q (cfs)	1%- Peak Q (cfs)	1%+ Peak Q (cfs)
Navarro-Mills Stream040	2.32	3,724	1,866	7,429
Navarro-Mills Stream041	1.00	1,576	790	3,145
Navarro-Mills Stream041	1.19	1,859	931	3,708
Navarro-Mills Stream042	1.23	2,093	1,049	4,175
Navarro-Mills Stream042	1.38	2,314	1,160	4,617
Navarro-Mills Stream043	1.04	1,303	653	2,600
Navarro-Mills Stream043	1.23	1,543	773	3,078
Navarro-Mills Stream044	1.00	1,111	557	2,216
Navarro-Mills Stream044	1.20	1,344	673	2,681
Navarro-Mills Stream046	1.03	1,831	918	3,654
Navarro-Mills Stream046	1.42	2,264	1,135	4,517
Navarro-Mills Stream046	2.84	4,160	2,085	8,300
Navarro-Mills Stream047	1.00	1,728	866	3,447
Navarro-Mills Stream047	1.42	2,277	1,141	4,543
Navarro-Mills Stream049	1.02	1,752	878	3,496
Navarro-Mills Stream049	1.04	1,883	944	3,757
Navarro-Mills Stream051	1.01	1,698	851	3,387
Navarro-Mills Stream051	1.09	1,813	909	3,617
Navarro-Mills Stream052	1.00	1,159	581	2,313
Navarro-Mills Stream052	1.33	1,983	994	3,957
Navarro-Mills Stream054	1.11	1,296	650	2,587
Navarro-Mills Stream054	1.98	2,263	1,134	4,515
Navarro-Mills Stream054	2.65	2,914	1,460	5,814
Navarro-Mills Stream056	1.00	1,284	644	2,562
Navarro-Mills Stream056	1.63	1,864	934	3,720
Navarro-Mills Stream056	2.44	2,512	1,259	5,013
Navarro-Mills Stream058	1.06	1,728	866	3,448
Navarro-Mills Stream058	1.20	1,877	941	3,745
Navarro-Mills Stream059	1.00	1,868	936	3,728
Navarro-Mills Stream059	1.06	1,928	966	3,846
Navarro-Mills Stream060	1.05	1,976	990	3,943
Navarro-Mills Stream060	1.24	2,130	1,068	4,251
Navarro-Mills Stream061	1.00	2,153	1,079	4,295
Navarro-Mills Stream061	1.78	3,207	1,607	6,399
Navarro-Mills Stream062	1.00	1,757	881	3,506
Navarro-Mills Stream062	1.06	1,872	938	3,734
Navarro-Mills Stream063	1.04	2,202	1,104	4,394
Navarro-Mills Stream063	1.49	2,708	1,357	5,403

Stream Name	Drainage Area (sq. mi)	1% Peak Q (cfs)	1%- Peak Q (cfs)	1%+ Peak Q (cfs)
Navarro-Mills Stream064	1.00	1,826	915	3,644
Navarro-Mills Stream064	1.25	2,046	1,025	4,082
Navarro-Mills Stream065	1.01	1,554	779	3,101
Navarro-Mills Stream065	1.52	2,179	1,092	4,348
Navarro-Mills Stream066	1.23	1,810	907	3,610
Navarro-Mills Stream066	2.22	2,830	1,418	5,646
Navarro-Mills Stream066	2.94	3,492	1,750	6,967
Navarro-Mills Stream067	1.34	1,659	832	3,311
Navarro-Mills Stream067	1.63	1,946	976	3,884
Navarro-Mills Stream068	1.00	974	488	1,942
Navarro-Mills Stream068	1.10	1,155	579	2,304
Navarro-Mills Stream069	1.12	1,357	680	2,708
Navarro-Mills Stream069	1.15	1,392	698	2,778
Navarro-Mills Stream071	1.41	1,755	880	3,503
Navarro-Mills Stream071	1.76	1,943	974	3,876
Navarro-Mills Stream071	2.69	2,698	1,352	5,384
Navarro-Mills Stream071	3.62	3,350	1,679	6,683
Navarro-Mills Stream071	4.69	3,639	1,824	7,261
Navarro-Mills Stream072	1.08	1,286	645	2,566
Navarro-Mills Stream072	1.81	1,870	937	3,730
Navarro-Mills Stream073	1.09	980	491	1,955
Navarro-Mills Stream073	1.98	2,263	1,134	4,515
Navarro-Mills Stream073	2.81	3,018	1,513	6,022
Navarro-Mills Stream073	3.37	3,422	1,715	6,829
Navarro-Mills Stream073	4.26	4,099	2,054	8,179
Navarro-Mills Stream073	5.01	4,545	2,278	9,069
Navarro-Mills Stream074	1.00	1,089	546	2,173
Navarro-Mills Stream074	2.00	1,823	914	3,638
Navarro-Mills Stream074	2.44	2,017	1,011	4,024
Navarro-Mills Stream074	3.44	2,633	1,320	5,253
Navarro-Mills Stream074	4.40	3,084	1,546	6,154
Navarro-Mills Stream074	5.39	4,861	2,436	9,699
Navarro-Mills Stream074	6.38	5,387	2,700	10,749
Navarro-Mills Stream074	7.18	5,847	2,931	11,667
Navarro-Mills Stream074	7.63	6,055	3,035	12,082
Navarro-Mills Stream077	1.29	1,592	798	3,177
Navarro-Mills Stream077	2.47	3,231	1,619	6,447
Navarro-Mills Stream078	1.05	1,179	591	2,353

Stream Name	Drainage Area (sq. mi)	1% Peak Q (cfs)	1%- Peak Q (cfs)	1%+ Peak Q (cfs)
Navarro-Mills Stream078	1.93	2,618	1,312	5,224
Navarro-Mills Stream078	2.81	3,590	1,799	7,163
Navarro-Mills Stream079	0.66	1,322	663	2,639
Navarro-Mills Stream080	0.97	1,778	891	3,548
Navarro-Mills Stream081	0.88	1,700	852	3,392
Navarro-Mills Stream082	0.55	868	435	1,731
Navarro-Mills Stream083	0.89	1,104	553	2,202
Navarro-Mills Stream084	0.91	1,200	601	2,394
Navarro-Mills Stream085	0.95	1,075	539	2,145
Navarro-Mills Stream086	0.94	983	493	1,962
Navarro-Mills Stream086	1.66	1,654	829	3,299
Navarro-Mills Stream087	0.72	851	427	1,698
Navarro-Mills Stream088	0.70	1,455	729	2,903
Navarro-Mills Stream089	0.66	1,414	709	2,822
Navarro-Mills Stream090	0.61	1,437	720	2,867
Navarro-Mills Stream091	0.84	1,430	717	2,854
Navarro-Mills Stream092	0.91	1,846	925	3,683
Navarro-Mills Stream093	0.91	1,650	827	3,292
Navarro-Mills Stream094	0.88	1,448	726	2,889
Navarro-Mills Stream095	0.69	1,354	678	2,701
Navarro-Mills Stream096	0.79	1,295	649	2,585
Navarro-Mills Stream097	1.08	1,968	986	3,927
Navarro-Mills Stream098	0.88	1,125	564	2,244
Navarro-Mills Stream099	0.93	1,441	722	2,876
North Fork Pin Oak Creek	1.23	1,962	983	3,914
North Fork Pin Oak Creek	2.18	2,793	1,400	5,573
North Fork Pin Oak Creek	3.11	3,338	1,673	6,660
North Fork Pin Oak Creek	4.32	4,146	2,078	8,273
North Fork Pin Oak Creek	6.06	5,390	2,701	10,755
North Fork Pin Oak Creek	8.95	7,219	3,618	14,404
North Fork Pin Oak Creek	10.02	7,815	3,917	15,594
Pecan Creek	1.03	1,816	910	3,623
Pecan Creek	1.12	1,960	983	3,912
Pecan Creek	4.96	6,251	3,133	12,472
Pecan Creek	5.02	6,255	3,135	12,480
Pecan Creek	6.89	7,861	3,940	15,685
Pecan Creek	7.78	8,576	4,298	17,111
Pecan Creek	8.77	9,106	4,564	18,169

Stream Name	Drainage Area (sq. mi)	1% Peak Q (cfs)	1%- Peak Q (cfs)	1%+ Peak Q (cfs)
Pecan Creek	9.77	8,634	4,327	17,227
Pecan Creek	10.62	8,990	4,506	17,937
Pecan Creek	11.18	9,289	4,655	18,534
Pin Oak 01	1.00	1,779	892	3,549
Pin Oak 01	1.11	1,830	917	3,651
Pin Oak 01	1.81	2,592	1,299	5,172
Pin Oak 01	2.86	3,942	1,976	7,865
Pin Oak 02	0.48	1,107	555	2,209
Pin Oak 03	0.95	1,625	814	3,242
Pin Oak 05	1.00	1,590	797	3,173
Pin Oak 05	1.42	2,207	1,106	4,404
Pin Oak 06	0.99	1,670	837	3,333
Pin Oak 06	2.84	3,865	1,937	7,711
Pin Oak 06	3.32	4,115	2,062	8,210
Pin Oak 07	0.85	1,563	783	3,118
Pin Oak 08	0.93	1,627	815	3,246
Pin Oak 08	2.54	3,408	1,708	6,799
Pin Oak 08	3.07	3,973	1,991	7,928
Pin Oak 08	4.17	5,160	2,586	10,295
Pin Oak 09	0.86	1,637	820	3,266
Pin Oak 10	0.50	1,041	522	2,078
Pin Oak 11	1.09	1,821	913	3,634
Pin Oak 13	1.00	1,527	765	3,047
Pin Oak 13	1.08	1,611	808	3,215
Pin Oak 14	0.77	1,175	589	2,345
Pin Oak 14	1.55	2,122	1,063	4,233
Pin Oak 14	2.01	2,654	1,330	5,295
Pin Oak 15	1.38	2,059	1,032	4,109
Pin Oak 15	2.37	3,073	1,540	6,132
Pin Oak 15	3.35	3,705	1,857	7,393
Pin Oak 15	4.32	4,242	2,126	8,465
Pin Oak 15	5.01	4,744	2,377	9,465
Pin Oak 17	1.20	1,299	651	2,592
Pin Oak 18	1.00	1,501	752	2,994
Pin Oak 18	1.90	2,305	1,155	4,599
Pin Oak 18	2.80	3,166	1,587	6,316
Pin Oak 18	3.80	3,936	1,973	7,854
Pin Oak 18	4.80	4,530	2,270	9,039

Stream Name	Drainage Area (sq. mi)	1% Peak Q (cfs)	1%- Peak Q (cfs)	1%+ Peak Q (cfs)
Pin Oak 18	5.79	5,012	2,512	9,999
Pin Oak 18	6.47	5,491	2,752	10,956
Pin Oak 18	6.92	5,758	2,886	11,488
Pin Oak 18	7.38	5,939	2,977	11,850
Pin Oak 19	0.83	1,255	629	2,505
Pin Oak 19	1.51	2,014	1,009	4,019
Pin Oak 19	1.83	2,335	1,170	4,659
Pin Oak 19	4.52	4,488	2,249	8,955
Pin Oak 19	5.51	4,969	2,490	9,914
Pin Oak 19	5.93	5,285	2,649	10,546
Pin Oak 20	1.07	1,389	696	2,771
Pin Oak 20	1.69	2,085	1,045	4,161
Pin Oak 22	1.72	2,469	1,238	4,927
Pin Oak 22	2.07	2,752	1,379	5,491
Pin Oak 23	0.74	1,207	605	2,408
Pin Oak 23	1.44	2,175	1,090	4,340
Pin Oak 23	2.48	3,366	1,687	6,717
Pin Oak 23	3.32	4,123	2,066	8,226
Pin Oak 23	4.14	4,760	2,386	9,498
Pin Oak 23	6.19	6,504	3,260	12,978
Pin Oak 24	0.63	1,276	639	2,545
Pin Oak 25	0.73	1,286	644	2,566
Pin Oak 26	0.83	1,517	760	3,026
Pin Oak 26	1.00	1,737	870	3,465
Pin Oak 26	1.95	2,756	1,382	5,500
Pin Oak 27	1.02	1,964	984	3,918
Pin Oak 27	1.75	2,847	1,427	5,681
Pin Oak 27	2.78	4,029	2,019	8,039
Pin Oak 29	1.35	2,396	1,201	4,781
Pin Oak 29	1.43	2,570	1,288	5,128
Pin Oak 29	2.25	3,762	1,886	7,507
Pin Oak 30	0.54	1,400	701	2,793
Pin Oak 31	0.69	1,467	735	2,927
Pin Oak 31	1.09	2,102	1,054	4,195
Pin Oak 33	1.01	1,767	886	3,526
Pin Oak 33	1.31	1,939	972	3,869
Pin Oak 34	1.23	1,575	789	3,142
Pin Oak 34	1.39	1,779	892	3,550

Stream Name	Drainage Area (sq. mi)	1% Peak Q (cfs)	1%- Peak Q (cfs)	1%+ Peak Q (cfs)
Pin Oak 35	1.05	2,208	1,107	4,406
Pin Oak 35	1.50	2,706	1,356	5,399
Pin Oak 35	1.94	3,126	1,566	6,236
Pin Oak 36	1.48	2,968	1,487	5,921
Pin Oak 36	2.08	3,443	1,726	6,870
Pin Oak 36	2.72	4,028	2,019	8,037
Pin Oak 37	0.74	1,842	923	3,675
Pin Oak 37	1.00	2,168	1,087	4,326
Pin Oak 37	1.44	2,704	1,355	5,395
Pin Oak 38	1.00	1,909	957	3,809
Pin Oak 38	1.34	2,451	1,228	4,890
Pin Oak 39	1.05	2,547	1,276	5,081
Pin Oak 39	1.47	3,291	1,649	6,565
Pin Oak 40	0.28	619	310	1,234
Pin Oak 41	0.83	1,662	833	3,316
Pin Oak 41	1.16	2,150	1,078	4,290
Pin Oak 42	0.92	2,262	1,134	4,513
Pin Oak 42	2.12	4,001	2,005	7,984
Pin Oak 42	2.26	4,014	2,012	8,008
Pin Oak 42	3.03	4,676	2,344	9,330
Pin Oak 43	1.00	2,026	1,016	4,043
Pin Oak 43	1.96	3,153	1,580	6,292
Pin Oak 43	2.43	3,785	1,897	7,552
Pin Oak 44	1.11	2,581	1,294	5,151
Pin Oak 44	2.09	3,689	1,849	7,361
Pin Oak 45	0.69	1,736	870	3,463
Pin Oak 45	1.09	2,503	1,255	4,995
Pin Oak 45	2.97	4,752	2,381	9,481
Pin Oak 46	0.33	892	447	1,780
Pin Oak 47	0.93	1,968	987	3,927
Pin Oak 49	1.00	2,313	1,159	4,614
Pin Oak 49	1.59	2,877	1,442	5,740
Pin Oak 49	2.10	3,633	1,821	7,249
Pin Oak 50	1.11	1,547	775	3,086
Pin Oak 50	1.96	2,333	1,169	4,655
Pin Oak 50	2.92	3,036	1,522	6,058
Pin Oak 50	3.65	3,398	1,703	6,780
Pin Oak 50	4.58	4,085	2,047	8,150

Stream Name	Drainage Area (sq. mi)	1% Peak Q (cfs)	1%- Peak Q (cfs)	1%+ Peak Q (cfs)
Pin Oak 50	5.22	4,555	2,283	9,088
Pin Oak 51	1.00	2,212	1,108	4,413
Pin Oak 51	1.93	3,406	1,707	6,795
Pin Oak 51	4.44	6,395	3,205	12,760
Pin Oak 51	5.71	7,753	3,886	15,470
Pin Oak 52	0.46	1,136	569	2,266
Pin Oak 52	0.85	1,949	977	3,889
Pin Oak 52	1.76	3,461	1,735	6,906
Pin Oak 53	0.38	977	490	1,949
Pin Oak 54	0.50	1,285	644	2,565
Pin Oak 55	0.53	1,452	728	2,897
Pin Oak 55	1.00	2,395	1,201	4,779
Pin Oak 55	1.14	2,360	1,183	4,708
Pin Oak 56	0.41	1,142	572	2,278
Pin Oak 58	1.23	1,735	870	3,463
Pin Oak 59	0.88	1,339	671	2,671
Pin Oak 60	1.08	1,669	837	3,331
Pin Oak 60	1.94	2,606	1,306	5,200
Pin Oak 60	2.88	3,377	1,692	6,737
Pin Oak 60	3.37	3,785	1,897	7,552
Pin Oak 61	1.23	2,053	1,029	4,097
Pin Oak 61	1.63	2,452	1,229	4,893
Pin Oak 61	1.83	2,690	1,348	5,367
Pin Oak 62	1.01	1,935	970	3,861
Pin Oak 62	1.06	2,003	1,004	3,996
Pin Oak 63	1.18	2,416	1,211	4,821
Pin Oak 63	1.85	3,410	1,709	6,803
Pin Oak 63	2.66	4,272	2,141	8,524
Pin Oak 63	3.13	4,674	2,343	9,327
Pin Oak 63	6.40	8,484	4,252	16,928
Pin Oak 64	1.06	1,965	985	3,922
Pin Oak 64	1.72	2,574	1,290	5,135
Pin Oak 64	2.71	3,729	1,869	7,441
Pin Oak 64	3.67	4,417	2,214	8,813
Pin Oak 64	4.66	5,289	2,651	10,554
Pin Oak 64	5.41	5,526	2,770	11,026
Pin Oak 64	6.98	6,645	3,330	13,259
Pin Oak 66	0.95	1,645	824	3,282

Stream Name	Drainage Area (sq. mi)	1% Peak Q (cfs)	1%- Peak Q (cfs)	1%+ Peak Q (cfs)
Pin Oak Creek	0.33	792	397	1,580
Pin Oak Creek	1.03	2,070	1,038	4,130
Pin Oak Creek	1.22	2,223	1,114	4,435
Pin Oak Creek	4.16	5,210	2,611	10,396
Pin Oak Creek	5.19	6,158	3,087	12,288
Pin Oak Creek	7.51	7,876	3,947	15,714
Pin Oak Creek	8.43	8,150	4,085	16,261
Pin Oak Creek	12.75	10,932	5,479	21,812
Pin Oak Creek	13.00	10,674	5,350	21,298
Pin Oak Creek	17.95	13,046	6,538	26,030
Pin Oak Creek	20.36	14,090	7,062	28,114
Pin Oak Creek	20.84	13,825	6,929	27,585
Pin Oak Creek	31.66	18,535	9,290	36,983
Pin Oak Creek	32.68	18,553	9,298	37,017
Pin Oak Creek	38.72	19,850	9,949	39,607
Pin Oak Creek	46.05	22,801	11,427	45,494
Pin Oak Creek	46.84	22,742	11,398	45,375
Pin Oak Creek	47.18	22,757	11,405	45,406
Pin Oak Creek	56.91	25,703	12,882	51,284
Pin Oak Creek	62.85	27,688	13,877	55,246
Pin Oak Creek	119.30	43,995	22,050	87,782
Pin Oak Creek	121.62	43,793	21,949	87,379
Pin Oak Creek	126.86	45,034	22,570	89,855
Pin Oak Creek	134.15	46,280	23,195	92,342
Pin Oak Creek	134.59	46,287	23,198	92,355
Pin Oak Creek	136.17	45,917	23,013	91,615
Pin Oak Creek	138.65	45,514	22,811	90,812
Pin Oak Creek	161.13	48,625	24,370	97,019
Pin Oak Creek	167.72	49,162	24,639	98,090
Pin Oak Creek	169.48	49,166	24,641	98,098
Pin Oak Creek	177.28	50,657	25,389	101,074
Post Oak Battle Creek Tributary 1	2.32	3,132	1,570	6,250
Post Oak Battle Creek Tributary 1	2.49	3,350	1,679	6,685
Post Oak Battle Creek Tributary 2	0.74	1,398	701	2,789
Post Oak Battle Creek Tributary 2	1.90	3,263	1,635	6,510
Post Oak Battle Creek Tributary 3	0.49	947	475	1,890
Post Oak Battle Creek Tributary 3	1.37	2,209	1,107	4,408
Post Oak Battle Creek Tributary 3-1	0.69	1,197	600	2,388

Stream Name	Drainage Area (sq. mi)	1% Peak Q (cfs)	1%- Peak Q (cfs)	1%+ Peak Q (cfs)
Post Oak Battle Creek Tributary 4	1.55	2,526	1,266	5,041
Post Oak Battle Creek Tributary 4	2.05	3,051	1,529	6,087
Post Oak Battle Creek Tributary 5	2.63	3,754	1,881	7,490
Post Oak Battle Creek Tributary 5	4.20	5,132	2,572	10,241
Post Oak Briar Creek Tributary 1	1.10	1,277	640	2,549
Post Oak Briar Creek Tributary 1	3.06	2,412	1,209	4,813
Post Oak Briar Creek Tributary 1	3.44	2,599	1,303	5,186
Post Oak Briar Creek Tributary 2	1.97	1,876	940	3,742
Post Oak Briar Creek Tributary 2	4.03	3,246	1,627	6,477
Post Oak Briar Creek Tributary 2	7.38	4,901	2,456	9,778
Post Oak Briar Creek Tributary 2-1	0.40	601	301	1,199
Post Oak Briar Creek Tributary 2-1	0.89	1,118	560	2,230
Post Oak Briar Creek Tributary 2-1	1.87	1,922	963	3,835
Post Oak Briar Creek Tributary 2-1-1	0.37	590	296	1,176
Post Oak Briar Creek Tributary 2-2	1.58	1,366	685	2,726
Post Oak Briar Creek Tributary 3	1.20	1,319	661	2,632
Post Oak Briar Creek Tributary 3	1.33	1,482	743	2,958
Post Oak Briar Creek Tributary 4	0.97	1,093	548	2,180
Post Oak Briar Creek Tributary 5	1.78	1,731	868	3,454
Post Oak Briar Creek Tributary 6	0.72	893	448	1,782
Post Oak Cedar Creek Tributary 1	3.56	3,425	1,717	6,834
Post Oak Cedar Creek Tributary 2	1.01	1,175	589	2,345
Post Oak Cedar Creek Tributary 2	1.27	1,320	661	2,633
Post Oak Cedar Creek Tributary 2	2.00	1,954	979	3,899
Post Oak Cedar Creek Tributary 2	2.14	2,041	1,023	4,073
Post Oak Cedar Creek Tributary 2	3.17	2,719	1,363	5,425
Post Oak Cedar Creek Tributary 2	3.61	2,996	1,502	5,979
Post Oak Cedar Creek Tributary 2	5.94	3,892	1,951	7,766
Post Oak Cedar Creek Tributary 2	9.94	5,560	2,787	11,094
Post Oak Cedar Creek Tributary 2-1	0.62	769	386	1,535
Post Oak Cedar Creek Tributary 2-1	2.80	2,722	1,364	5,431
Post Oak Cedar Creek Tributary 2-1-1	0.64	815	408	1,625
Post Oak Cedar Creek Tributary 3	1.00	1,153	578	2,300
Post Oak Cedar Creek Tributary 3	1.36	1,493	749	2,980
Post Oak Cedar Creek Tributary 4	0.06	123	62	245
Post Oak Cedar Creek Tributary 4	1.17	1,276	640	2,546
Post Oak Cedar Creek Tributary 4-1	0.27	424	212	845
Post Oak Cedar Creek Tributary 5	0.37	459	230	916

Stream Name	Drainage Area (sq. mi)	1% Peak Q (cfs)	1%- Peak Q (cfs)	1%+ Peak Q (cfs)
Post Oak Cedar Creek Tributary 5	1.49	1,375	689	2,744
Post Oak Cedar Creek Tributary 5-1	0.35	434	218	866
Post Oak Cedar Creek Tributary 6	0.73	854	428	1,704
Post Oak Creek	1.06	1,707	856	3,406
Post Oak Creek	1.25	1,698	851	3,388
Post Oak Creek	2.06	2,857	1,432	5,699
Post Oak Creek	2.59	3,378	1,693	6,741
Post Oak Creek	3.59	4,254	2,132	8,488
POST OAK CREEK	4.10	3,067	1,537	6,119
Post Oak Creek	4.47	4,879	2,445	9,735
Post Oak Creek	6.63	6,639	3,327	13,246
POST OAK CREEK	7.62	5,188	2,600	10,351
POST OAK CREEK	7.73	5,332	2,672	10,639
Post Oak Creek	9.43	8,533	4,277	17,025
Post Oak Creek	10.41	9,225	4,623	18,406
Post Oak Creek	10.98	9,501	4,762	18,958
POST OAK CREEK	12.46	6,895	3,456	13,757
POST OAK CREEK	15.70	8,028	4,024	16,019
POST OAK CREEK	20.65	9,642	4,833	19,239
POST OAK CREEK	24.98	10,716	5,371	21,382
POST OAK CREEK	29.18	16,177	8,108	32,277
POST OAK CREEK	37.13	18,608	9,326	37,129
Post Oak Hughes Branch Tributary 1	1.36	1,768	886	3,527
Post Oak Melton Branch Tributary 1	3.11	3,742	1,875	7,466
Post Oak Melton Branch Tributary 1	4.75	4,887	2,450	9,752
Post Oak Melton Branch Tributary 1	9.19	7,757	3,888	15,477
Post Oak Melton Branch Tributary 1	10.96	8,935	4,478	17,828
Post Oak Melton Branch Tributary 1-1	1.09	1,784	894	3,559
Post Oak Melton Branch Tributary 1-1	1.76	2,479	1,242	4,946
Post Oak Melton Branch Tributary 1-2	1.89	2,247	1,126	4,483
Post Oak Melton Branch Tributary 1-2	3.08	3,278	1,643	6,540
Post Oak Melton Branch Tributary 1-3	1.04	1,802	903	3,595
Post Oak Melton Branch Tributary 1-3	1.29	1,974	989	3,938
Post Oak Post Oak Creek Tributary 1	1.22	1,925	965	3,840
Post Oak Post Oak Creek Tributary 1	1.30	2,083	1,044	4,156
Post Oak Post Oak Creek Tributary 2	0.55	786	394	1,568
Post Oak Post Oak Creek Tributary 2	1.08	1,411	707	2,816
Post Oak Post Oak Creek Tributary 2-1	0.47	696	349	1,389

Stream Name	Drainage Area (sq. mi)	1% Peak Q (cfs)	1%- Peak Q (cfs)	1%+ Peak Q (cfs)
Post Oak Post Oak Creek Tributary 3	2.67	2,454	1,230	4,896
Post Oak Post Oak Creek Tributary 3	2.81	2,547	1,277	5,082
Post Oak Post Oak Creek Tributary 4	0.72	881	442	1,758
Post Oak Post Oak Creek Tributary 4	2.64	2,253	1,129	4,494
Post Oak Post Oak Creek Tributary 4-1	0.46	635	318	1,266
Post Oak Post Oak Creek Tributary 4-1	0.81	922	462	1,840
Post Oak Post Oak Creek Tributary 4-1-1	0.08	150	75	300
Post Oak Post Oak Creek Tributary 5	1.53	1,653	828	3,298
Post Oak Post Oak Creek Tributary 5	1.86	1,715	860	3,422
Post Oak Post Oak Creek Tributary 5	2.29	2,054	1,029	4,098
Post Oak Post Oak Creek Tributary 5-1	0.11	196	98	390
Post Oak Post Oak Creek Tributary 6	3.51	2,653	1,330	5,294
Post Oak Richland Creek Tributary 1	2.50	2,815	1,411	5,616
Post Oak Richland Creek Tributary 1	7.61	6,275	3,145	12,520
Post Oak Richland Creek Tributary 1-1	0.23	469	235	936
Post Oak Richland Creek Tributary 1-1	1.25	2,018	1,011	4,026
Post Oak Richland Creek Tributary 2	0.26	709	355	1,414
Post Oak Richland Creek Tributary 2	0.73	1,590	797	3,173
Post Oak Richland Creek Tributary 2	1.92	2,773	1,390	5,533
Post Oak Richland Creek Tributary 2	3.18	4,057	2,033	8,095
Post Oak Richland Creek Tributary 2	8.12	6,718	3,367	13,404
Post Oak Richland Creek Tributary 2-1	1.83	2,631	1,319	5,250
Post Oak Richland Creek Tributary 2-2	0.57	1,212	607	2,417
Post Oak Richland Creek Tributary 2-2	0.66	1,392	698	2,778
Post Oak Richland Creek Tributary 2-2	1.15	1,991	998	3,972
Post Oak Richland Creek Tributary 2-3	0.23	621	311	1,239
Post Oak Richland Creek Tributary 3	1.25	2,018	1,011	4,026
Post Oak Richland Creek Tributary 3	2.27	3,033	1,520	6,051
Post Oak Richland Creek Tributary 3	7.33	6,209	3,112	12,389
Post Oak Richland Creek Tributary 3-1	0.48	1,148	575	2,290
Post Oak Richland Creek Tributary 3-1	0.55	1,291	647	2,575
Post Oak Richland Creek Tributary 3-1	1.95	3,268	1,638	6,520
Post Oak Rush Creek Tributary 1	1.08	1,397	700	2,787
Post Oak Rush Creek Tributary 1	1.30	1,527	765	3,047
Post Oak Rush Creek Tributary 1	1.36	1,663	834	3,319
Post Oak Rush Creek Tributary 2	0.18	307	154	613
Post Oak Rush Creek Tributary 2	2.46	2,616	1,311	5,220

Stream Name	Drainage Area (sq. mi)	1% Peak Q (cfs)	1%- Peak Q (cfs)	1%+ Peak Q (cfs)
Post Oak Rush Creek Tributary 2	3.05	3,009	1,508	6,003
Post Oak Rush Creek Tributary 2	8.51	5,939	2,977	11,851
Post Oak Rush Creek Tributary 2-1	1.46	1,586	795	3,165
Post Oak Rush Creek Tributary 2-2	0.99	1,390	697	2,773
Post Oak Rush Creek Tributary 3	4.50	3,561	1,785	7,106
Post Oak Treadwell Branch Tributary 1	1.33	2,227	1,116	4,443
Post Oak Treadwell Branch Tributary 2	0.31	713	357	1,422
Richland Creek	1.03	1,862	933	3,714
Richland Creek	1.50	2,323	1,164	4,635
Richland Creek	2.61	3,636	1,822	7,254
Richland Creek	4.03	5,060	2,536	10,096
Richland Creek	5.10	6,122	3,068	12,215
Richland Creek	6.76	7,299	3,658	14,564
Richland Creek	8.77	9,049	4,535	18,055
Richland Creek	10.35	10,064	5,044	20,080
Richland Creek	11.34	10,356	5,190	20,664
Richland Creek	13.20	11,774	5,901	23,493
Richland Creek	15.09	12,812	6,421	25,564
Richland Creek	15.98	13,267	6,649	26,471
Richland Creek	16.83	13,682	6,857	27,299
Richland Creek	17.06	13,717	6,875	27,370
Richland Creek	19.54	13,203	6,617	26,343
RICHLAND CREEK	20.57	14,526	7,280	28,982
RICHLAND CREEK	21.54	14,465	7,250	28,862
Richland Creek	22.27	14,305	7,169	28,542
Richland Creek	23.24	14,622	7,328	29,175
Richland Creek	23.76	14,654	7,344	29,238
Richland Creek	26.50	15,745	7,891	31,415
Richland Creek	27.35	15,922	7,980	31,769
Richland Creek	28.10	16,029	8,033	31,982
Richland Creek	31.94	17,118	8,579	34,155
Richland Creek	32.80	16,995	8,518	33,909
RICHLAND CREEK	33.30	22,396	11,225	44,686
RICHLAND CREEK	34.13	21,375	10,713	42,649
Richland Creek	35.37	17,440	8,741	34,797
Richland Creek	35.68	17,413	8,727	34,744
Richland Creek	37.45	17,854	8,948	35,623
Richland Creek	38.10	17,831	8,937	35,578

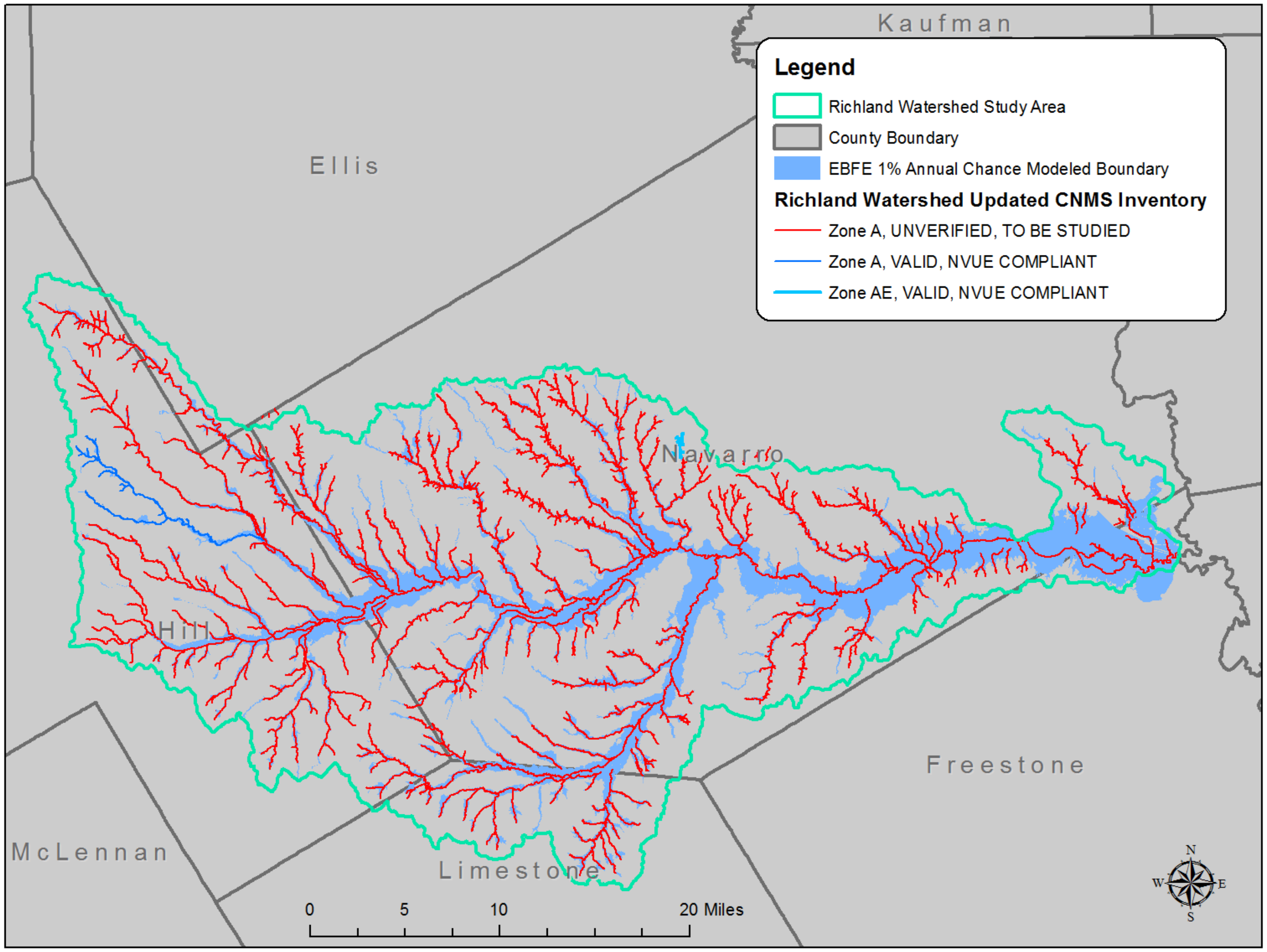
Stream Name	Drainage Area (sq. mi)	1% Peak Q (cfs)	1%- Peak Q (cfs)	1%+ Peak Q (cfs)
Richland Creek	38.80	17,940	8,991	35,794
Richland Creek	39.33	17,900	8,971	35,716
Richland Creek	41.02	18,418	9,231	36,748
Richland Creek	42.44	18,091	9,067	36,096
Richland Creek	44.24	18,962	9,503	37,833
Richland Creek	44.85	18,829	9,437	37,570
Richland Creek	45.39	18,366	9,205	36,644
Richland Creek	46.16	18,503	9,274	36,919
Richland Creek	47.12	18,536	9,290	36,985
Richland Creek	48.10	18,564	9,304	37,040
Richland Creek	48.95	18,566	9,305	37,044
Richland Creek	49.73	25,139	12,599	50,159
Richland Creek	50.46	25,968	13,015	51,813
Richland Creek	51.06	26,002	13,032	51,880
RICHLAND CREEK	58.31	31,692	15,884	63,234
Richland Creek	70.06	32,084	16,080	64,016
Richland Creek	75.33	33,745	16,913	67,331
RICHLAND CREEK	96.97	36,959	18,523	73,743
RICHLAND CREEK	99.27	36,524	18,306	72,876
RICHLAND CREEK	105.85	37,424	18,756	74,670
RICHLAND CREEK	113.86	37,605	18,847	75,031
RICHLAND CREEK	122.12	40,117	20,106	80,045
RICHLAND CREEK	147.31	45,330	22,719	90,445
RICHLAND CREEK	202.44	56,706	28,421	113,144
RICHLAND CREEK	210.67	57,398	28,767	114,524
RICHLAND CREEK	238.39	60,051	30,097	119,817
RICHLAND CREEK	246.89	61,548	30,847	122,804
Richland Creek	288.42	87,883	44,046	175,349
Richland Creek	288.93	87,720	43,964	175,024
Richland Creek	296.80	88,750	44,481	177,080
Richland Creek	304.89	90,286	45,250	180,144
Richland Creek	314.28	91,238	45,727	182,043
Richland Creek	317.20	91,293	45,755	182,153
Richland Creek	320.20	91,465	45,841	182,496
Richland Creek AC	715.25	44,900	44,900	44,900
Richland Creek AC	716.71	44,900	44,900	44,900
Richland Creek AC	727.02	44,900	44,900	44,900
Richland Creek AC	728.02	44,900	44,900	44,900

Stream Name	Drainage Area (sq. mi)	1% Peak Q (cfs)	1%- Peak Q (cfs)	1%+ Peak Q (cfs)
Richland Creek AC	728.51	44,900	44,900	44,900
Richland Creek AC	731.29	44,900	44,900	44,900
Richland Creek AC	731.51	44,900	44,900	44,900
Richland Creek AC	735.75	44,900	44,900	44,900
Richland Creek AC	738.53	44,900	44,900	44,900
Richland Creek AC	780.89	44,900	44,900	44,900
Richland Creek AC	796.99	44,900	44,900	44,900
Richland Creek AC	816.90	44,900	44,900	44,900
Richland Creek AC	820.22	44,900	44,900	44,900
Richland Creek AC	825.46	44,900	44,900	44,900
Richland Creek AC	843.76	44,900	44,900	44,900
Richland Creek AC	848.43	44,900	44,900	44,900
Richland Creek AC	868.40	44,900	44,900	44,900
Richland Creek AC	1959.62	115,000	115,000	115,000
Richland Creek AC	1960.26	56,800	56,800	56,800
Richland Creek AC	1961.02	56,800	56,800	56,800
Richland Creek AC	1991.11	56,800	56,800	56,800
Richland Creek AC	1994.40	56,800	56,800	56,800
Rush Creek	6.85	4,591	2,301	9,161
Rush Creek	13.75	7,673	3,845	15,309
Rush Creek	24.55	11,761	5,895	23,467
Rush Creek	26.99	12,280	6,155	24,502
Rush Creek	27.43	16,312	8,175	32,547
Rush Creek	27.98	16,357	8,198	32,636
Tom Harris Branch	1.05	1,198	600	2,390
Tom Harris Branch	2.02	1,964	985	3,920
Tom Harris Branch	3.01	3,496	1,752	6,976
Tom Harris Branch	3.99	4,217	2,113	8,414
Tom Harris Branch	4.37	4,442	2,226	8,863
Tom Harris Branch	5.37	5,170	2,591	10,315
Tom Harris Branch	6.36	5,801	2,908	11,575
Tom Harris Branch	6.47	5,851	2,932	11,674
Treadwell Branch	1.10	1,957	981	3,905
Treadwell Branch	9.22	8,610	4,315	17,179
Treadwell Branch	11.51	9,990	5,007	19,933
White Rock Creek	1.33	2,271	1,138	4,531
White Rock Creek	2.24	3,283	1,645	6,550
White Rock Creek	3.14	4,107	2,058	8,194

Stream Name	Drainage Area (sq. mi)	1% Peak Q (cfs)	1%- Peak Q (cfs)	1%+ Peak Q (cfs)
White Rock Creek	5.71	6,696	3,356	13,360
White Rock Creek	7.45	8,068	4,044	16,098
White Rock Creek	8.43	8,891	4,456	17,739
White Rock Creek	11.53	11,017	5,522	21,982
White Rock Creek	12.20	11,441	5,734	22,828
White Rock Creek	14.16	12,561	6,295	25,062
White Rock Creek	14.61	11,294	5,660	22,535
White Rock Creek	16.83	13,970	7,002	27,874
White Rock Creek	17.81	12,712	6,371	25,364
White Rock Creek	18.17	12,715	6,373	25,370
White Rock Creek	19.15	13,193	6,612	26,324
White Rock Creek	20.15	13,481	6,757	26,898
White Rock Creek	21.13	13,665	6,849	27,264
White Rock Creek	21.41	13,655	6,844	27,246
White Rock Creek	23.42	14,301	7,167	28,534
White Rock Creek	24.06	14,482	7,258	28,896
White Rock Creek	25.82	14,967	7,501	29,862
White Rock Creek	26.45	15,098	7,567	30,124
White Rock Creek	34.93	18,386	9,215	36,685
White Rock Creek	35.71	18,487	9,265	36,886
White Rock Creek	61.50	36,842	18,465	73,510
White Rock Creek	63.59	37,518	18,803	74,858
White Rock Creek	64.49	37,362	18,725	74,546
White Rock Creek	65.34	37,369	18,729	74,562
White Rock Creek	67.21	37,426	18,758	74,675
White Rock Creek	67.93	37,300	18,694	74,423
White Rock Creek	70.69	38,023	19,057	75,866
White Rock Creek	71.61	38,380	19,236	76,579
White Rock Creek	72.60	38,512	19,302	76,842
White Rock Creek	73.43	37,884	18,987	75,588
White Rock Creek	82.35	41,366	20,732	82,536
White Rock Creek	84.88	41,911	21,005	83,623
Wolf Creek	1.05	1,220	611	2,434
Wolf Creek	1.94	1,944	974	3,879
Wolf Creek	2.92	2,589	1,297	5,165
Wolf Creek	3.90	4,262	2,136	8,503
Wolf Creek	4.67	4,754	2,382	9,485
Wolf Creek	7.40	6,724	3,370	13,417

Stream Name	Drainage Area (sq. mi)	1% Peak Q (cfs)	1%- Peak Q (cfs)	1%+ Peak Q (cfs)
Wolf Creek	8.64	7,470	3,744	14,906

Appendix B BLE Maps



Appendix III: Additional Data

Discovery Figures

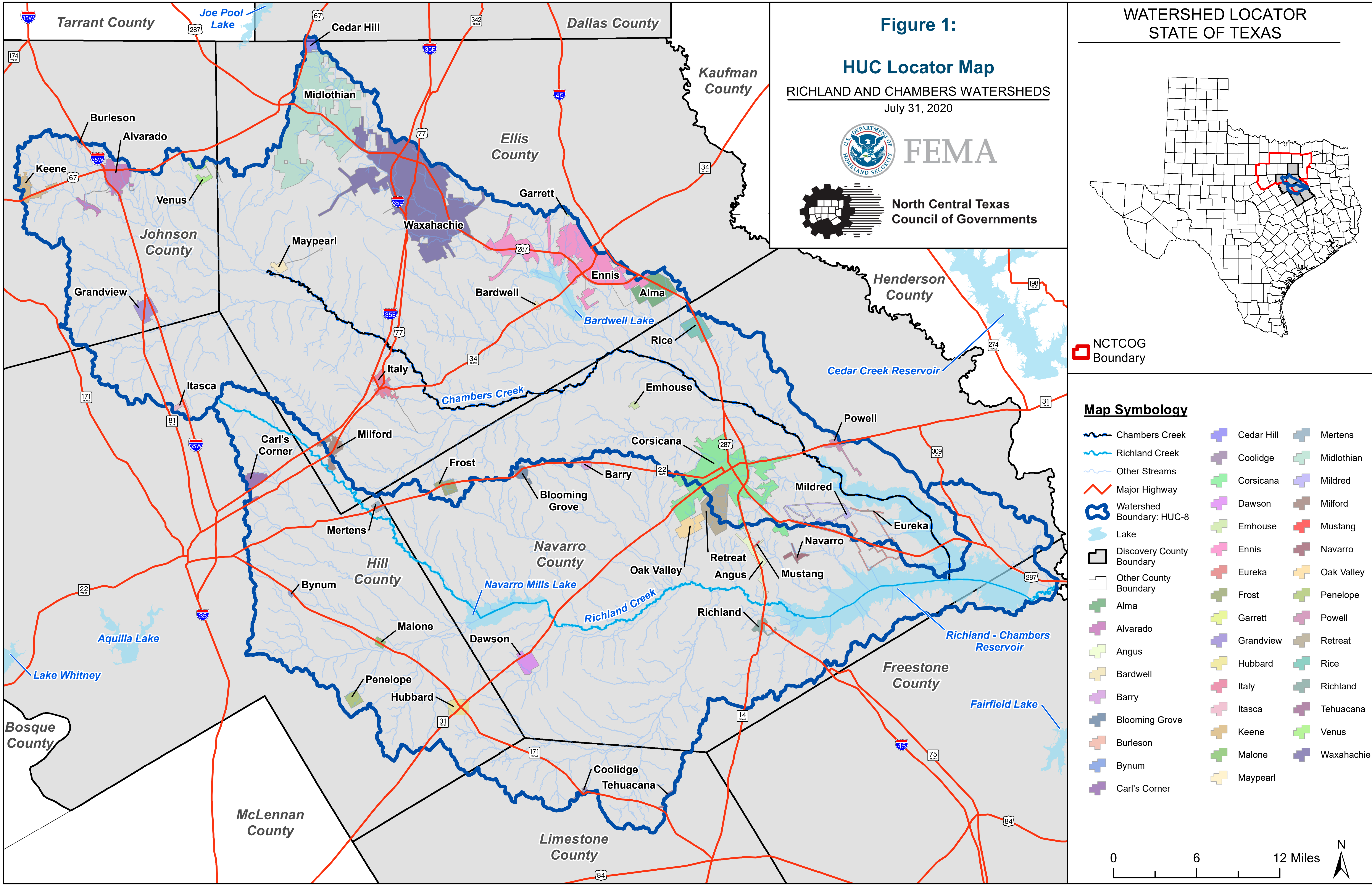


Figure 1:

HUC Locator Map

RICHLAND AND CHAMBERS WATERSHEDS

July 31, 2020

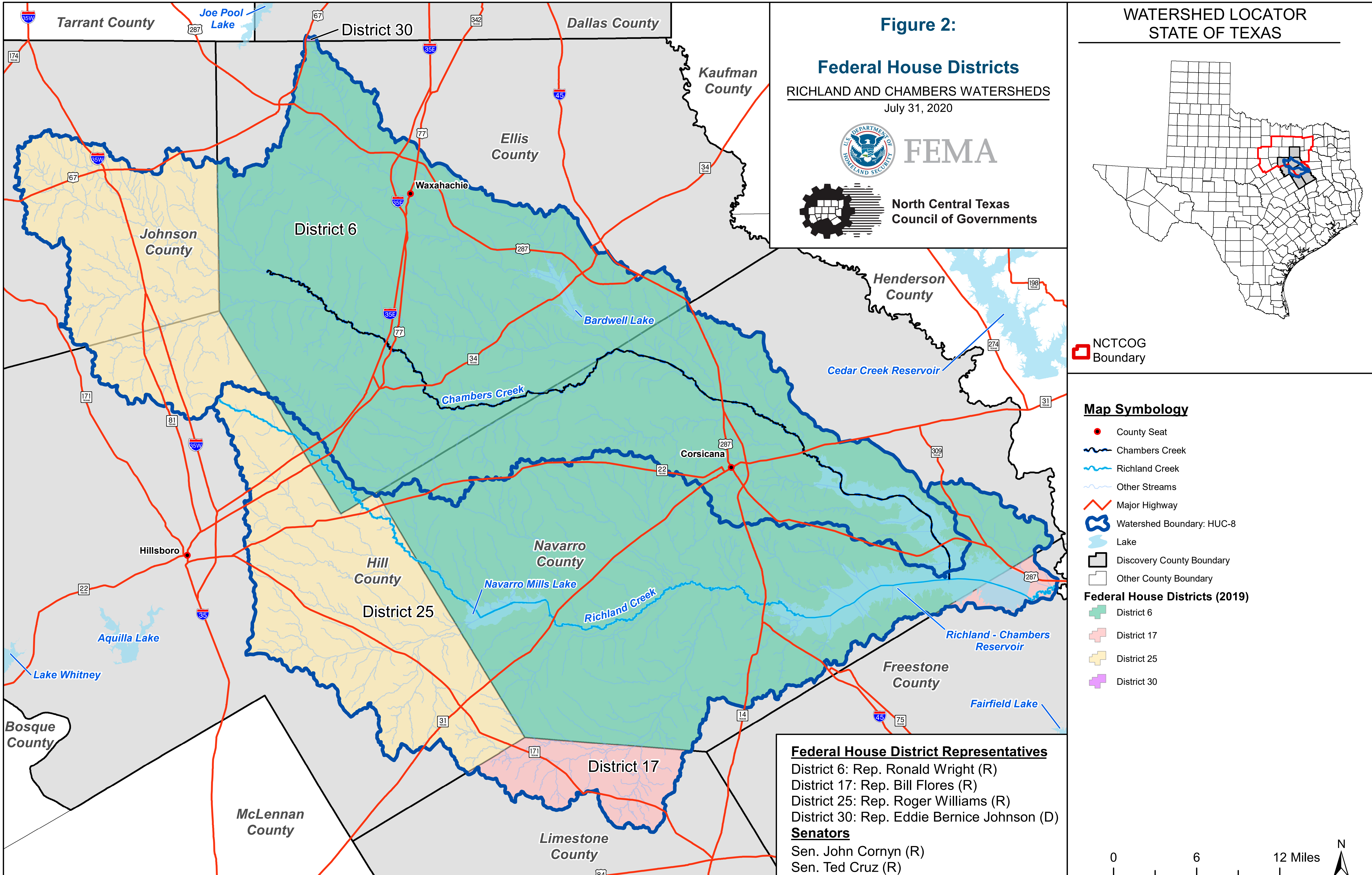


Figure 2:

Federal House Districts

RICHLAND AND CHAMBERS WATERSHEDS

July 31, 2020

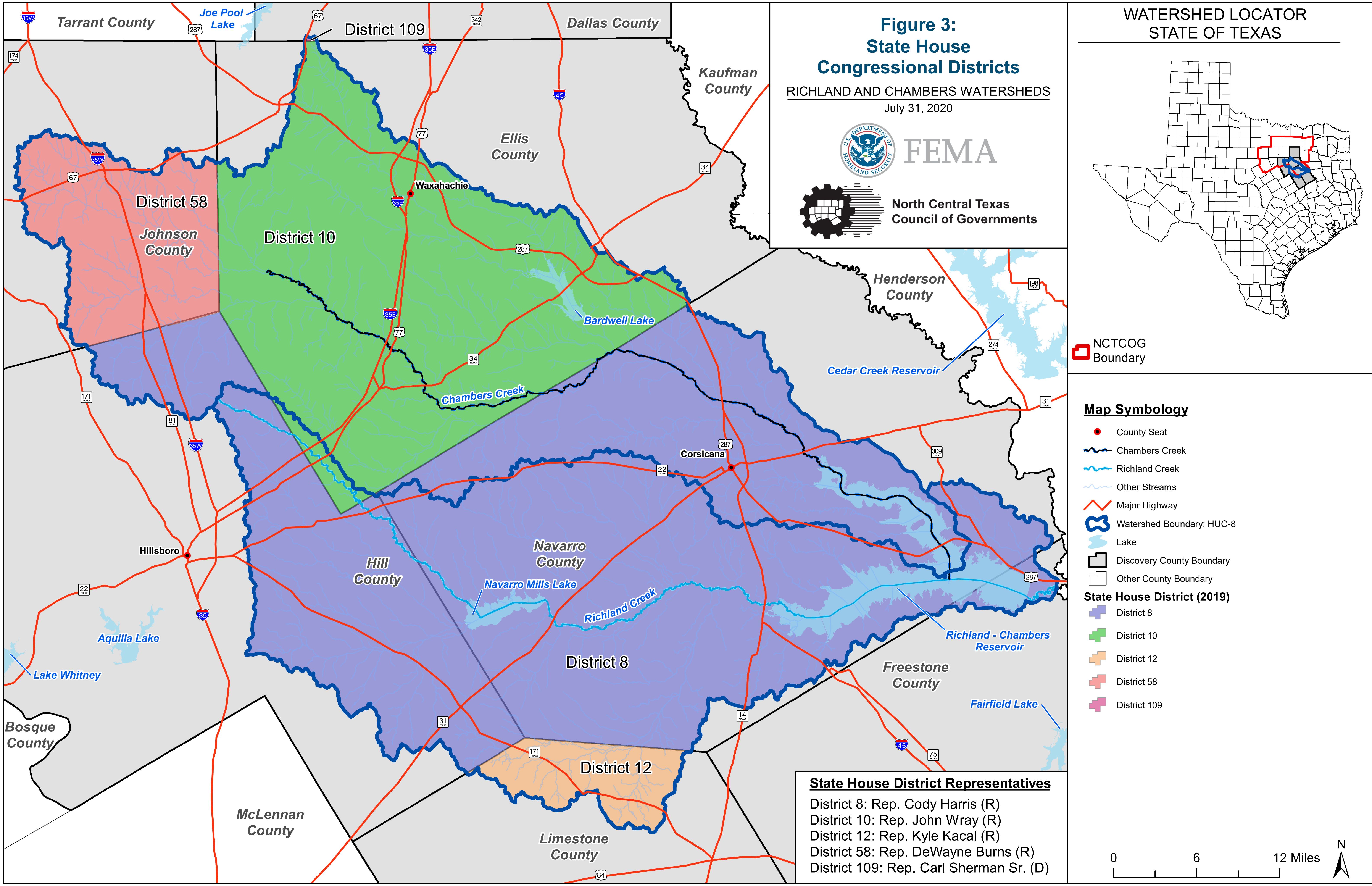


Figure 3:
State House
Congressional Districts
RICHLAND AND CHAMBERS WATERSHEDS
July 31, 2020
FEMA
North Central Texas
Council of Governments
WATERSHED LOCATOR
STATE OF TEXAS
NCTCOG
Boundary
Map Symbology
County Seat
Chambers Creek
Richland Creek
Other Streams
Major Highway
Watershed Boundary: HUC-8
Lake
Discovery County Boundary
Other County Boundary
State House District (2019)
District 8
District 10
District 12
District 58
District 109
State House District Representatives
District 8: Rep. Cody Harris (R)
District 10: Rep. John Wray (R)
District 12: Rep. Kyle Kacal (R)
District 58: Rep. DeWayne Burns (R)
District 109: Rep. Carl Sherman Sr. (D)
0
6
12 Miles
N
Tarrant County
Joe Pool
Lake
District 109
Dallas County
Kaufman
County
Ellis
County
Waxahachie
District 58
Johnson
County
District 10
Bardwell Lake
Henderson
County
Cedar Creek Reservoir
Chambers Creek
Corsicana
Hillsboro
Navarro
County
Hill
County
Navarro Mills Lake
Richland Creek
Richland - Chambers
Reservoir
Aquilla Lake
Lake Whitney
District 8
Freestone
County
Fairfield Lake
Bosque
County
District 12
McLennan
County
Limestone
County

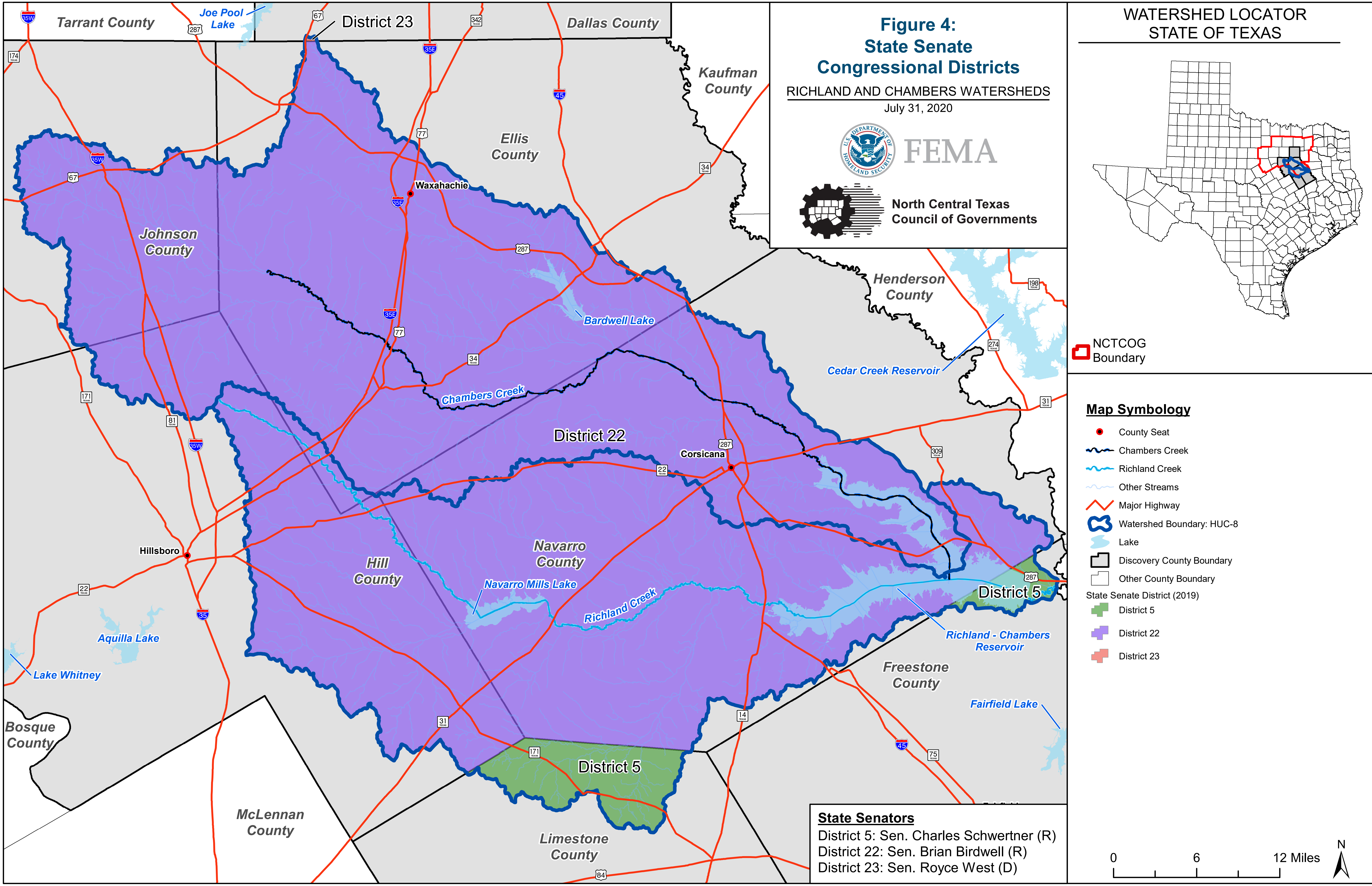


Figure 4:
State Senate
Congressional Districts
RICHLAND AND CHAMBERS WATERSHEDS
July 31, 2020
FEMA
North Central Texas
Council of Governments
WATERSHED LOCATOR
STATE OF TEXAS
NCTCOG
Boundary
Map Symbology
County Seat
Chambers Creek
Richland Creek
Other Streams
Major Highway
Watershed Boundary: HUC-8
Lake
Discovery County Boundary
Other County Boundary
State Senate District (2019)
District 5
District 22
District 23
State Senators
District 5: Sen. Charles Schwertner (R)
District 22: Sen. Brian Birdwell (R)
District 23: Sen. Royce West (D)
0
6
12 Miles
N
Tarrant County
Joe Pool
Lake
District 23
Dallas County
Kaufman
County
Ellis
County
Waxahachie
Johnson
County
Bardwell Lake
Henderson
County
Cedar Creek Reservoir
Chambers Creek
District 22
Corsicana
Hillsboro
Navarro
County
Hill
County
Navarro Mills Lake
Richland Creek
District 5
Richland - Chambers
Reservoir
Aquilla Lake
Lake Whitney
Freestone
County
Fairfield Lake
Bosque
County
District 5
McLennan
County
Limestone
County

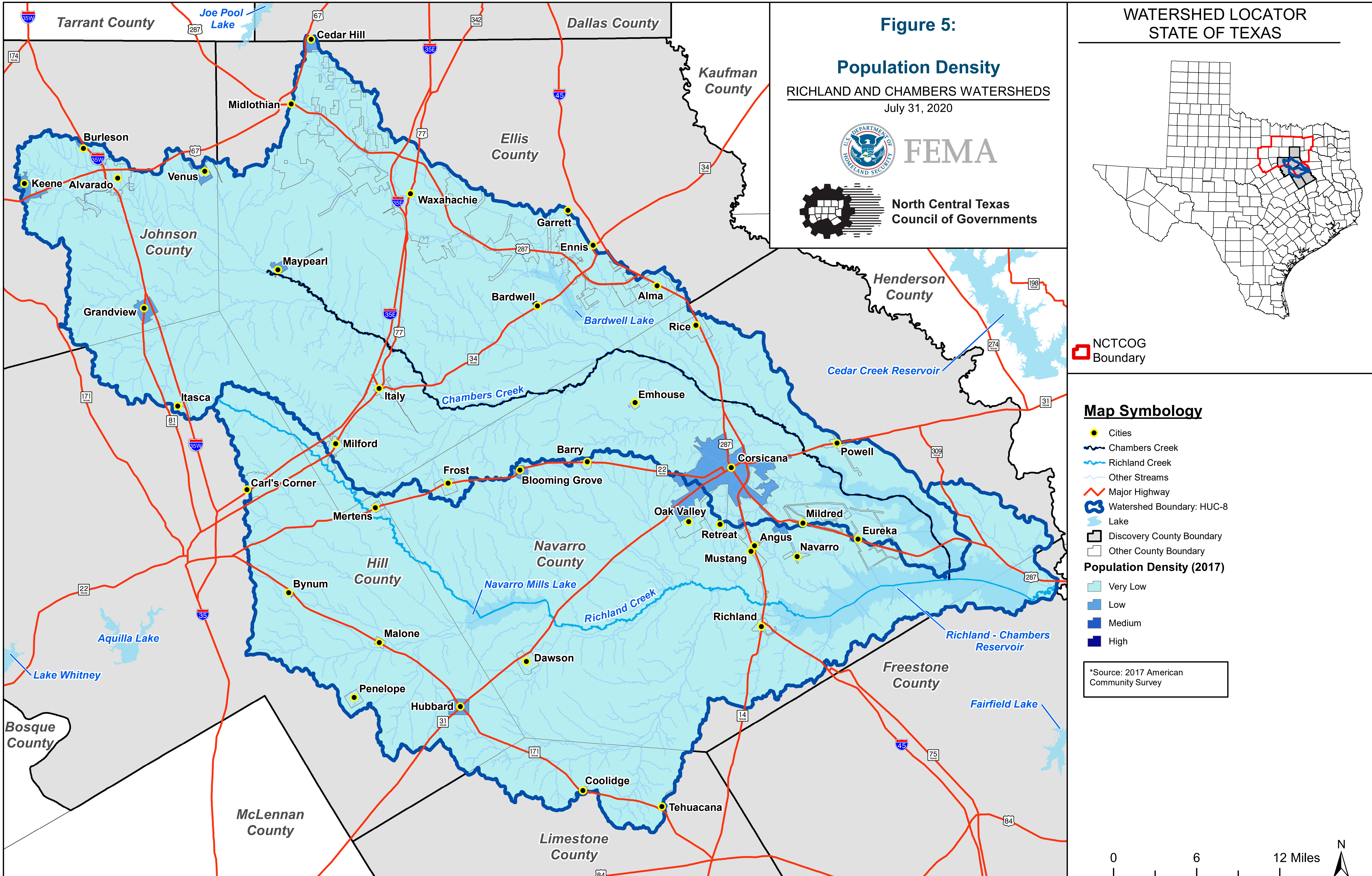


Figure 5:
Population Density
RICHLAND AND CHAMBERS WATERSHEDS
July 31, 2020
FEMA
North Central Texas Council of Governments
WATERSHED LOCATOR STATE OF TEXAS
NCTCOG Boundary
Map Symbology
Cities
Chambers Creek
Richland Creek
Other Streams
Major Highway
Watershed Boundary: HUC-8
Lake
Discovery County Boundary
Other County Boundary
Population Density (2017)
Very Low
Low
Medium
High
*Source: 2017 American Community Survey
0
6
12 Miles
N
Tarrant County
Joe Pool Lake
Dallas County
Kaufman County
Ellis County
Johnson County
Henderson County
Navarro County
Hill County
Freestone County
Limestone County
McLennan County
Bosque County
Cedar Hill
Midlothian
Burleson
Keene
Alvarado
Venus
Waxahachie
Garrett
Ennis
Maypearl
Bardwell
Alma
Bardwell Lake
Rice
Grandview
Cedar Creek Reservoir
Emhouse
Italy
Chambers Creek
Itasca
Milford
Barry
Powell
Corsicana
Frost
Blooming Grove
Carl's Corner
Mertens
Oak Valley
Mildred
Retreat
Eureka
Angus
Navarro
Mustang
Bynum
Navarro Mills Lake
Richland Creek
Richland
Richland - Chambers Reservoir
Malone
Aquilla Lake
Lake Whitney
Dawson
Penelope
Hubbard
Fairfield Lake
Coolidge
Tehuacana

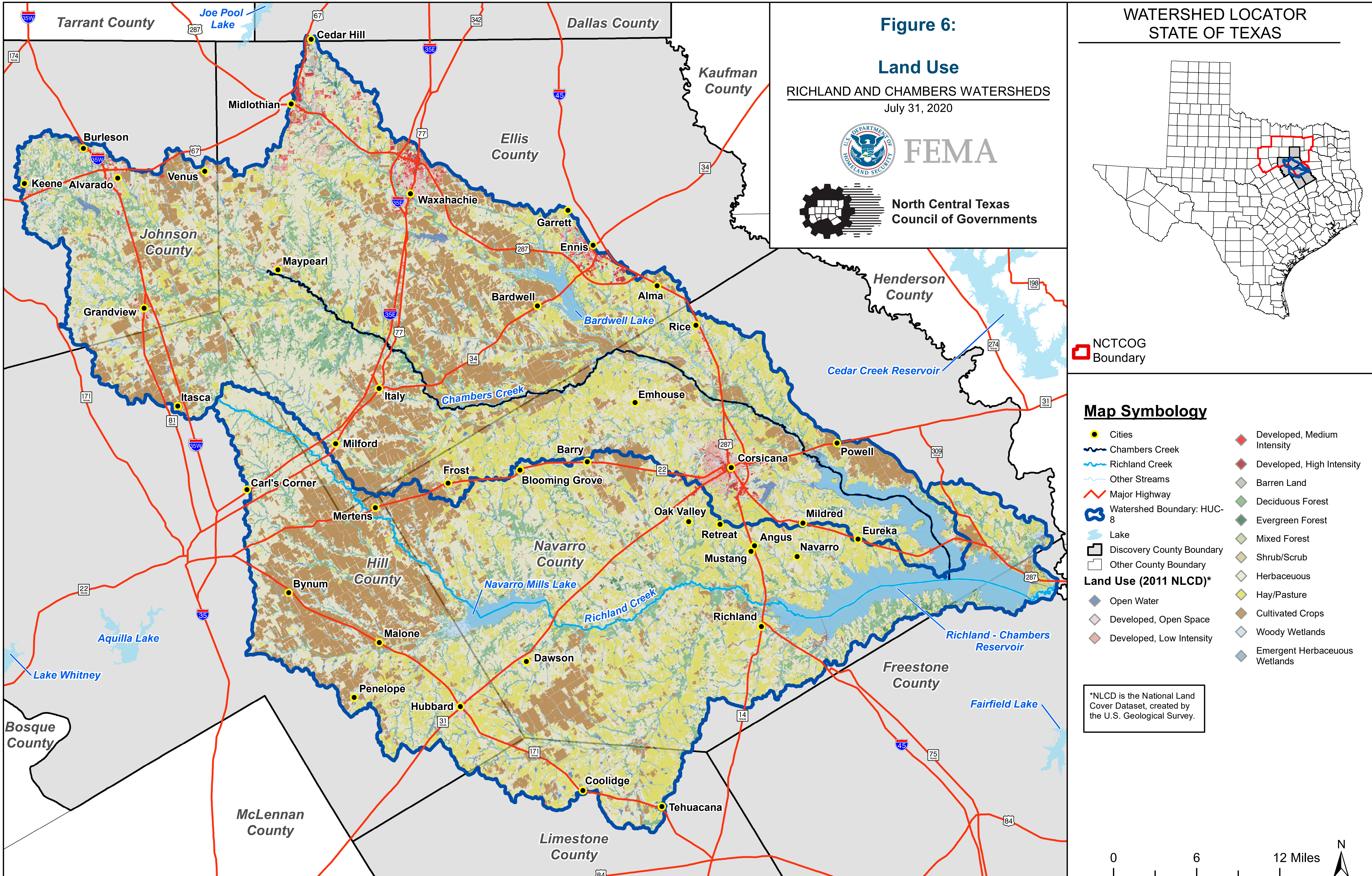


Figure 6:

Land Use

RICHLAND AND CHAMBERS WATERSHEDS

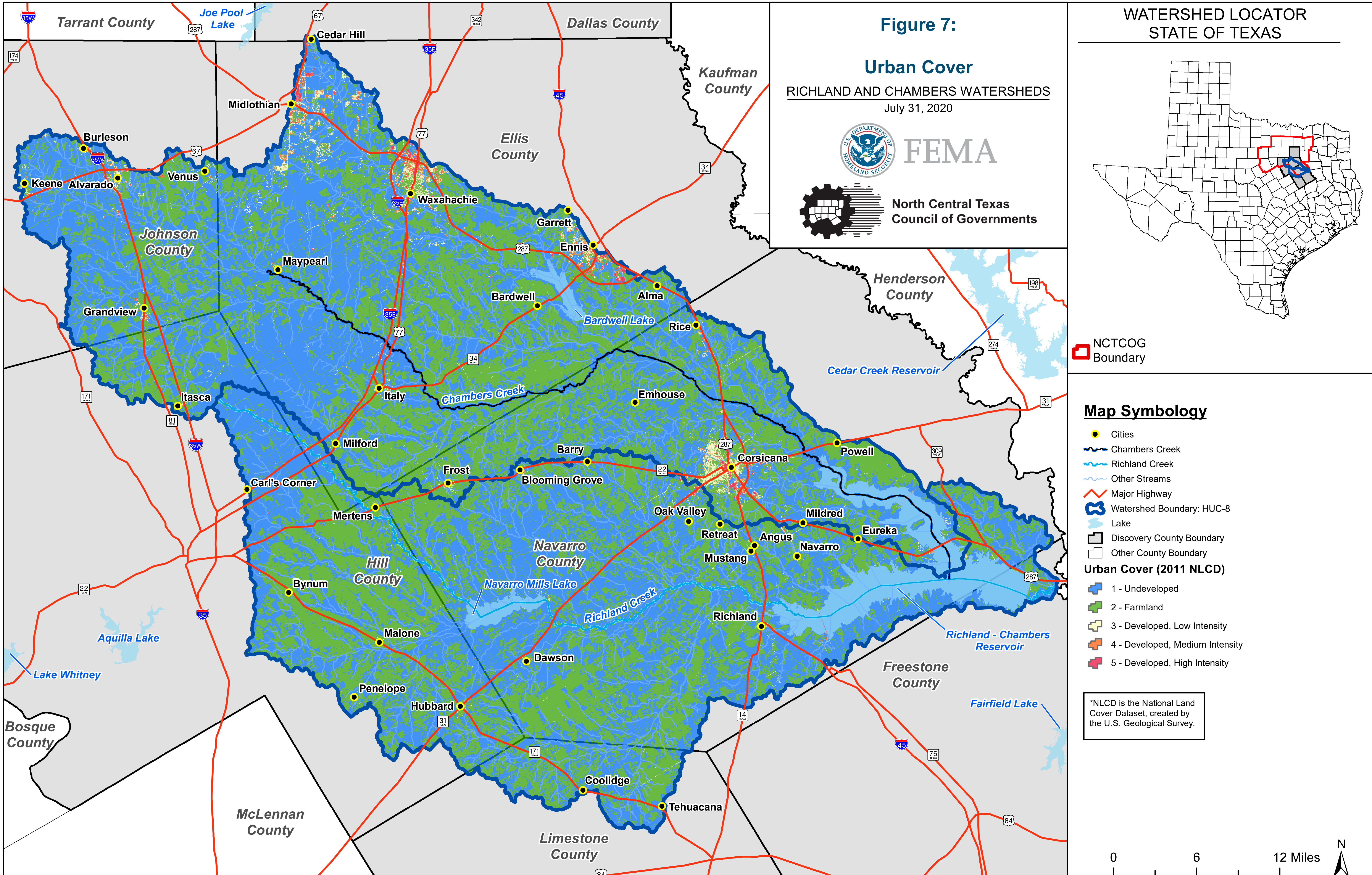
July 31, 2020

Figure 7:

Urban Cover

RICHLAND AND CHAMBERS WATERSHEDS

July 31, 2020



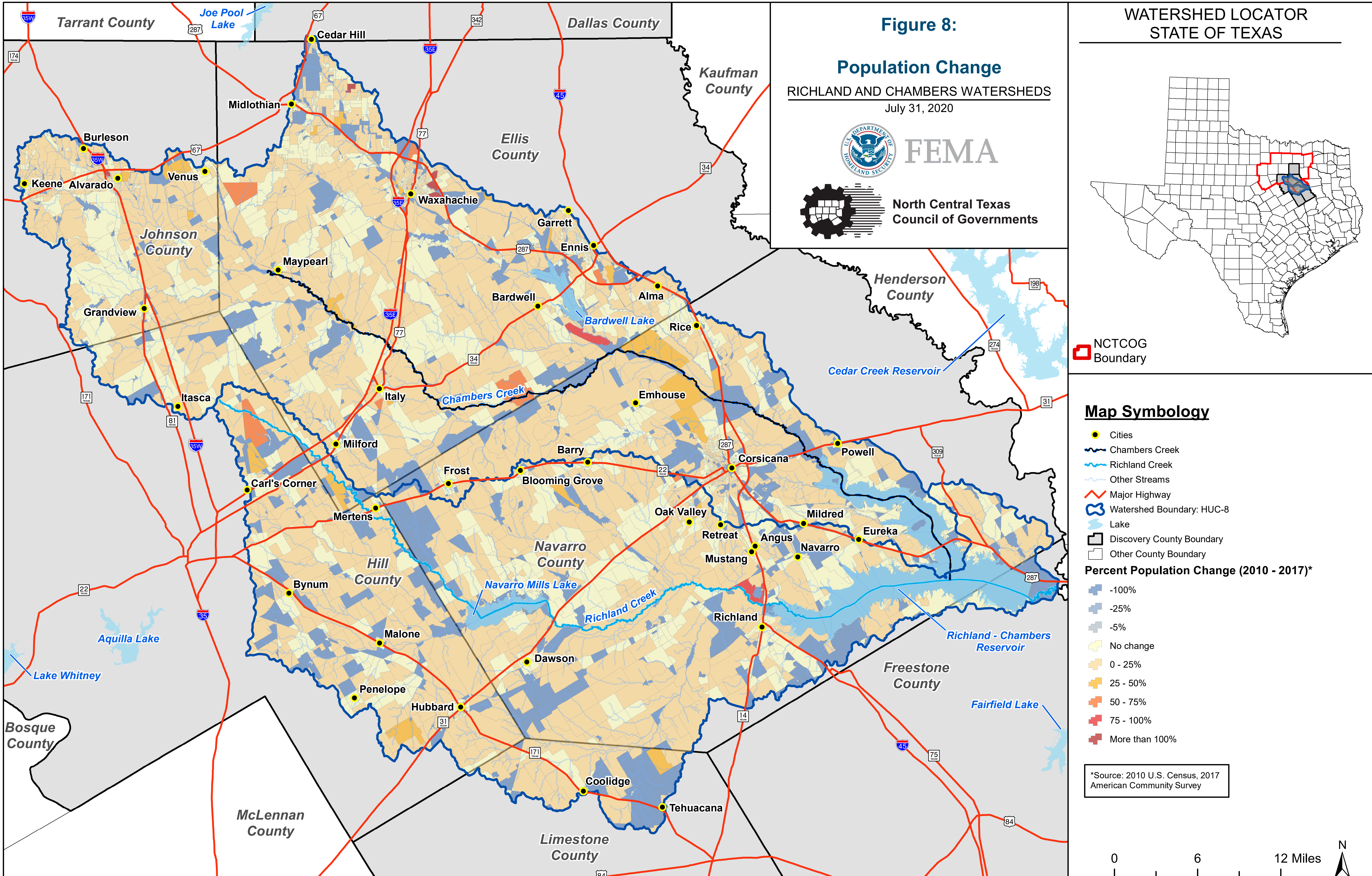


Figure 8:
Population Change
RICHLAND AND CHAMBERS WATERSHEDS
July 31, 2020
FEMA
North Central Texas Council of Governments
WATERSHED LOCATOR STATE OF TEXAS
NCTCOG Boundary
Map Symbology
Cities
Chambers Creek
Richland Creek
Other Streams
Major Highway
Watershed Boundary: HUC-8
Lake
Discovery County Boundary
Other County Boundary
Percent Population Change (2010 - 2017)*
-100%
-25%
-5%
No change
0 - 25%
25 - 50%
50 - 75%
75 - 100%
More than 100%
*Source: 2010 U.S. Census, 2017 American Community Survey
0
6
12 Miles
N
Tarrant County
Dallas County
Kaufman County
Ellis County
Johnson County
Henderson County
Navarro County
Hill County
Freestone County
Limestone County
McLennan County
Bosque County
Joe Pool Lake
Bardwell Lake
Cedar Creek Reservoir
Navarro Mills Lake
Richland - Chambers Reservoir
Aquilla Lake
Lake Whitney
Fairfield Lake
Chambers Creek
Richland Creek
Cedar Hill
Midlothian
Burleson
Keene
Alvarado
Venus
Waxahachie
Garrett
Ennis
Maypearl
Bardwell
Alma
Rice
Grandview
Italy
Itasca
Emhouse
Milford
Barry
Corsicana
Powell
Frost
Blooming Grove
Carl's Corner
Mertens
Oak Valley
Retreat
Mildred
Angus
Eureka
Mustang
Navarro
Bynum
Richland
Malone
Dawson
Penelope
Hubbard
Coolidge
Tehuacana

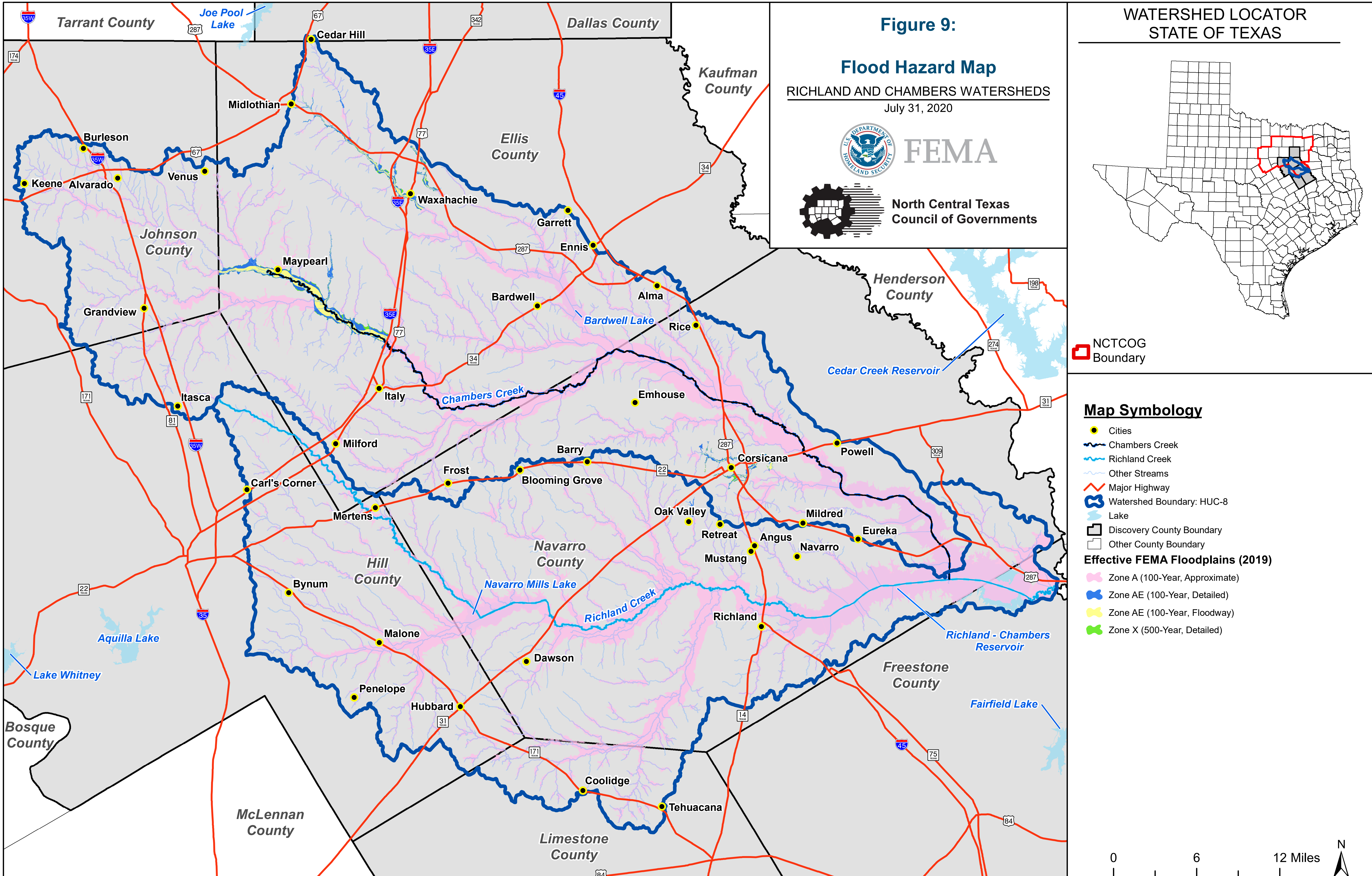


Figure 9:
Flood Hazard Map
RICHLAND AND CHAMBERS WATERSHEDS
July 31, 2020
FEMA
North Central Texas
Council of Governments
WATERSHED LOCATOR
STATE OF TEXAS
NCTCOG Boundary
Map Symbology
Cities
Chambers Creek
Richland Creek
Other Streams
Major Highway
Watershed Boundary: HUC-8
Lake
Discovery County Boundary
Other County Boundary
Effective FEMA Floodplains (2019)
Zone A (100-Year, Approximate)
Zone AE (100-Year, Detailed)
Zone AE (100-Year, Floodway)
Zone X (500-Year, Detailed)
0
6
12 Miles
N
Tarrant County
Dallas County
Kaufman County
Ellis County
Johnson County
Henderson County
Navarro County
Hill County
Freestone County
Limestone County
McLennan County
Bosque County
Joe Pool Lake
Bardwell Lake
Cedar Creek Reservoir
Chambers Creek
Richland Creek
Navarro Mills Lake
Richland - Chambers Reservoir
Aquilla Lake
Lake Whitney
Fairfield Lake
Cedar Hill
Midlothian
Burleson
Keene
Alvarado
Venus
Waxahachie
Garrett
Ennis
Maypearl
Alma
Bardwell
Grandview
Rice
Italy
Itasca
Emhouse
Milford
Powell
Barry
Corsicana
Frost
Blooming Grove
Carl's Corner
Mertens
Oak Valley
Mildred
Retreat
Eureka
Angus
Navarro
Mustang
Bynum
Richland
Malone
Dawson
Penelope
Hubbard
Coolidge
Tehuacana

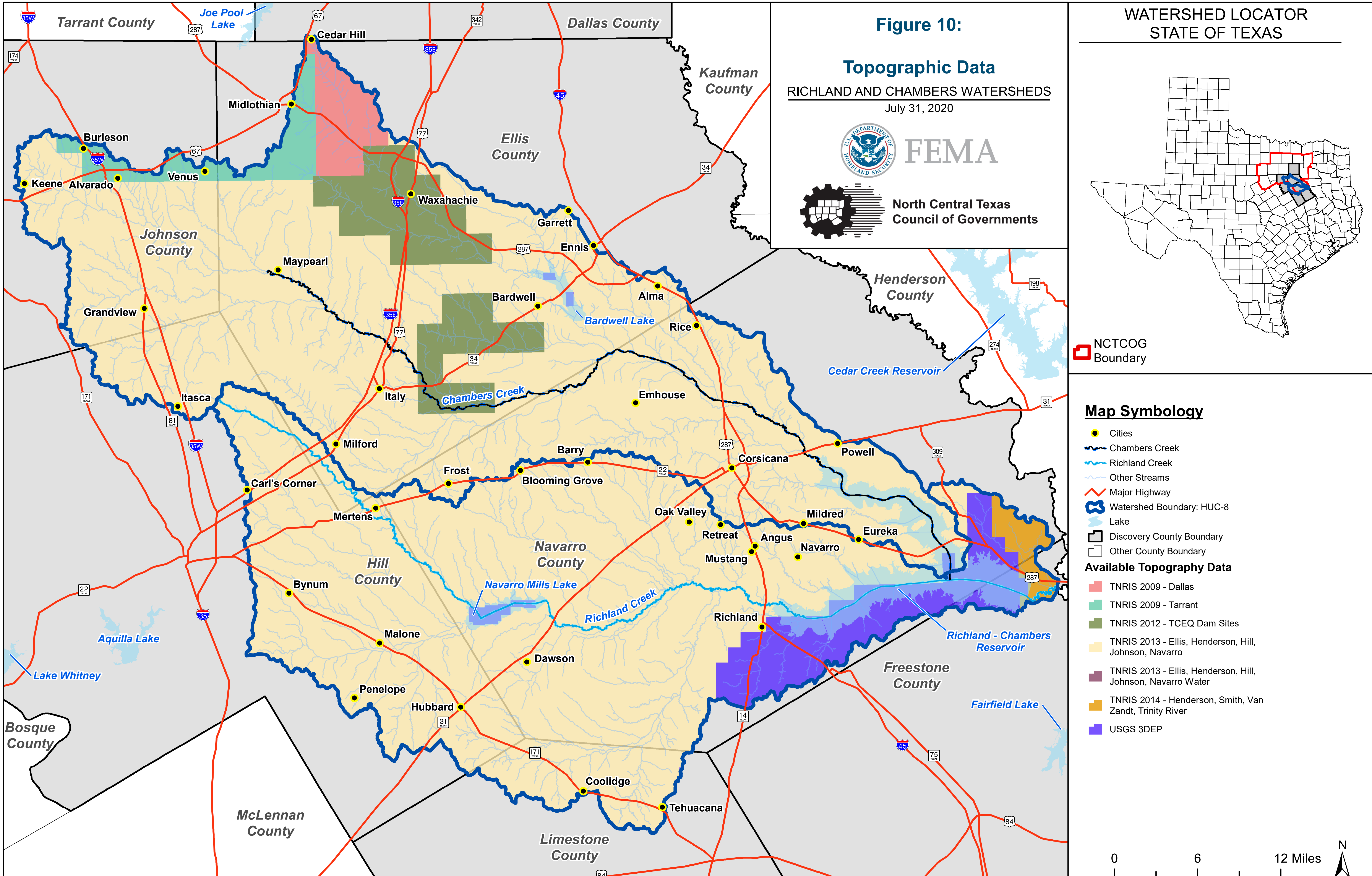


Figure 10:
Topographic Data
RICHLAND AND CHAMBERS WATERSHEDS
July 31, 2020
FEMA
North Central Texas Council of Governments
WATERSHED LOCATOR STATE OF TEXAS
NCTCOG Boundary
Map Symbology
Cities
Chambers Creek
Richland Creek
Other Streams
Major Highway
Watershed Boundary: HUC-8
Lake
Discovery County Boundary
Other County Boundary
Available Topography Data
TNRIS 2009 - Dallas
TNRIS 2009 - Tarrant
TNRIS 2012 - TCEQ Dam Sites
TNRIS 2013 - Ellis, Henderson, Hill, Johnson, Navarro
TNRIS 2013 - Ellis, Henderson, Hill, Johnson, Navarro Water
TNRIS 2014 - Henderson, Smith, Van Zandt, Trinity River
USGS 3DEP
0
6
12 Miles
N
Tarrant County
Dallas County
Kaufman County
Ellis County
Johnson County
Henderson County
Navarro County
Hill County
Freestone County
Bosque County
McLennan County
Limestone County
Joe Pool Lake
Bardwell Lake
Cedar Creek Reservoir
Navarro Mills Lake
Richland - Chambers Reservoir
Aquilla Lake
Lake Whitney
Fairfield Lake
Chambers Creek
Richland Creek
Cedar Hill
Midlothian
Burleson
Keene
Alvarado
Venus
Waxahachie
Garrett
Ennis
Maypearl
Alma
Bardwell
Rice
Grandview
Itasca
Italy
Emhouse
Milford
Barry
Frost
Blooming Grove
Corsicana
Powell
Carl's Corner
Mertens
Oak Valley
Retreat
Mildred
Eureka
Angus
Navarro
Mustang
Bynum
Malone
Richland
Dawson
Penelope
Hubbard
Coolidge
Tehuacana

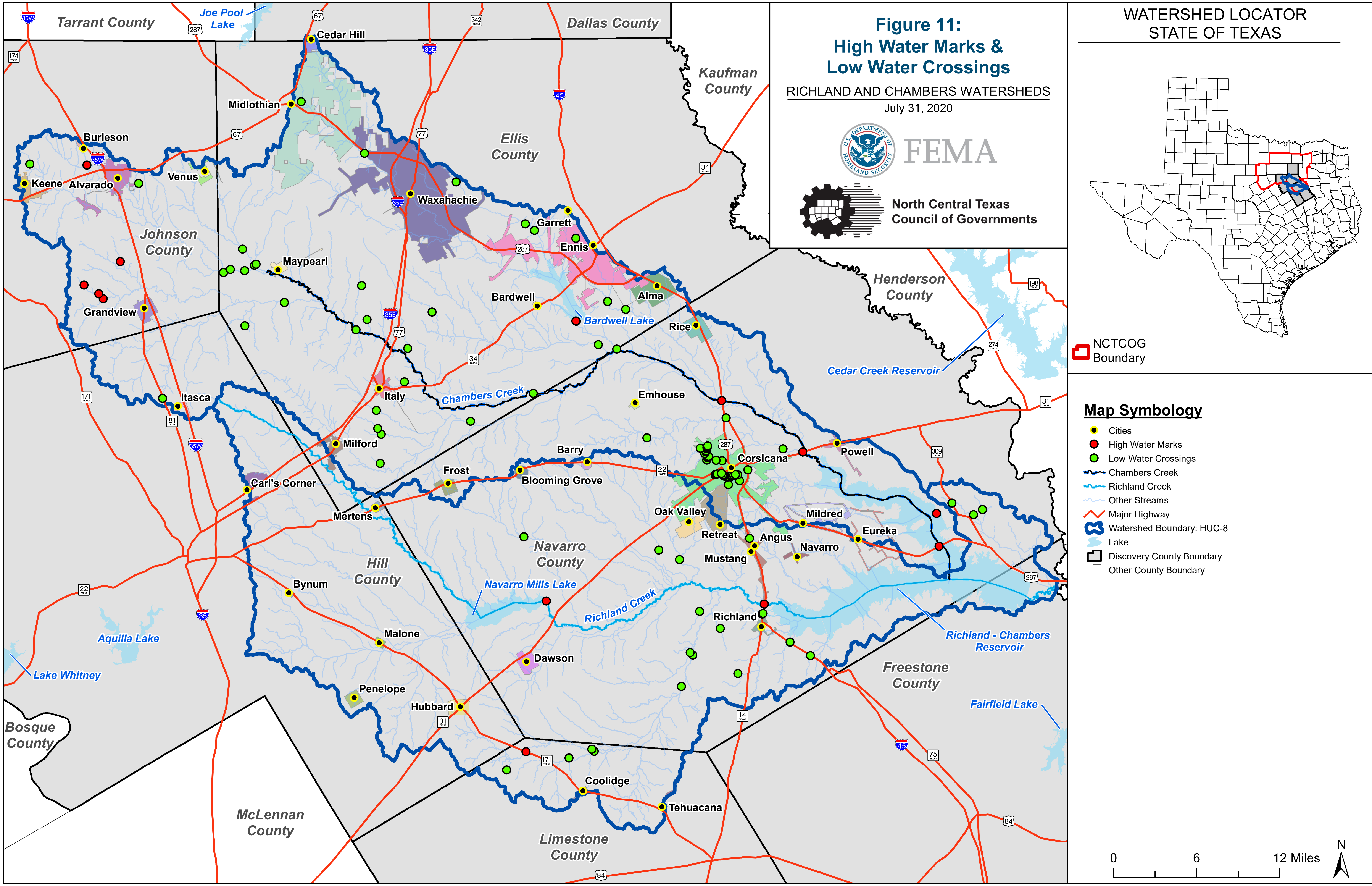


Figure 11:
High Water Marks &
Low Water Crossings
RICHLAND AND CHAMBERS WATERSHEDS
July 31, 2020
FEMA
North Central Texas
Council of Governments
WATERSHED LOCATOR
STATE OF TEXAS
NCTCOG
Boundary
Map Symbology
Cities
High Water Marks
Low Water Crossings
Chambers Creek
Richland Creek
Other Streams
Major Highway
Watershed Boundary: HUC-8
Lake
Discovery County Boundary
Other County Boundary
0
6
12 Miles
N
Tarrant County
Joe Pool
Lake
Dallas County
Kaufman
County
Ellis
County
Johnson
County
Henderson
County
Navarro
County
Hill
County
Freestone
County
Bosque
County
McLennan
County
Limestone
County
Cedar Hill
Midlothian
Burleson
Keene
Alvarado
Venus
Waxahachie
Garrett
Ennis
Maypearl
Bardwell
Alma
Bardwell Lake
Rice
Grandview
Itasca
Italy
Chambers Creek
Emhouse
Milford
Barry
Frost
Blooming Grove
Corsicana
Powell
Carl's Corner
Mertens
Oak Valley
Retreat
Mildred
Eureka
Angus
Navarro
Mustang
Bynum
Navarro Mills Lake
Richland Creek
Richland
Richland - Chambers
Reservoir
Malone
Dawson
Aquilla Lake
Lake Whitney
Penelope
Hubbard
Coolidge
Tehuacana
Cedar Creek Reservoir
Fairfield Lake

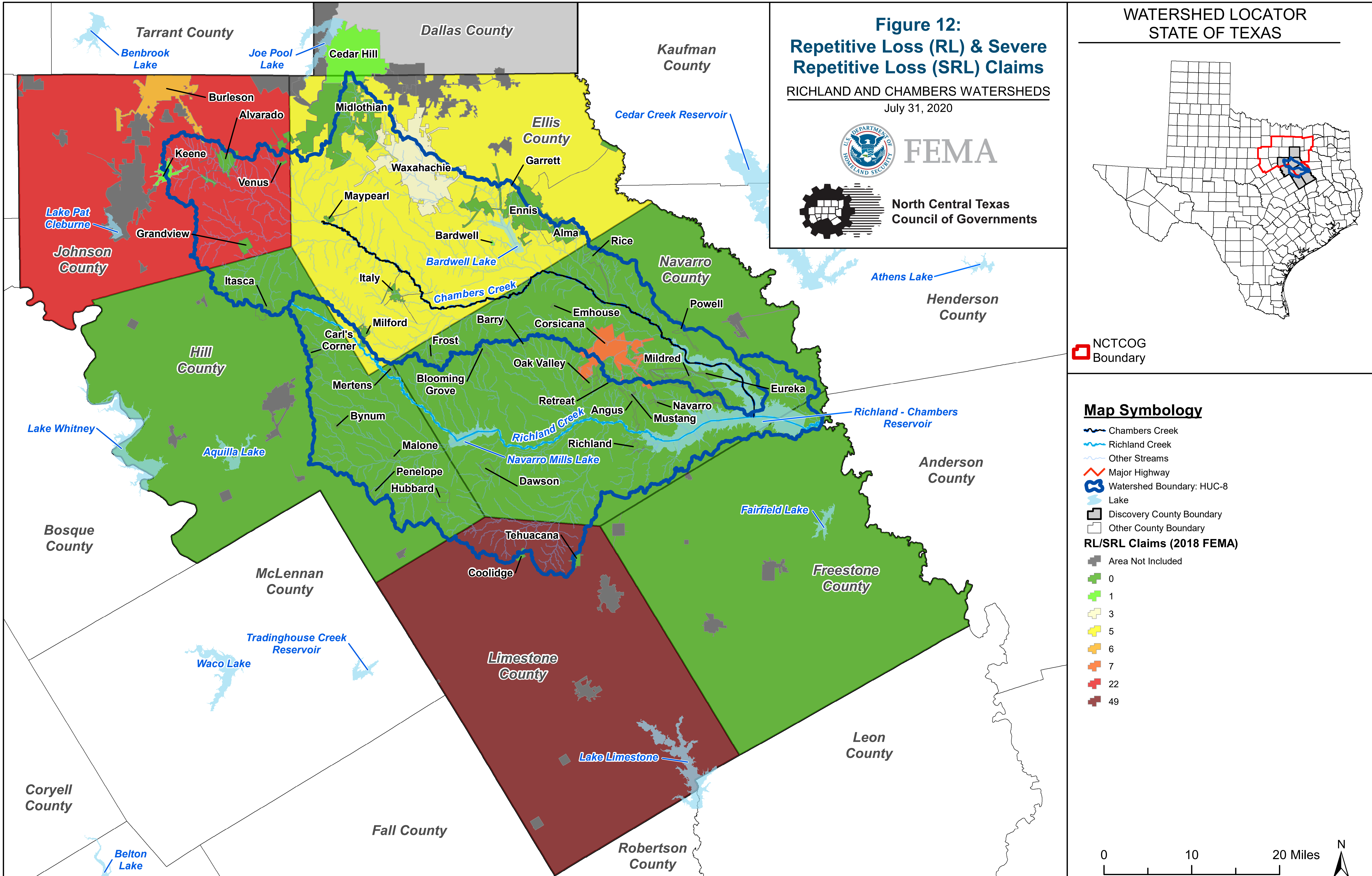


Figure 12: Repetitive Loss (RL) & Severe Repetitive Loss (SRL) Claims

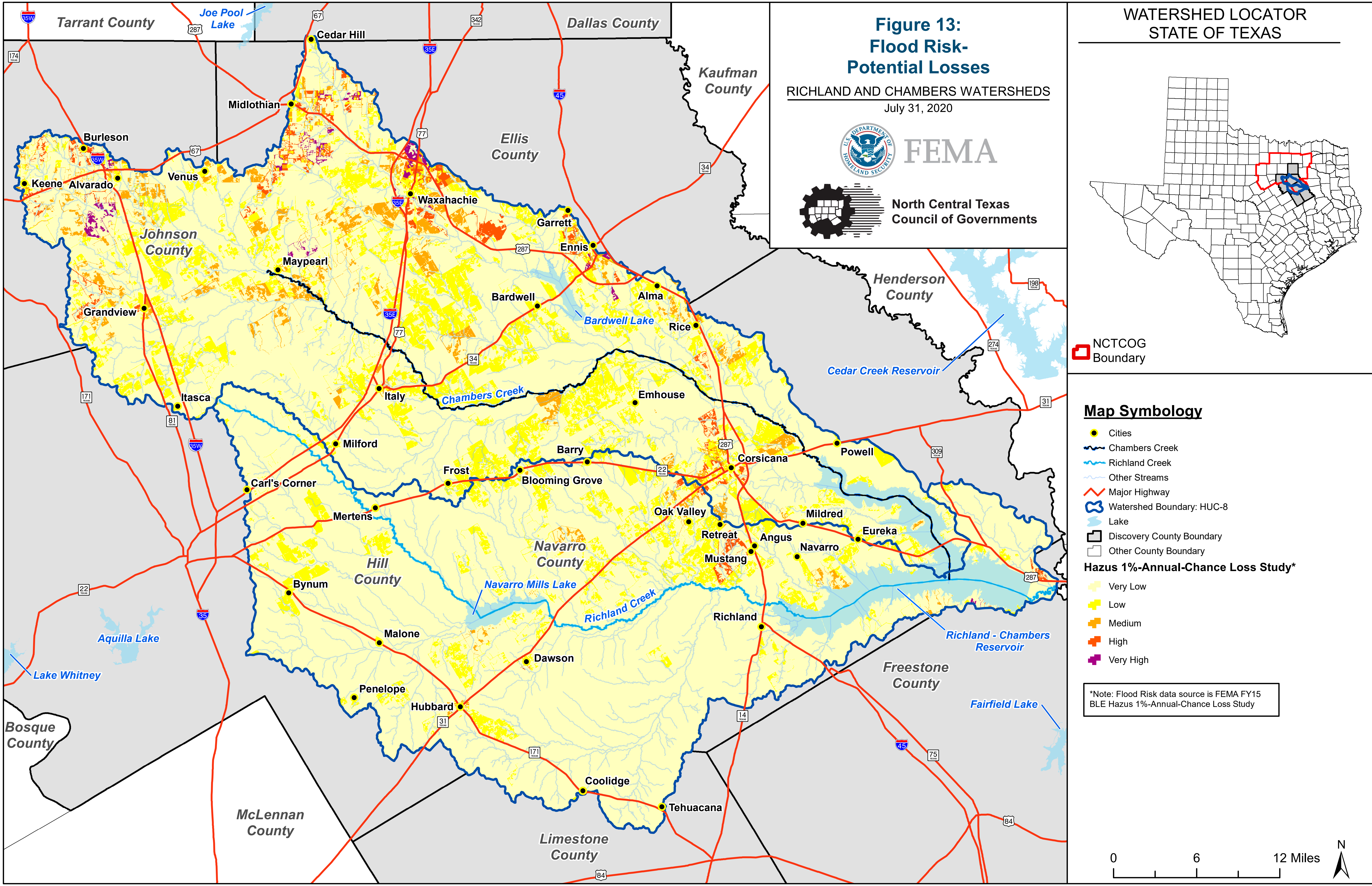


Figure 13: Flood Risk- Potential Losses

RICHLAND AND CHAMBERS WATERSHEDS

July 31, 2020

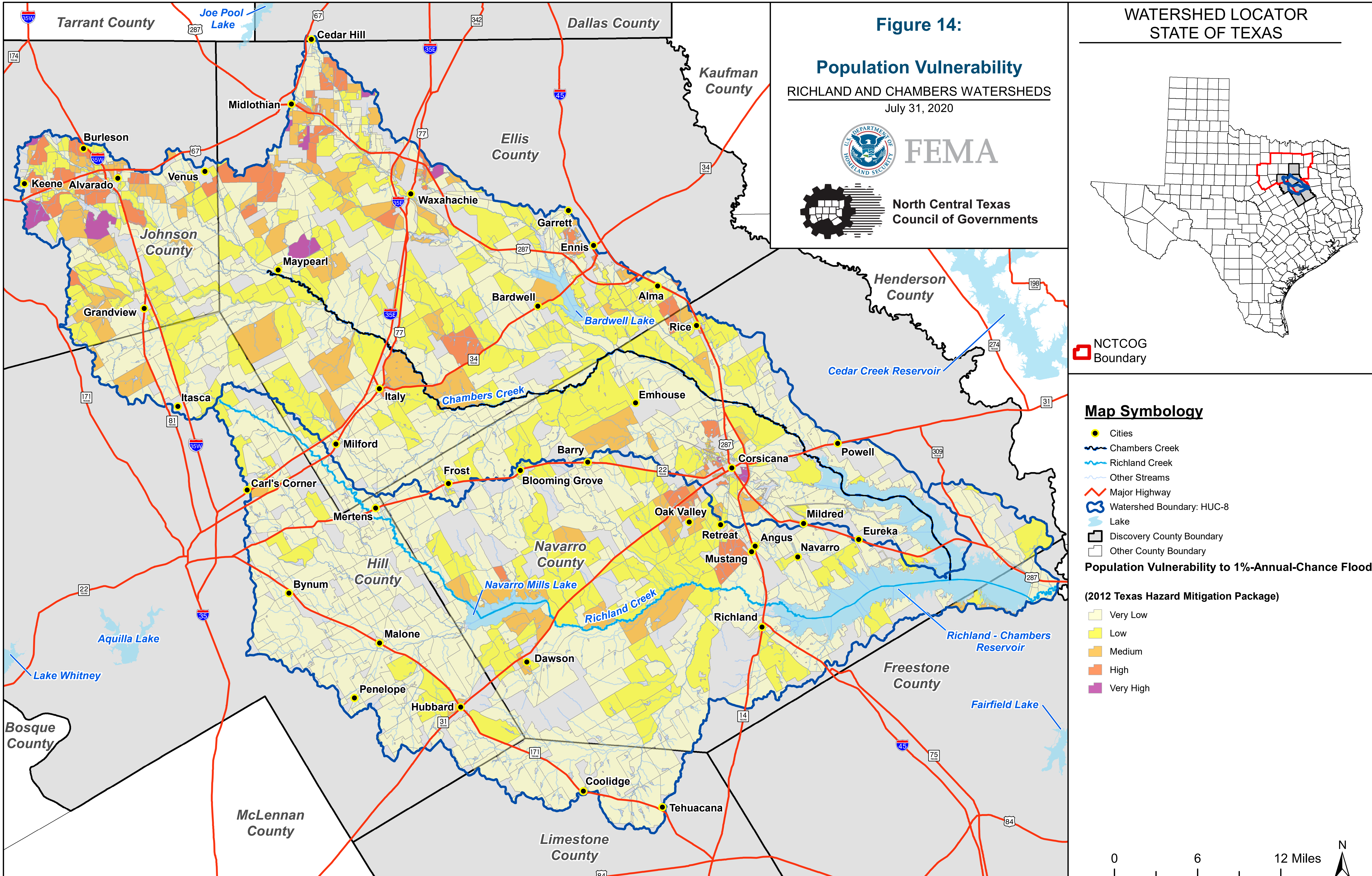


Figure 14:

Population Vulnerability

RICHLAND AND CHAMBERS WATERSHEDS

July 31, 2020

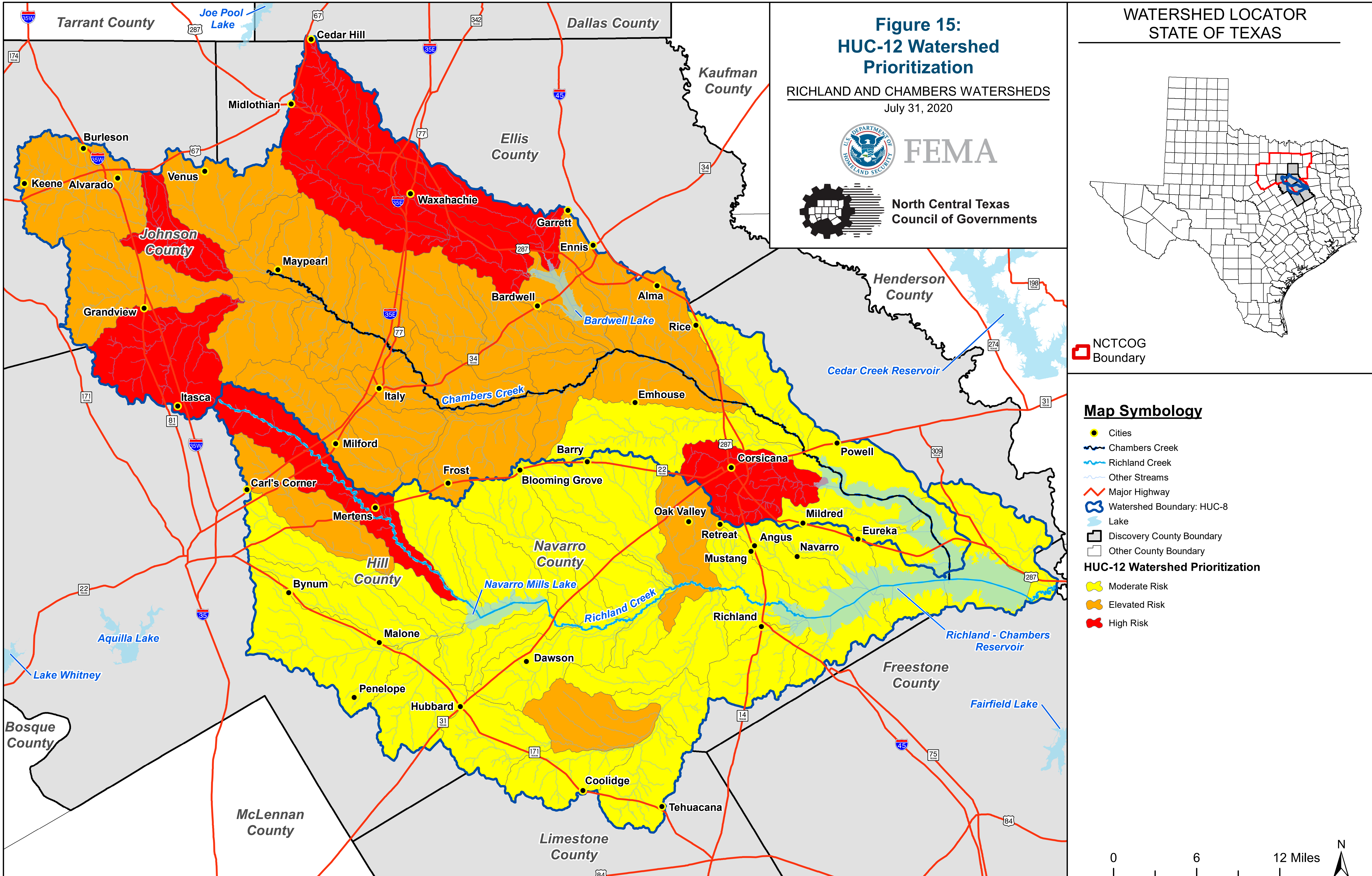


Figure 15:
HUC-12 Watershed Prioritization
RICHLAND AND CHAMBERS WATERSHEDS
July 31, 2020
FEMA
North Central Texas
Council of Governments
WATERSHED LOCATOR
STATE OF TEXAS
NCTCOG
Boundary
Map Symbology
Cities
Chambers Creek
Richland Creek
Other Streams
Major Highway
Watershed Boundary: HUC-8
Lake
Discovery County Boundary
Other County Boundary
HUC-12 Watershed Prioritization
Moderate Risk
Elevated Risk
High Risk
0
6
12 Miles
N
Tarrant County
Joe Pool
Lake
Dallas County
Kaufman
County
Ellis
County
Johnson
County
Henderson
County
Navarro
County
Hill
County
Freestone
County
Limestone
County
McLennan
County
Bosque
County
Cedar Hill
Midlothian
Burleson
Keene
Alvarado
Venus
Waxahachie
Garrett
Ennis
Maypearl
Bardwell
Alma
Rice
Grandview
Itasca
Italy
Emhouse
Milford
Barry
Frost
Blooming Grove
Corsicana
Powell
Carl's Corner
Mertens
Oak Valley
Mildred
Retreat
Angus
Eureka
Navarro
Mustang
Bynum
Richland
Malone
Dawson
Penelope
Hubbard
Coolidge
Tehuacana
Bardwell Lake
Cedar Creek Reservoir
Chambers Creek
Navarro Mills Lake
Richland Creek
Richland - Chambers
Reservoir
Aquilla Lake
Lake Whitney
Fairfield Lake

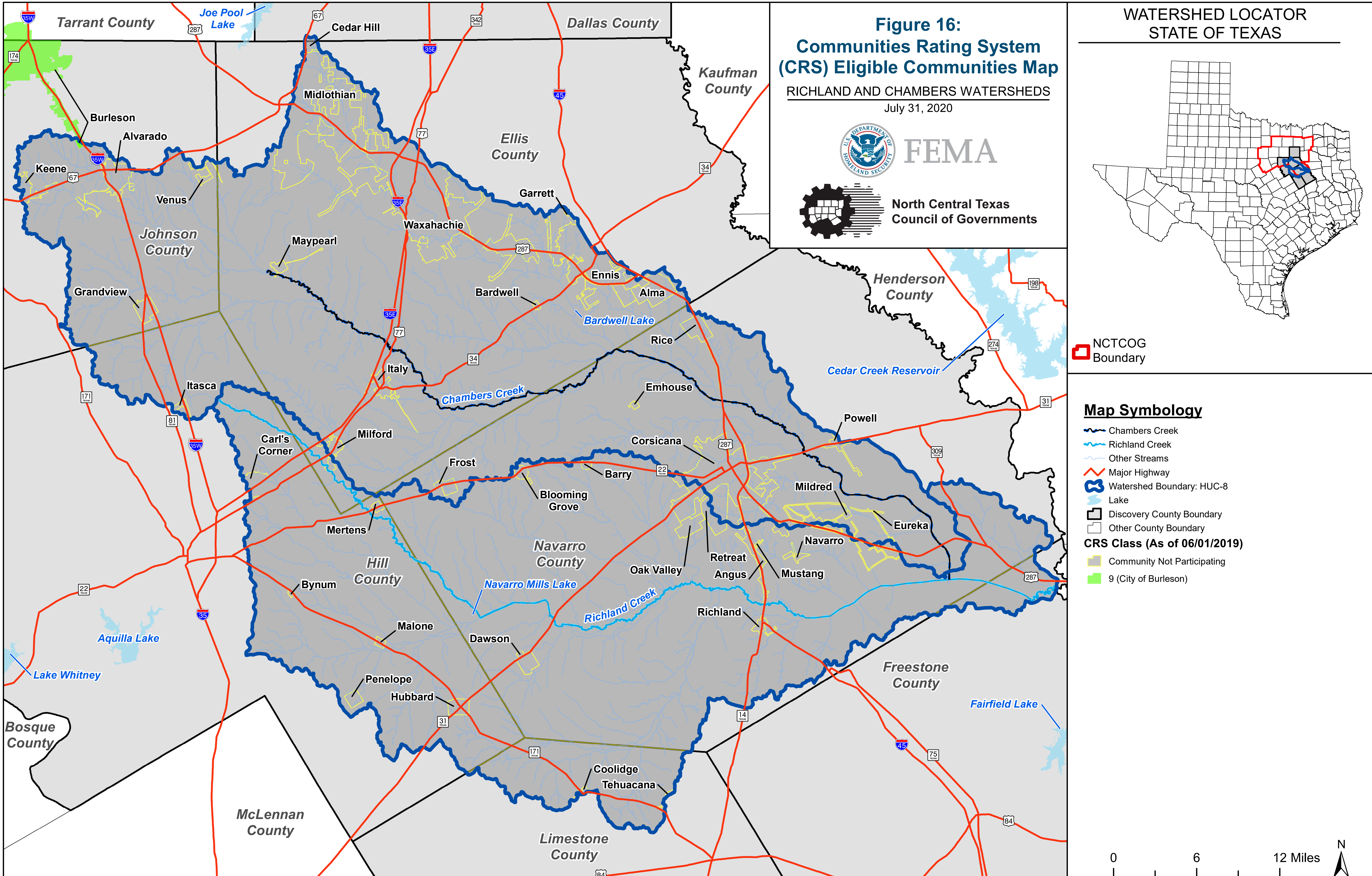


Figure 16: Communities Rating System (CRS) Eligible Communities Map

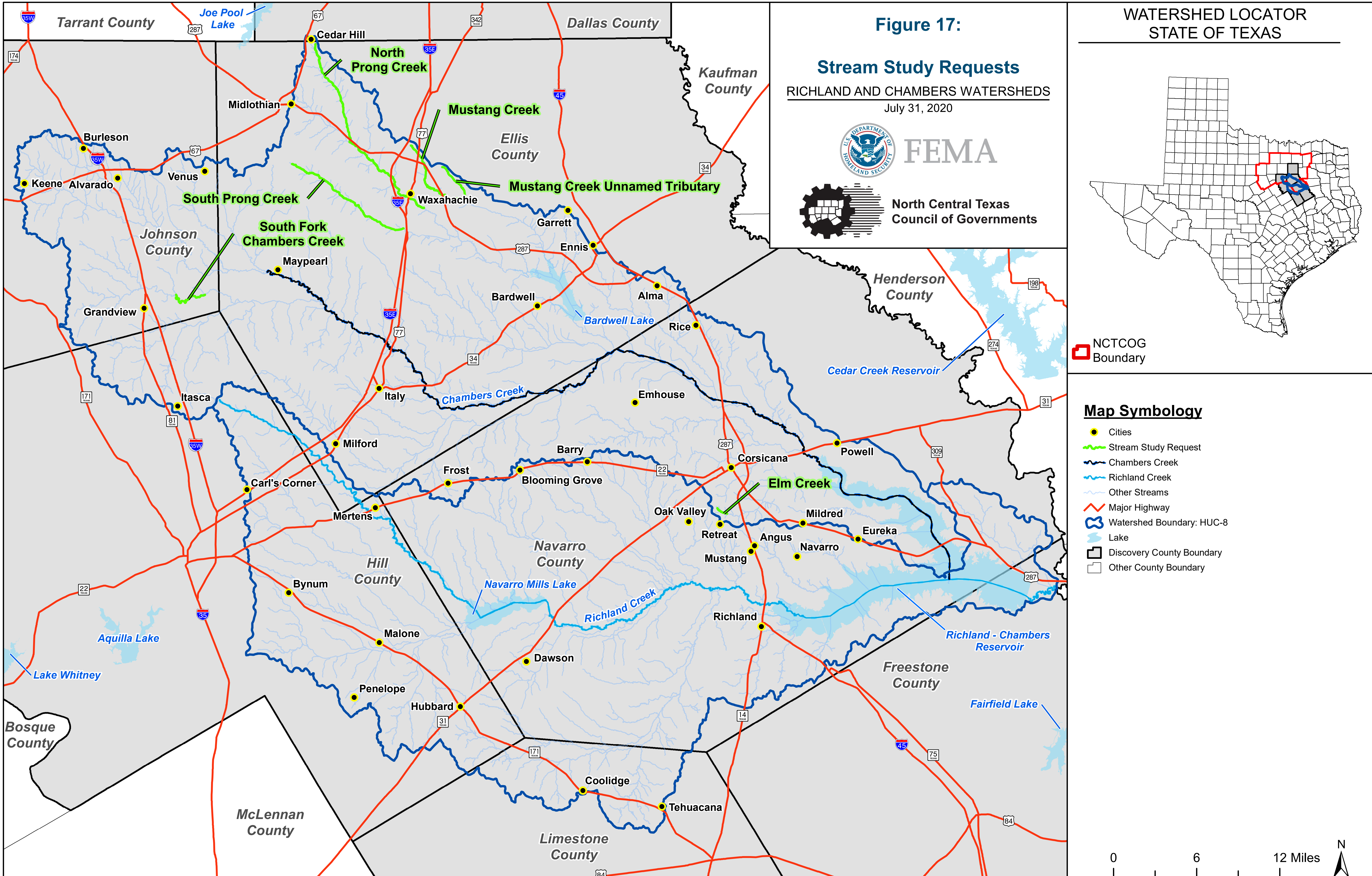


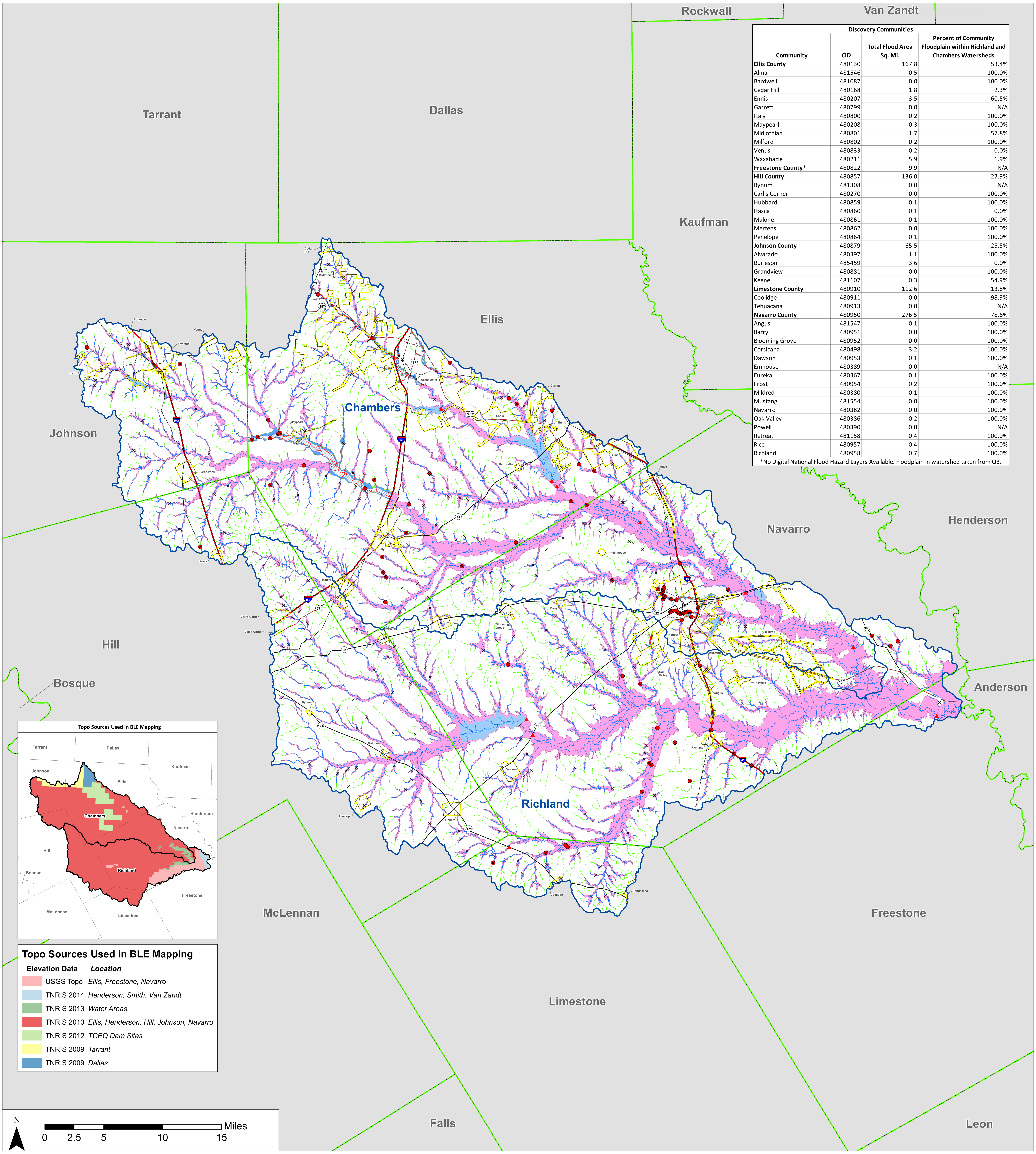
Figure 17:

Stream Study Requests

RICHLAND AND CHAMBERS WATERSHEDS

July 31, 2020

Figure 18: Pre-Discovery Map



Discovery Communities			
Community	CID	Total Flood Area Sq. Mi.	Percent of Community Floodplain within Richland and Chambers Watersheds
Ellis County	480130	167.8	53.4%
Alma	481546	0.5	100.0%
Bardwell	481087	0.0	100.0%
Cedar Hill	480168	1.8	2.3%
Ennis	480207	3.5	60.5%
Garrett	480799	0.0	N/A
Italy	480800	0.2	100.0%
Maypearl	480208	0.3	100.0%
Midlothian	480801	1.7	57.8%
Milford	480802	0.2	100.0%
Venus	480833	0.2	0.0%
Waxahacie	480211	5.9	1.9%
Freestone County*	480822	9.9	N/A
Hill County	480857	136.0	27.9%
Bynum	481308	0.0	N/A
Carl's Corner	480270	0.0	100.0%
Hubbard	480859	0.1	100.0%
Itasca	480860	0.1	0.0%
Malone	480861	0.1	100.0%
Mertens	480862	0.0	100.0%
Penelope	480864	0.1	100.0%
Johnson County	480879	65.5	25.5%
Alvarado	480397	1.1	100.0%
Burleson	485459	3.6	0.0%
Grandview	480881	0.0	100.0%
Keene	481107	0.3	54.9%
Limestone County	480910	112.6	13.8%
Coolidge	480911	0.0	98.9%
Tehuacana	480913	0.0	N/A
Navarro County	480950	276.5	78.6%
Angus	481547	0.1	100.0%
Barry	480951	0.0	100.0%
Blooming Grove	480952	0.0	100.0%
Corsicana	480498	3.2	100.0%
Dawson	480953	0.1	100.0%
Emhouse	480389	0.0	N/A
Eureka	480367	0.1	100.0%
Frost	480954	0.2	100.0%
Mildred	480380	0.1	100.0%
Mustang	481554	0.0	100.0%
Navarro	480382	0.0	100.0%
Oak Valley	480386	0.2	100.0%
Powell	480390	0.0	N/A
Retreat	481158	0.4	100.0%
Rice	480957	0.4	100.0%
Richland	480958	0.7	100.0%

*No Digital National Flood Hazard Layers Available. Floodplain in watershed taken from Q3.

Topo Sources Used in BLE Mapping

Elevation Data	Location
USGS Topo	*Ellis, Freestone, Navarro*
TNRIS 2014	*Henderson, Smith, Van Zandt*
TNRIS 2013	*Water Areas*
TNRIS 2013	*Ellis, Henderson, Hill, Johnson, Navarro*
TNRIS 2012	*TCEQ Dam Sites*
TNRIS 2009	*Tarrant*
TNRIS 2009	*Dallas*

Map Symbology

- USGS Gage
- Low Water Mark
- Dam
- Lake
- City Boundary
- County Boundary
- Watershed Boundary

Transportation

- Interstate Highway
- US Highway
- State Highway
- Railroad

Effective FEMA Floodplains*

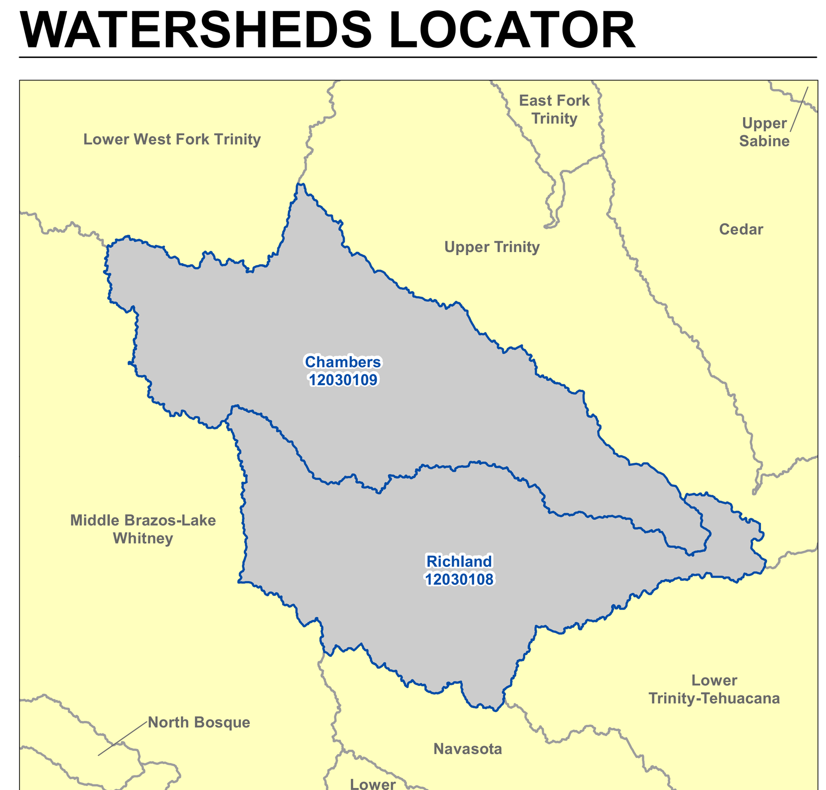
- Floodway
- Zone AE (100-Year, Detailed)
- Zone A (100-Year, Approximate)
- Zone X500 (500-Year, Detailed)

Effective Streams Study Type*

- Zone AE (100-Year, Detailed)
- Zone A (100-Year, Approximate)
- Zone X (Unshaded X, Areas of Minimal Flood Risk)

*Data as of April 2019

WATERSHEDS LOCATOR



NATIONAL FLOOD INSURANCE PROGRAM

Pre-Discovery Map

RICHLAND AND CHAMBERS WATERSHEDS, TEXAS

Stream Miles:	4,218
Zone AE Miles:	100
Zone A Miles:	880
Zone X Miles:	3,237
Population:	167,234

HUC-8 Codes
12030108
12030109

U.S. DEPARTMENT OF HOMELAND SECURITY

FEMA

Figure 19: Discovery Map

County	CID	Population[1]	Total Losses[2]	Closed Losses[2]	Open Losses[2]	CWOP Losses[2]	Total Payments[2]	Current FEMA DFIRM Status	Effective Date
Dallas	480165	2,552,213	1,508	1,150	35	323	$ 27,683,950.47	Effective	3/21/2019
Ellis	480798	164,092	245	172	25	48	$ 5,240,559.48	Effective	6/3/2013
Freestone	480822	19,816	10	7	0	3	$ 554,997.33	Effective	9/1/2007
Hill	480857	35,098	30	23	0	7	$ 319,610.53	Letter of Final Determination	12/20/2019
Johnson	480712	160,173	300	246	3	51	$ 4,581,195.23	Effective	4/5/2019
Limestone	480910	23,480	283	250	2	31	$ 4,525,136.85	Effective	9/16/2011
Navarro	480950	48,239	100	84	0	16	$ 2,551,828.77	Effective	6/5/2012

[1] 2017 American Community Survey Data
[2] FEMA Loss Statistics from 1978 to September 30, 2018 (https://bsa.nfipstat.fema.gov/reports/1040.htm)
Total Losses-All losses submitted regardless of the status.
Closed Losses-Losses that have been paid.
Open Losses-Losses that have not been paid in full.
CWOP Lossess-Losses that have been closed without payment.
Total Payments-Total amount paid on losses.

Discovery Communities

Community	CID	Total Flood Area Sq. Mi.	Percent of Community Floodplain within Richland and Chambers Watersheds
Ellis County	480130	167.8	53.4%
Alma	481546	0.5	100.0%
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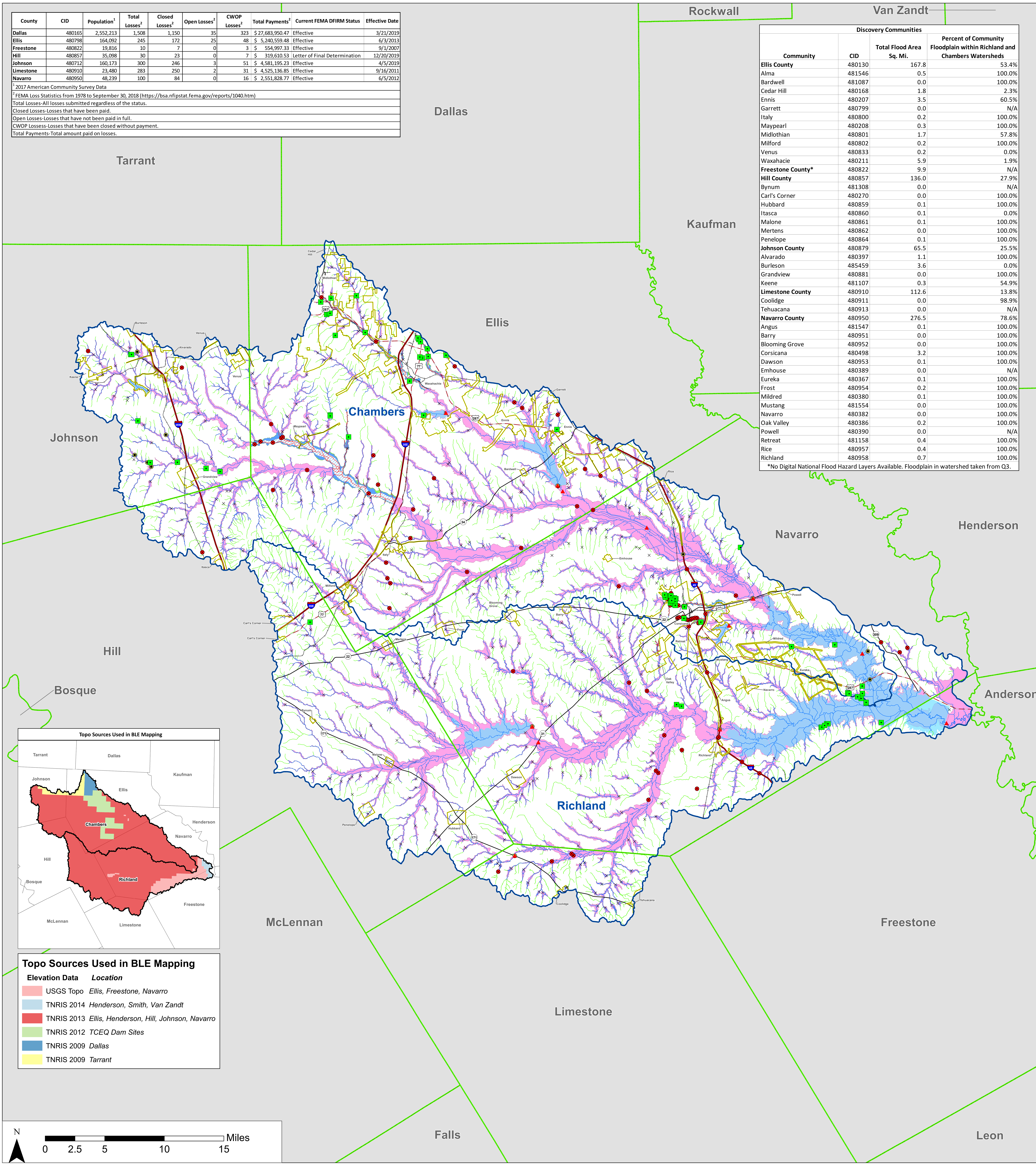
*No Digital National Flood Hazard Layers Available. Floodplain in watershed taken from Q3.



Topo Sources Used in BLE Mapping

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TNRIS 2013	*Ellis, Henderson, Hill, Johnson, Navarro*
TNRIS 2012	*TCEQ Dam Sites*
TNRIS 2009	*Dallas*
TNRIS 2009	*Tarrant*

Map Symbology

USGS Gage
LOMC
High Water Mark
Low Water Mark
Dam
Lake
City Boundary
County Boundary
Watershed Boundary

Transportation

Interstate Highway
US Highway
State Highway
Railroad

Effective FEMA Floodplains*

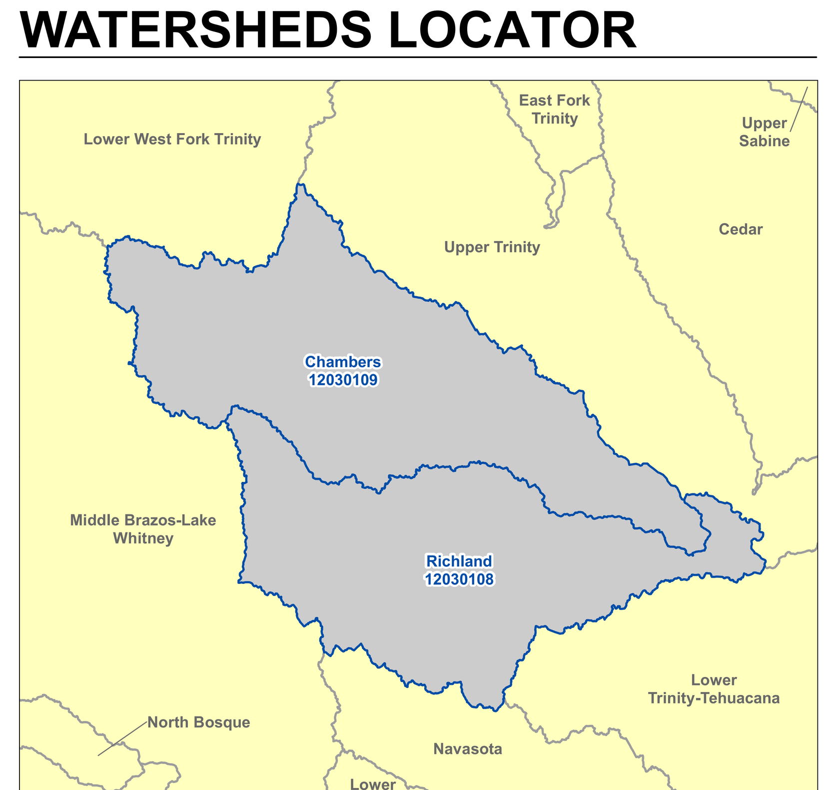
Floodway
Zone AE (100-Year, Detailed)
Zone A (100-Year, Approximate)
Zone X500 (500-Year, Detailed)

Effective Streams Study Type*

Zone AE (100-Year, Detailed)
Zone A (100-Year, Approximate)
Zone X (Unshaded X, Areas of Minimal Flood Risk)

***Data as of April 2019**

WATERSHEDS LOCATOR



NATIONAL FLOOD INSURANCE PROGRAM

Discovery Map

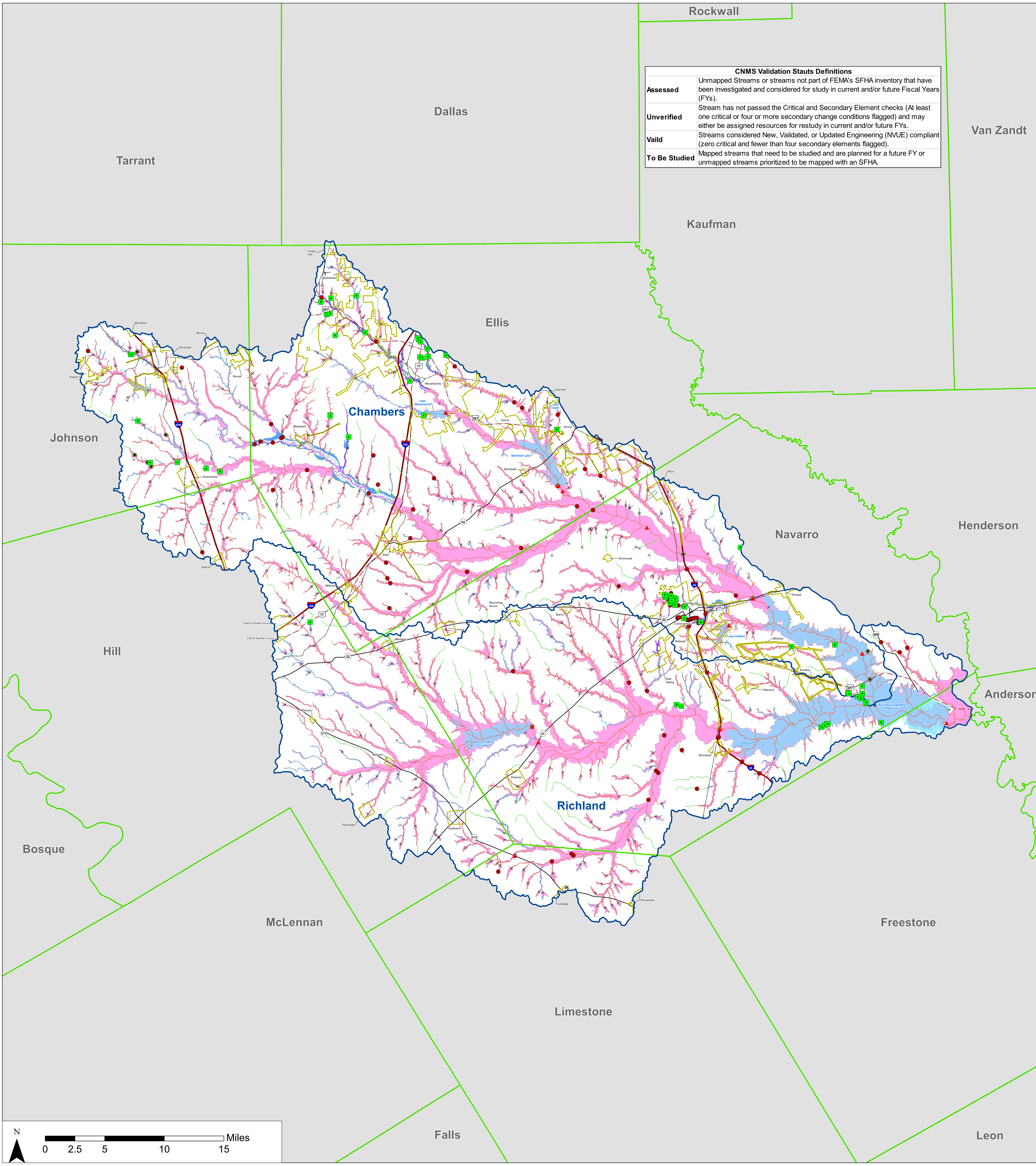
RICHLAND AND CHAMBERS WATERSHEDS, TEXAS

Stream Miles: 4,218
Zone AE Miles: 100
Zone A Miles: 880
Zone X Miles: 3,237
Population: 167,234

HUC-8 Codes
12030108
12030109

FEMA

Figure 20: Post-Discovery Map



CNMS Validation Stauts Definitions	
Assessed	Unmapped Streams or streams not part of FEMA's SFHA inventory that have been investigated and considered for study in current and/or future Fiscal Years (FYs).
Unverified	Stream has not passed the Critical and Secondary Element checks (At least one critical or four or more secondary change conditions flagged) and may either be assigned resources for restudy in current and/or future FYs.
Vaild	Streams considered New, Vaildated, or Updated Engineering (NVUE) compliant (zero critical and fewer than four secondary elements flagged).
To Be Studied	Mapped streams that need to be studied and are planned for a future FY or unmapped streams prioritized to be mapped with an SFHA.

Map Symbology

- USGS Gage
- LOMC
- High Water Mark
- Low Water Mark
- Dam
- Lake
- City Boundary
- County Boundary
- Watershed Boundary

Transportation

- Interstate Highway
- US Highway
- State Highway
- Railroad

Effective FEMA Floodplains*

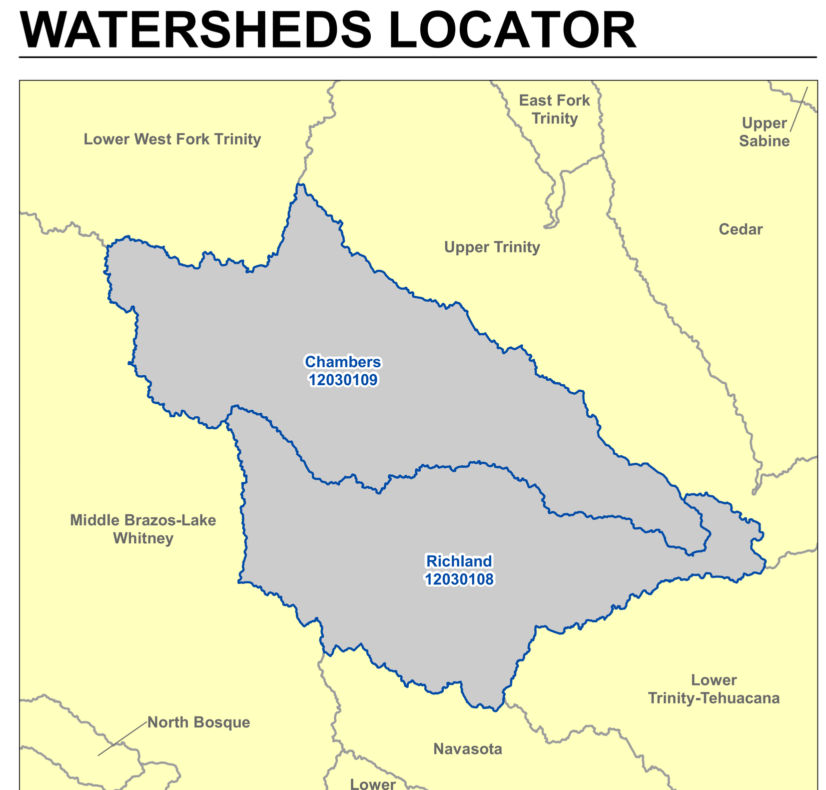
- Floodway
- Zone AE (100-Year, Detailed)
- Zone A (100-Year, Approximate)
- Zone X500 (500-Year, Detailed)

VALIDATION STATUS, STATUS TYPE**

- Unverified, Being Studied
- Unverified, To Be Studied
- Assessed, Being Studied
- Valid, Being Studied
- Valid, NVUE Compliant

***Data as of December 2019**
****Data as of February 2020**

WATERSHEDS LOCATOR



NATIONAL FLOOD INSURANCE PROGRAM

Post Discovery Map

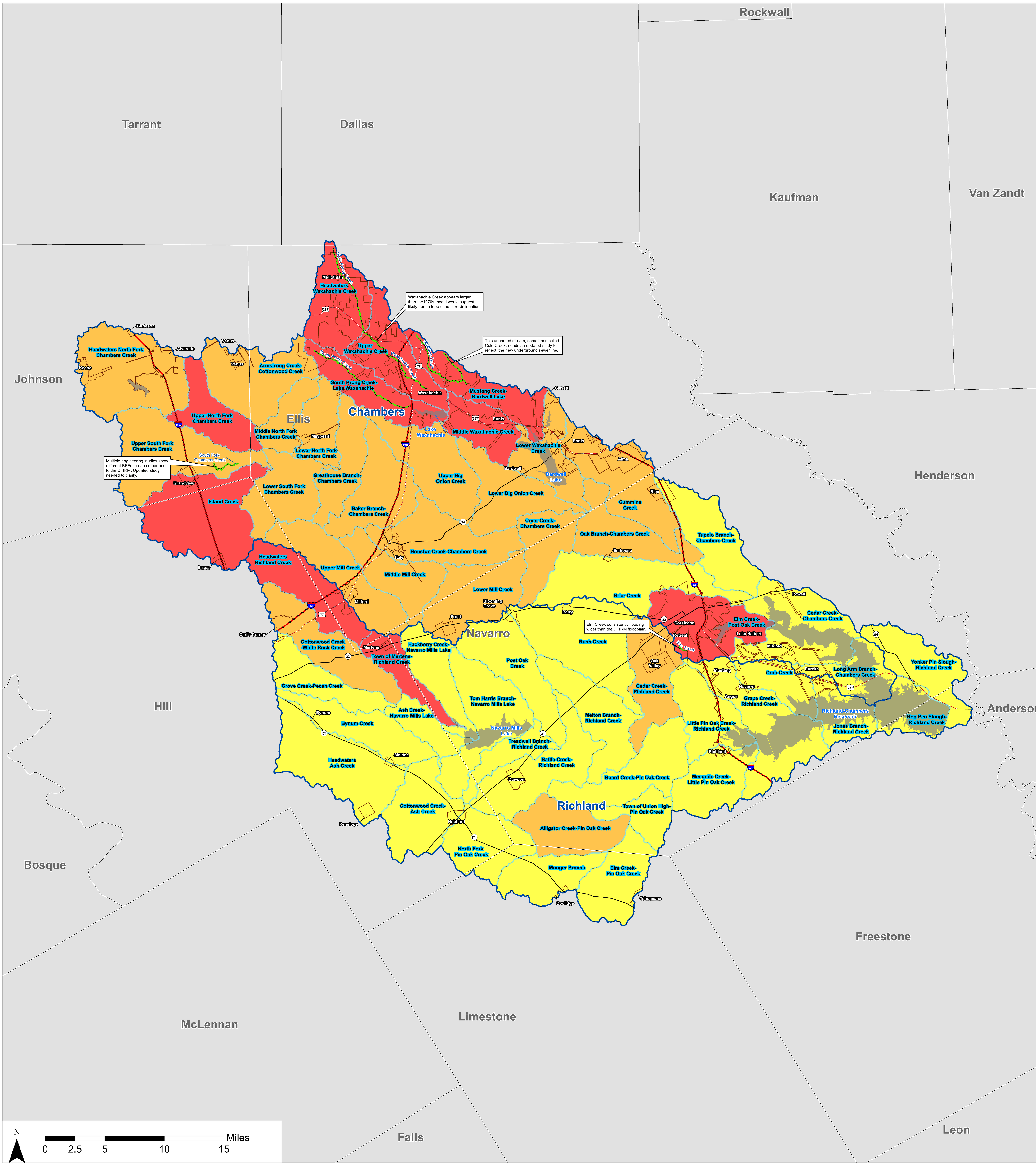
RICHLAND AND CHAMBERS WATERSHEDS, TEXAS

Stream Miles:	4,218
Zone AE Miles:	100
Zone A Miles:	880
Zone X Miles:	3,237
Population:	167,234

HUC-8 Codes
12030108
12030109

FEMA

Figure 21: HUC-12 Watershed Prioritizations and Potential Projects



Map Symbology

- Potential Study Stream
- Incorporated Area
- Lake
- County Boundary
- HUC-8 Watershed Boundary
- HUC-12 Watershed Boundary

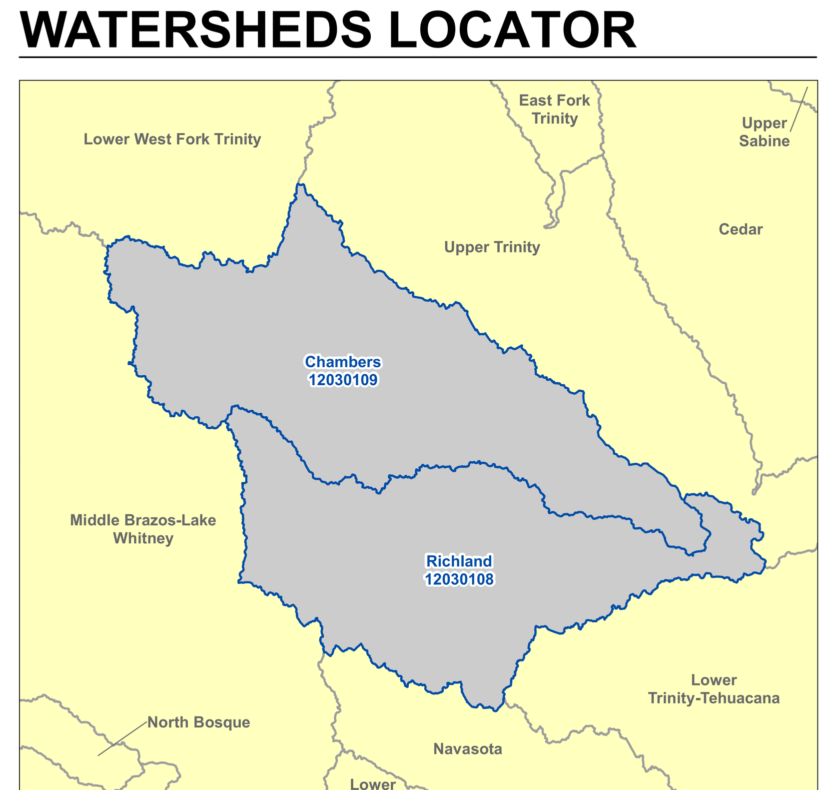
Transportation

- Interstate Highway
- US Highway
- State Highway

HUC-12s - Prioritization Rank

- High Risk
- Elevated Risk
- Moderate Risk

WATERSHEDS LOCATOR



NATIONAL FLOOD INSURANCE PROGRAM

Watershed Prioritizations and Potential Projects Map

RICHLAND AND CHAMBERS WATERSHEDS, TEXAS

Total Watersheds Area:	1,991 sq. mi.
High Risk Area:	376 sq. mi.
Elevated Risk Area:	696 sq. mi.
Moderate Risk Area:	919 sq. mi.

HUC-8 Codes
12030108
12030109

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Pre-Discovery Meeting Slides

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North Central Texas Council of Governments

North Texas Discovery

"Capturing a More Complete Picture of Your Watershed"

Pre-Discovery Meeting

June 26, 2019

HALFF

Introduction

- NCTCOG:
  - Edith Marvin – EMarvin@nctcog.org
  - Mia Brown – MBBrown@nctcog.org
- Halff Associates:
  - Jarred Overbey – JOverbey@halff.com
  - Samuel Amoako-Atta – SAmoak-Atta@halff.com
  - Alison Hanson– AHanson@halff.com
  - Katy Onley– KOnley@halff.com
- FEMA:
  - Alan Johnson – alan.johnson@fema.dhs.gov
- TWDB / TNRIS:
  - Manuel Razo – Manuel.Razo@twdb.texas.gov
  - Michael Segner – Michael.Segner@twdb.texas.gov

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AGENDA

- Overview of Risk MAP
- NCTCOG Discovery Activities
- Discovery Overview
- 2019 NCTCOG Discovery Watershed
  - Richland and Chambers Watersheds
  - Pre-Discovery Activities
  - Discovery Activities
  - Post-Discovery Activities
- Data Gathering Website and Walk-through

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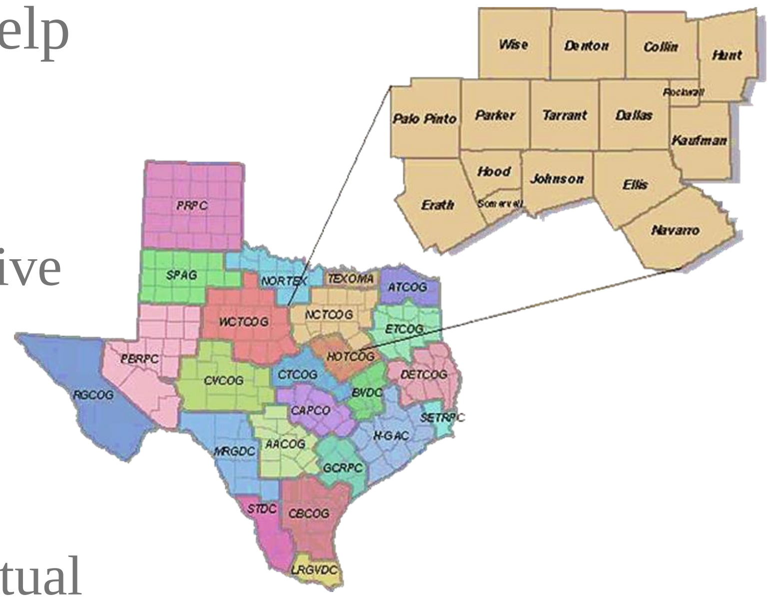
What is NCTCOG?

- Voluntary association of, by, and for local governments, established in 1966, to help them:
  - Plan for common needs
  - Strengthen their individual and collective power
  - Recognize regional opportunities
  - Resolve regional problems
  - Make joint decisions/cooperate for mutual benefit



230+ Member Governments

- Cities
- Counties
- School Districts
- Special Districts

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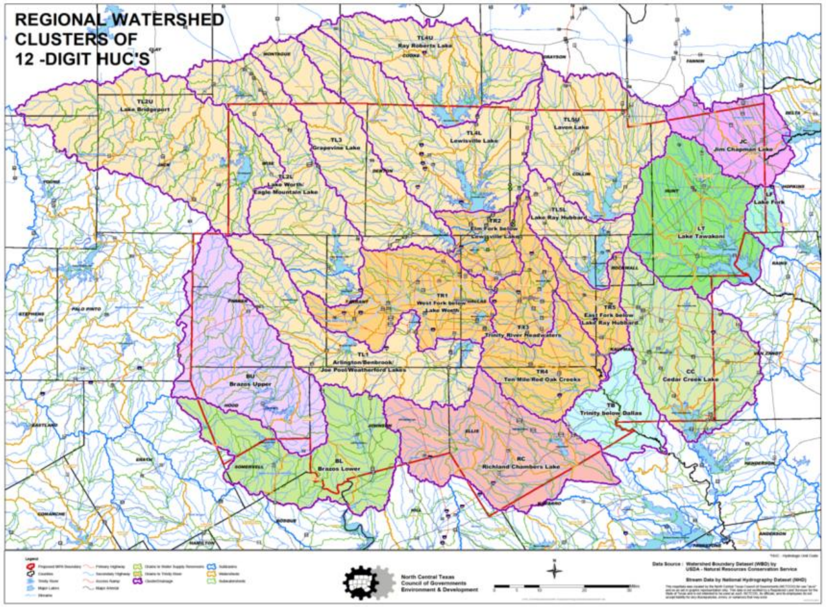
NCTCOG Environment and Development Watershed Management Program

- Focus on water quality, stormwater, and floodplain topics/issues.
- Floodplain
  - NCT region does not have a flood control district. Lots of local/regional entities working in their own jurisdictions.
  - NCTCOG will never replace a flood control district, but as an agency, we work toward regional cooperation on flooding issues to help everyone accomplish common goals together.



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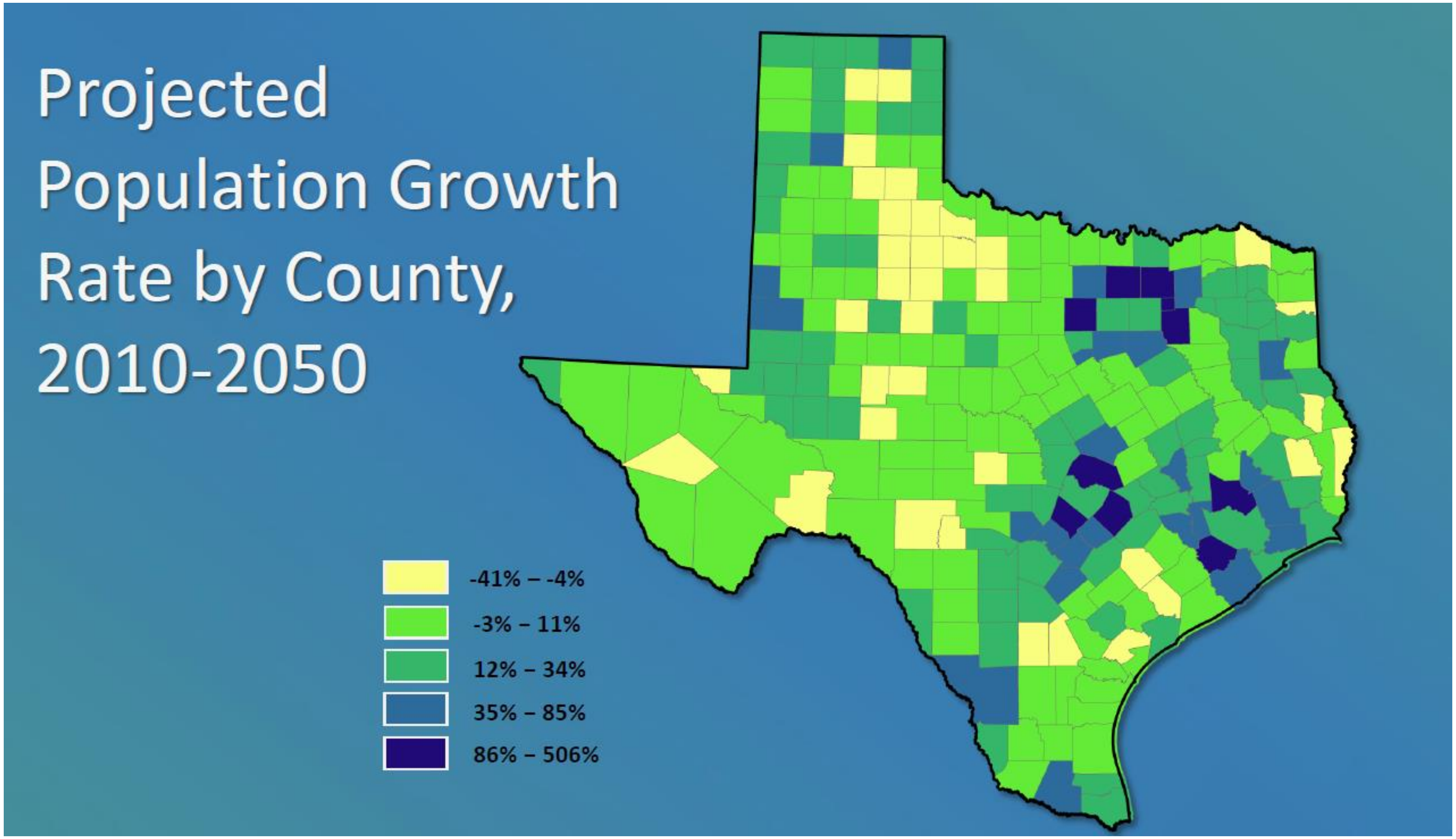
Source : Dr. Lloyd Potter, Texas State Demographer



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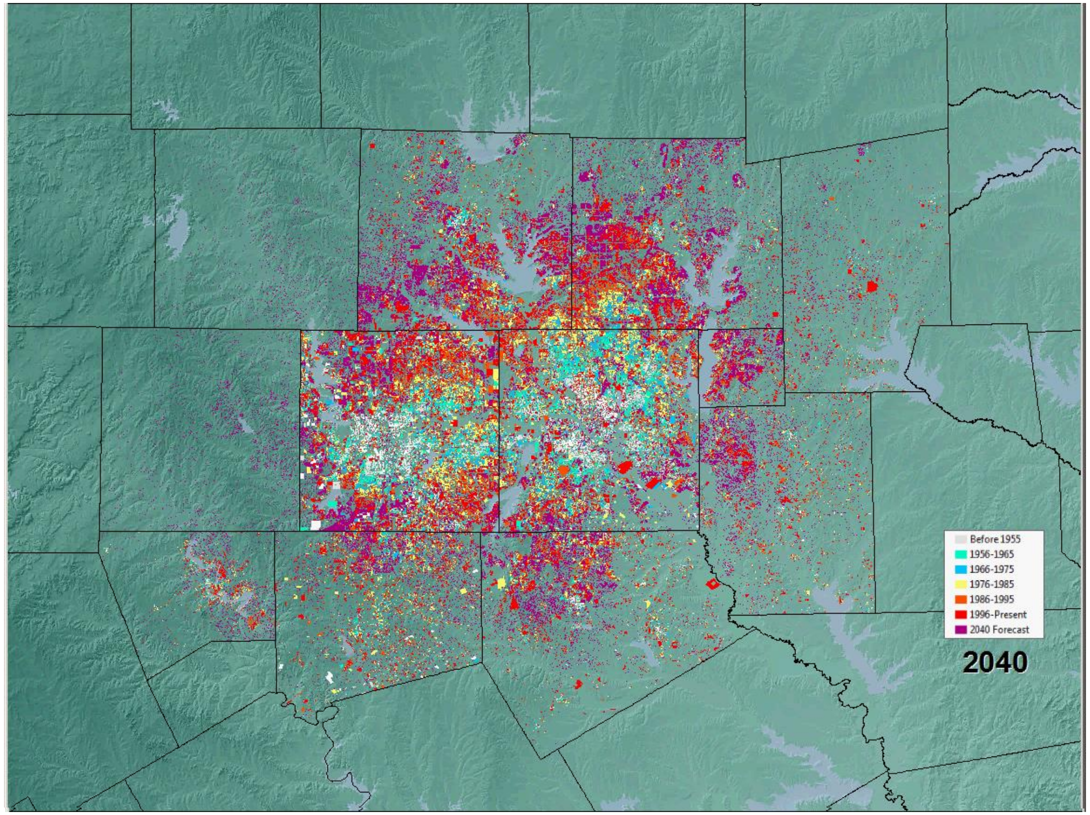
North Central Texas 1950-2040 Growth



NCTCOG Goals as a CTP

- NCTCOG is an “uncommon” CTP
- Direct Goals
  - Better data for better decision making
  - Coordination between communities and local/regional/state/federal organizations (what COGs do best!)
  - Partnerships
- Indirect Goals
  - Higher Standards

FEMA's Risk MAP Program

- Risk Mapping, Assessment, and Planning
  - Provides communities with flood information and tools they can use to enhance their mitigation plans and take action to better protect their citizens.
  - Risk MAP Vision
    - **ACTION-driven**, not **MAP-driven** through local understanding and ownership of risk

Discovery
Overview

- ***Capture a more complete picture of your watershed by working closely with local communities…***

Watershed Selected for Discovery	Community Engagement / Data Collection	Discovery Meeting	Post-Meeting Coordination / Scope Refinement
• Selection Criteria: • Risk • Need • Elevation data availability • Regional knowledge • CTP/State input	• Develop watershed partnerships • Discovery Newsletter • Pre-Discovery community visits • Gather all available data • Data needs • Issues / Concerns • Areas of Mitigation	• Review / validate watershed for project areas • Provide information • Mapping • Mitigation Planning • Grants • NFIP Compliance • Comprehensive understanding of risk in the watershed	• Once data is collected • FEMA will coordinate with State/NCTCOG on proposed scope refinement • Selected Projects – move toward Kick off meeting • Non-Selected Projects – engaged for potential mitigation actions, mitigation plan updates, and/or mitigation technical assistance

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Discovery Steps

Overview

1. FEMA Selects Watershed for Discovery
2. Watershed Stakeholder Coordination
3. Data Gathering and Analysis. BLE data development (completed)
4. Discovery Meeting
5. Post Meeting Coordination
6. Risk MAP Project Recommendations to FEMA

Base Level Engineering(BLE)

Overview

Large Scale Automated Engineering (LSAE) Process

- BLE is best used at a larger scale (HUC8)
- LiDAR must be available
- Model review and adjustments
- Gage review included in hydrology

Key Features

Stream Centerline

NCTCOG County Boundaries

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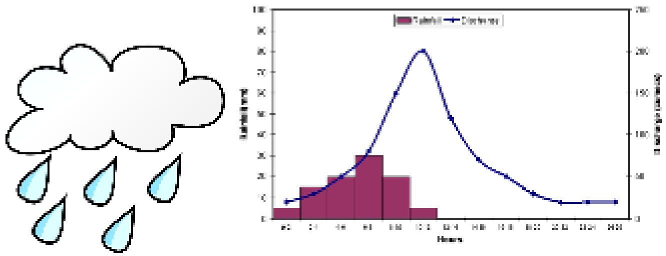
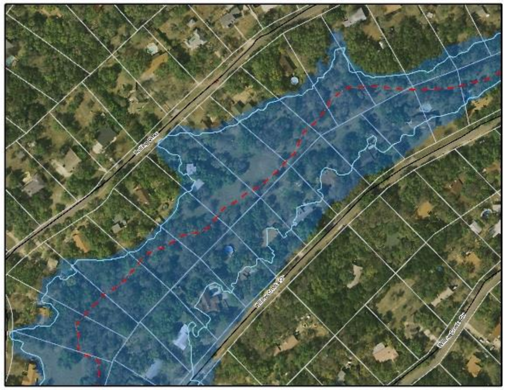
Base Level Engineering(BLE)

Overview

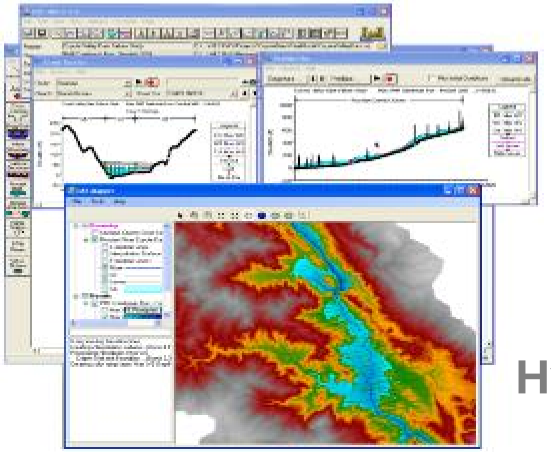
MODELING



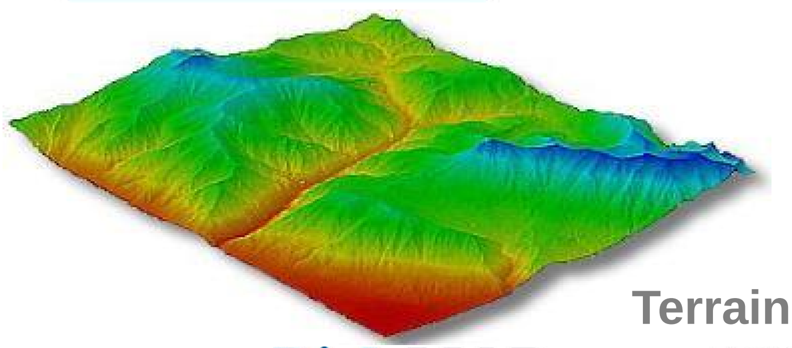
Hydrology



Mapping



Hydraulics



Terrain

OUTPUTS

- Hydrology modeling (Regression) flows w/gage analysis
- Hydraulic modeling (HEC-RAS) for 10%, 4%, 2%, 1% and 0.2% storm events
- 10%, 1% and 0.2% floodplain boundaries

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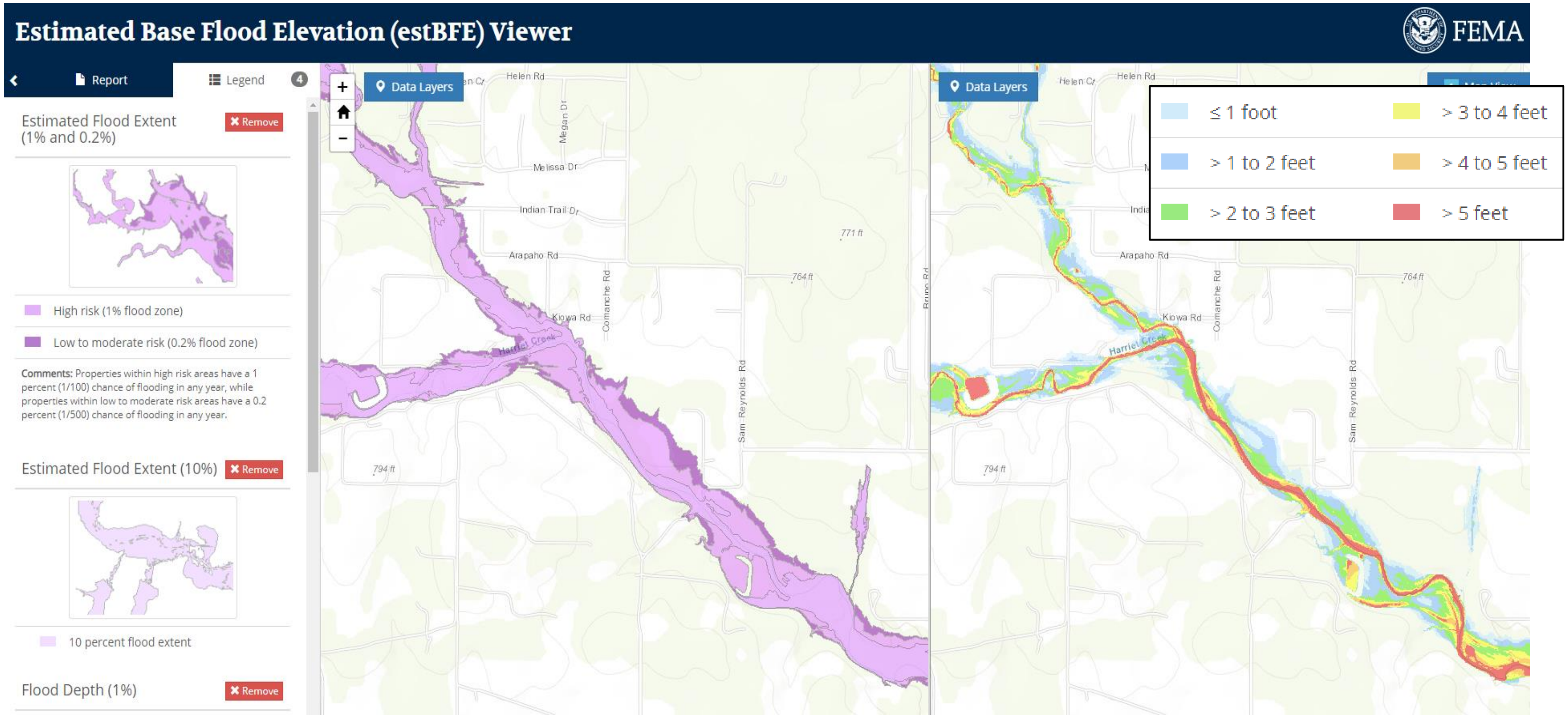
Base Level Engineering(BLE)



Non-Regulatory

- Areas of Expanded Flood Risk
- Depth and Analysis Grids
- Flood Risk Assessment

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Base Level Engineering(BLE)

Overview

- Building Block for Future Model Refinement

- Creates a data-based starting point for conversations about existing flood risk

CHEAPER

FASTER

DATA FOR REVIEW

COLLABORATIVE

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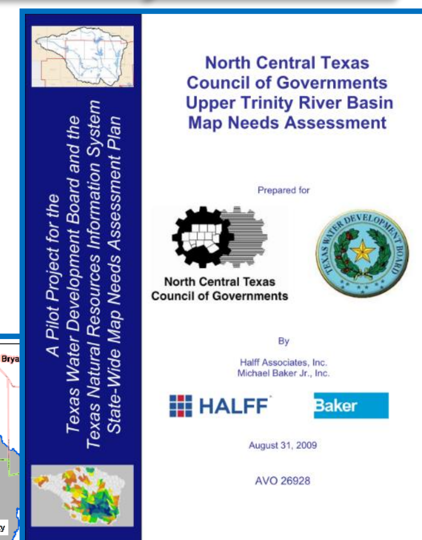
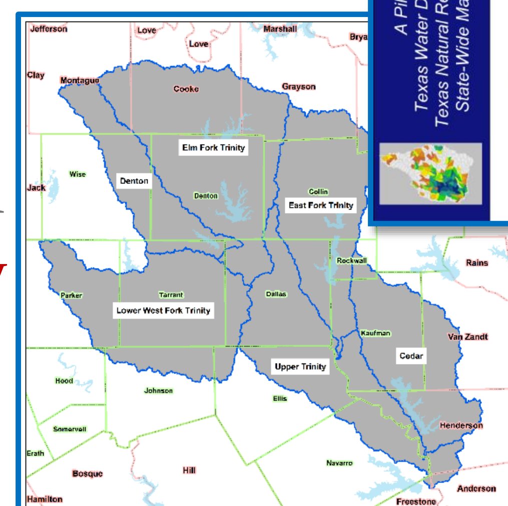
NCTCOG Discovery Activities

- 2004-2008 FEMA Map Modernization
- 2009 Map Needs Assessment
- 2012 Partnered with FEMA for CTP Grant
- 2013 Discovery
- 2017 Discovery
- 2018 Discovery
- 2019 Discovery



- 2009 TWDB/NCTCOG Map Needs Assessment (MNA) documented…
  - 1,291 new mapping needs
  - 2,370 miles of stream
  - $44 Million in Flood Mapping Needs
- 2013 Discovery utilized MNA data and update results. 2019 Discovery will do the same.



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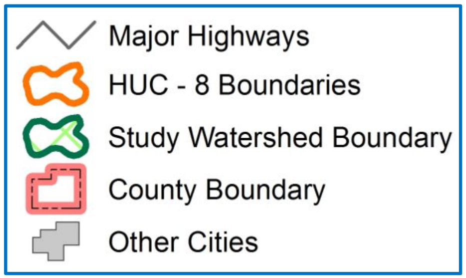
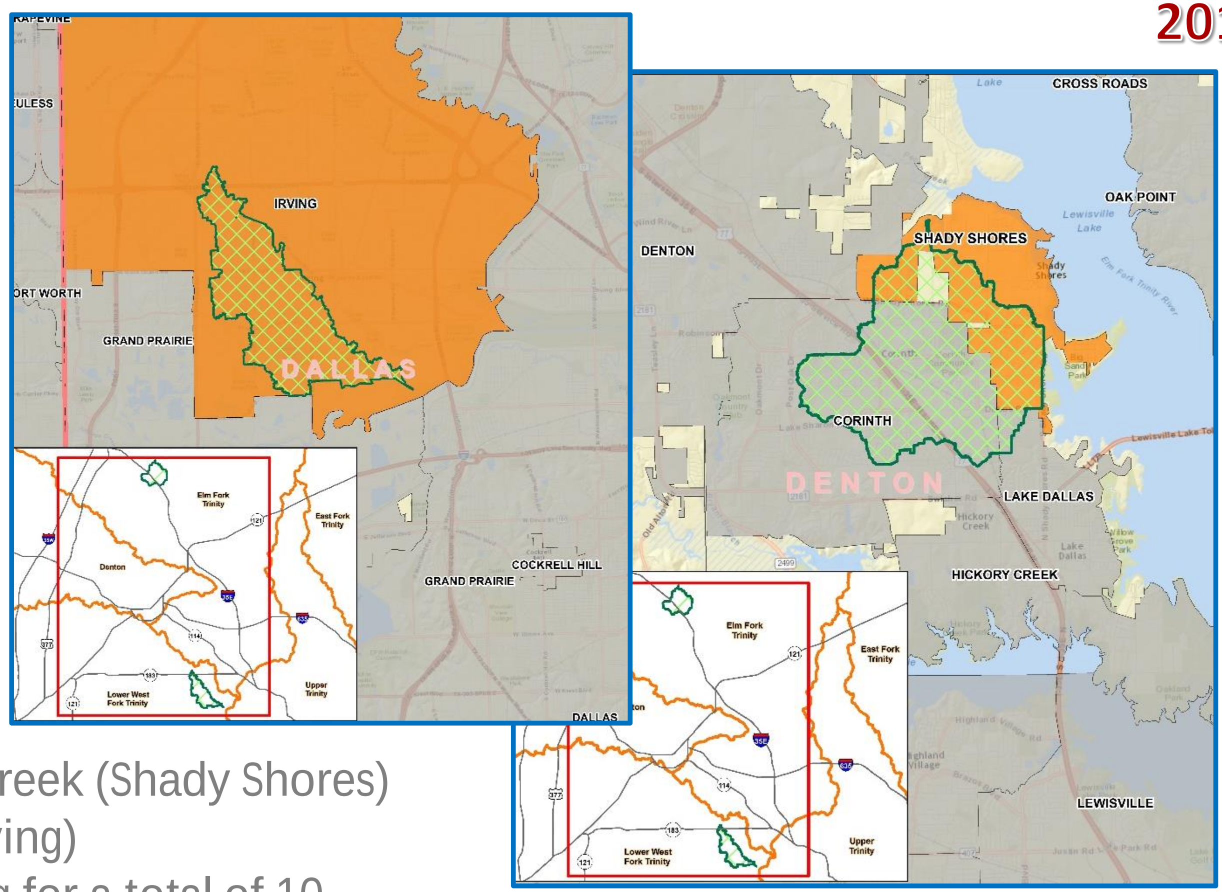
Example Post-Discovery Projects

2015





2015 Study – Lynchburg Creek (Shady Shores) and West Irving Creek (Irving)

- New H&H and Mapping for a total of 10 streams
- Flood Risk Products including Flood Risk Assessment

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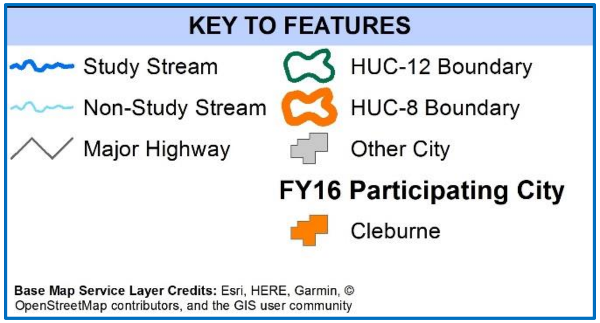
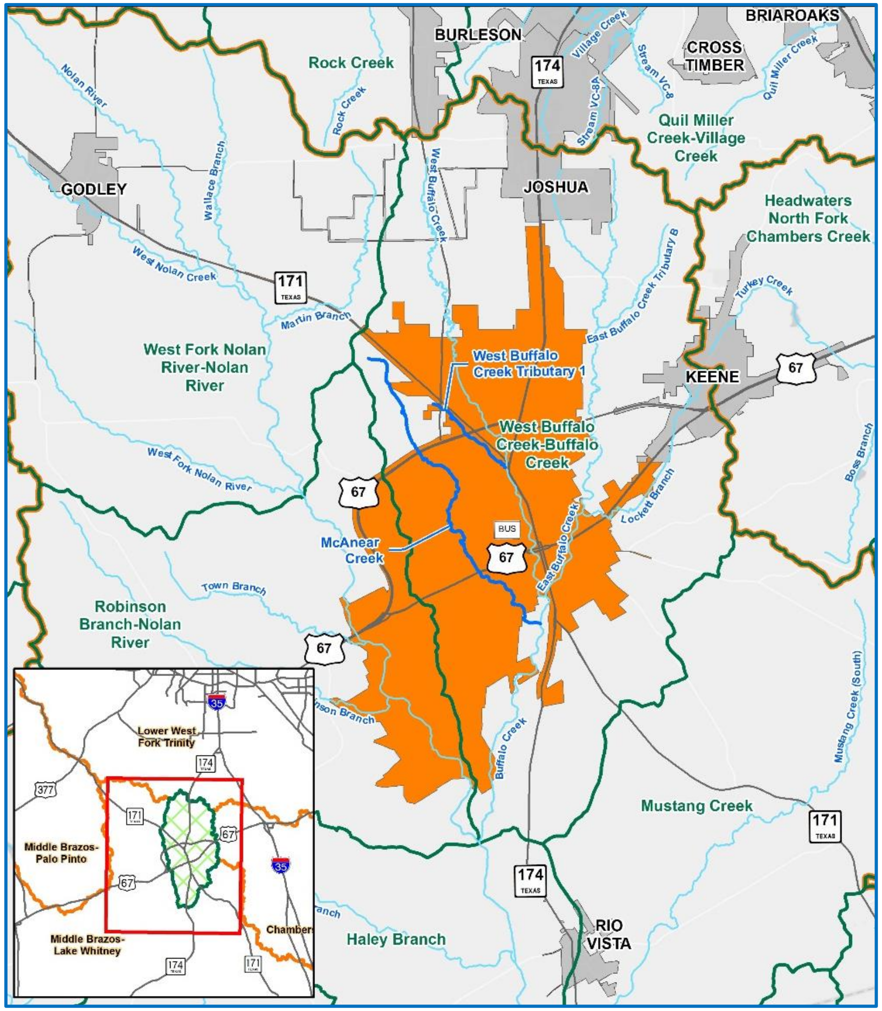
Example Post-Discovery Projects

2016

2016 McAnear Study – Cleburne

- New H&H and Mapping for 2 streams
- Flood Risk Products including Flood Risk Assessment





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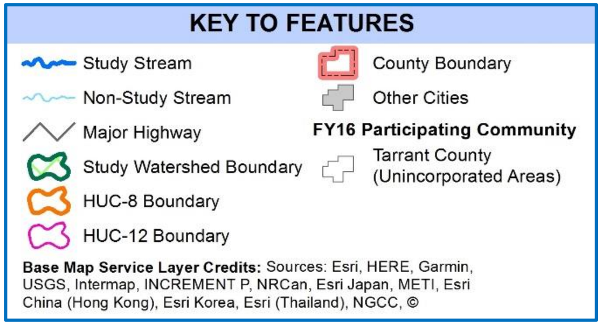
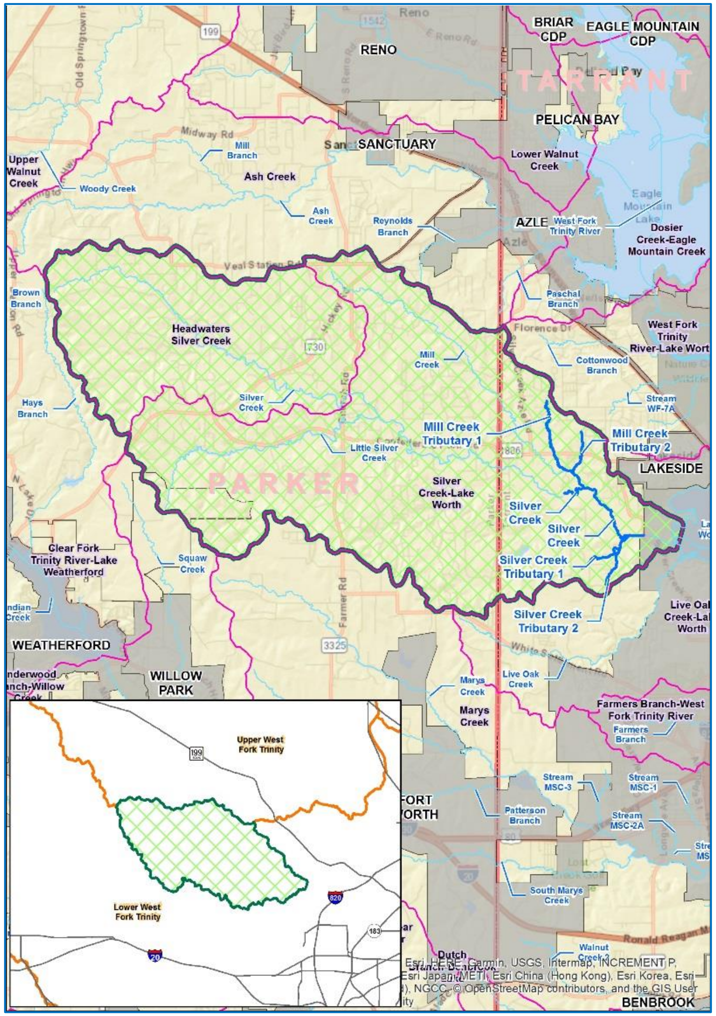
Example Post-Discovery Projects

2016

2016 Silver Creek Study – Parker County

- New H&H and Mapping for 6 streams
- Flood Risk Products including Flood Risk Assessment





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Texas Water Development Board

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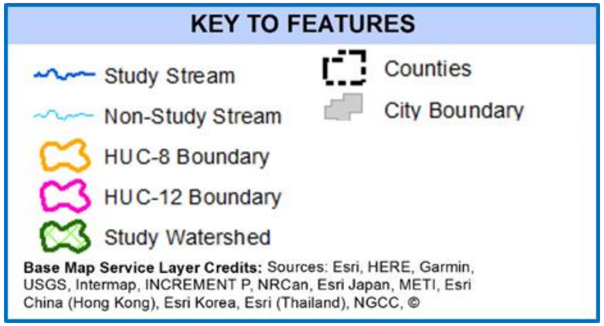
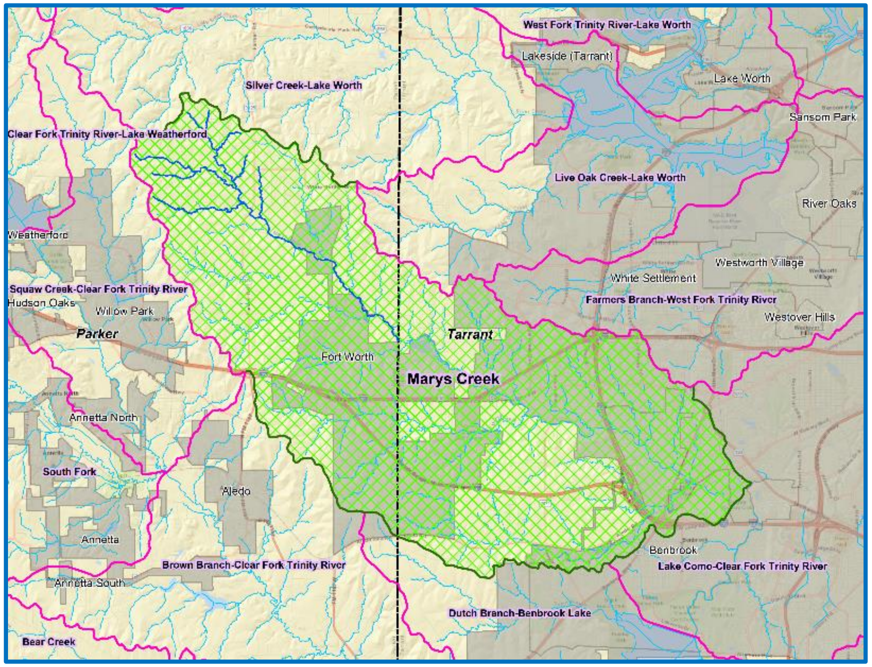
Example Post-Discovery Projects

2018

2018 Mary's Creek Study – Parker County

- New H&H and Mapping for 8 streams
- Flood Risk Products including Flood Risk Assessment





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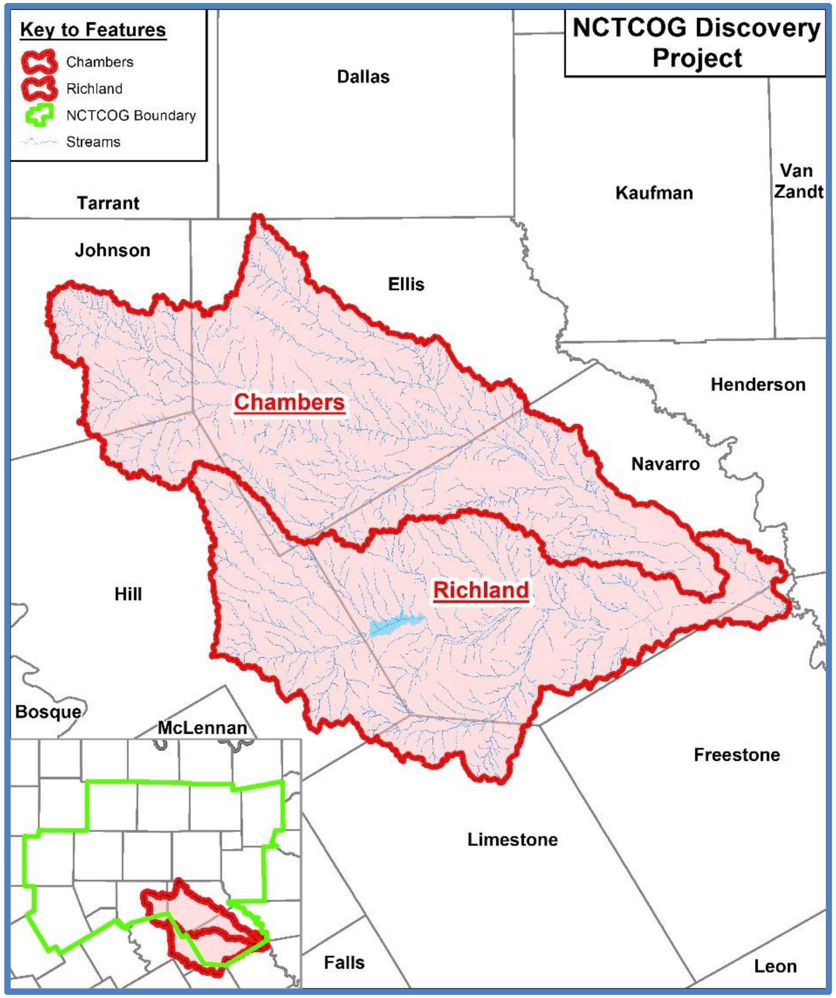
North Central Texas Council of Governments

2019 North Texas Discovery

Richland and Chambers Watersheds Discovery

- Goals:
  - – Provide information
    - Mitigation planning and actions
    - Risk Communication
  - – Gather information
    - Local flood risks and hazards
    - Current mitigation



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Discovery Newsletter

Pre-Discovery Activities

Pre-Discovery Newsletter
Richland and Chambers Watersheds

North Central Texas Council of Governments

"Capturing a More Complete Picture of Your Community and Your Watershe

Risk MAP Process and Discovery

Risk Mapping, Assessment, and Planning (Risk MAP) is the Federal Emergency Management Agency (FEMA) Program that assists communities with flood information and tools they can use to enhance their mitigation plans and better protect their citizens. Discovery is the first phase of an overall process to achieve mitigation actions for reducing risks. The North Central Texas Council of Governments (NCTCOG) has been awarded a FEMA grant to conduct Discovery in the Richland and Chambers Watersheds in 2019.

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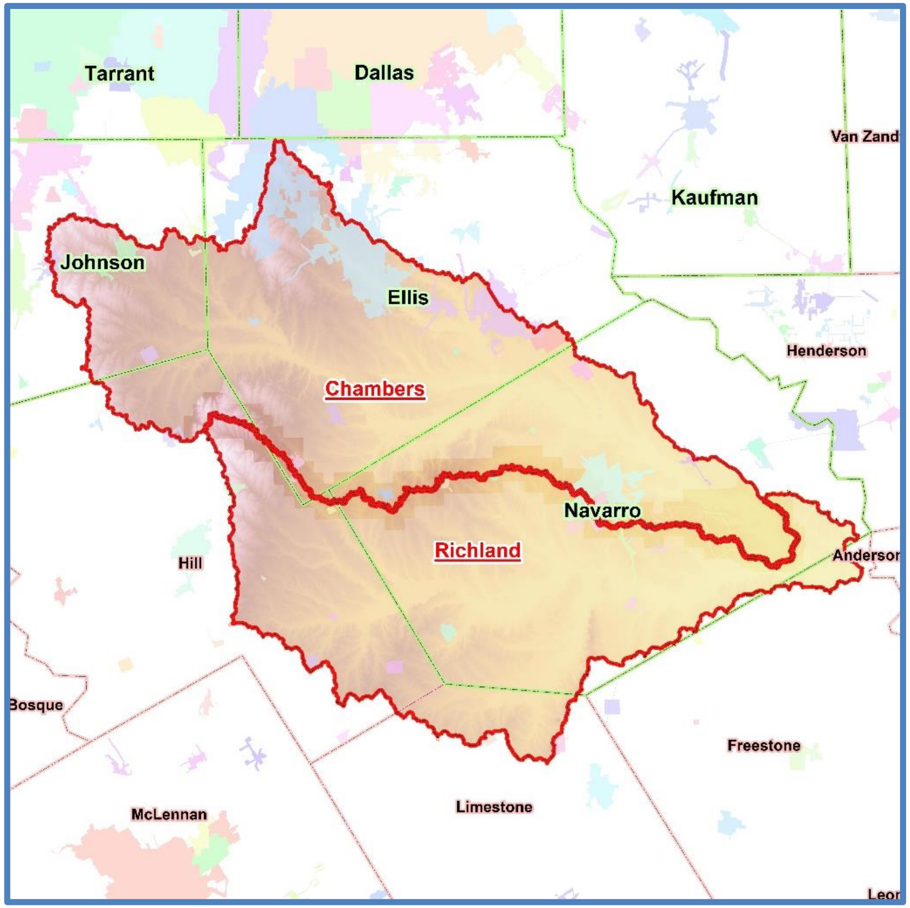
Discover the Data

Pre-Discovery Activities

- Record flooding issues concerns on our website
- Demonstrate later in presentation



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Discovery Community Engagement

What information are we interested in?

FEMA ENGAGEMENT WITH STAKEHOLDERS AND DATA COLLECTION
Review of all available data begins the process…

Risk Identification and Communication

- Low water crossings?
- Large areas of fill placement?
- Future development areas?
- Capital improvement projects?
- Channelization projects?
- Large reservoirs? O&M plan?
- Flood risk reduction projects?
- Digital stream inventory?
- Digital building stock?
- High water marks from recent flooding event?
- Elevation data? LiDAR?
- Local flood studies?

Mitigation Planning and Mitigation Actions

- Approved hazard mitigation plan?
- Local evacuation plans?
- Current land use plan?
- Future land use plan?
- Drainage master plan(s)?
- Flood reduction projects?
- Culvert enlargement projects?
- Areas of evacuation during high water?
- Local HAZUS runs?
- Digital parcel boundaries?

Engage:

- U.S. Geological Service
- U.S. Army Corps of Engineers
- U.S. Environmental Protection Agency
- State NFIP coordinator
- State Hazard Mitigation Officer
- State floodplain management associations
- State emergency management associations
- Local elected officials
- Regional authorities
- Local floodplain administrators
- Local emergency management officials
- Local levee districts
- Watershed groups
- Special interest groups
- Local business and commerce entities
- CTPs

NFIP Community Actions

- Participating in the NFIP?
- Community assistance meetings?
- Community Rating System (CRS)?
- Repetitive loss properties?
- Areas of insurance claims?
- Community assistance visits?
- Community assistance calls?
- Active Letters of Map Change (LOMCs)?
- Recent disaster? Declared?
- Data from PDAs?

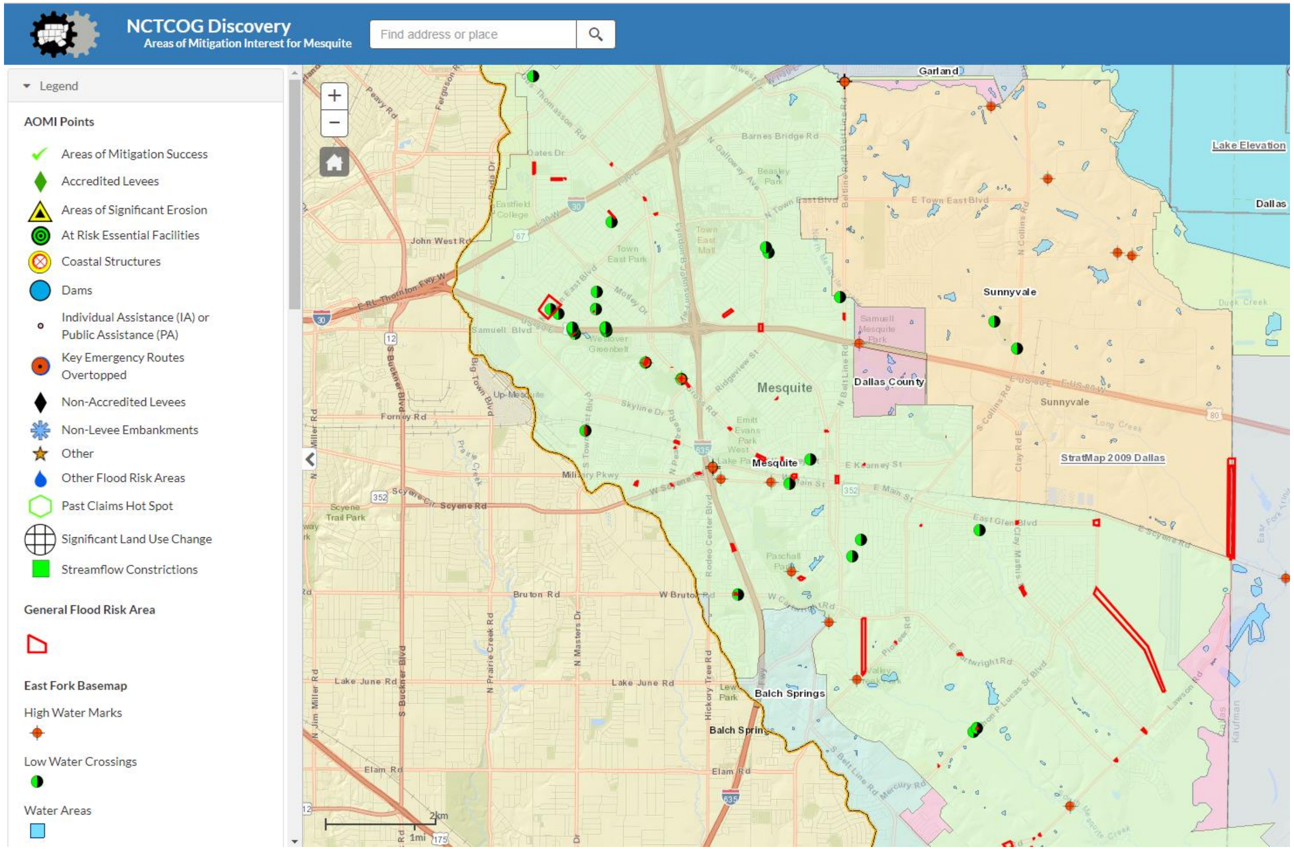
Community Benefits and Grant Opportunities

- Grant administration plan?
- Ongoing grant projects?
- Hard projects? (infrastructure)
- Soft projects? (outreach/education)
- Targeted buy-out areas?
- Elevation projects planned?
- Pre-Disaster Mitigation (PDM) grants?
- Severe Repetitive Loss (SRL) grants?
- Grants in need of engineering info?
- Post-disaster 404 projects?
- Post-disaster 406 projects?

Discovery Meetings Coming …

Pre-Discovery Activities

- Enter your data online before the meeting
- Discovery meetings in fall
- All community stakeholders are encouraged to attend



Discovery Meetings - Open House

Open House Style Meetings – Come and Go

TWDB

USACE

FEMA

Discovery Map and Changes Since Last FIRM Maps

Other Stakeholder

NCTCOG Programs

Data Collection

Check-in

Discovery Meetings – What to Expect

Discovery Activities

FEMA

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Who Should Come?

- Community Officials Including:
  - Leaders, Floodplain Administrators, City Engineers, Watershed Organizations, Planners, Emergency Managers, and GIS specialists
- Federal, State, and Regional Agencies
- Other locally identified stakeholders concerned with flood risks or hazard mitigation

What Do I Bring?

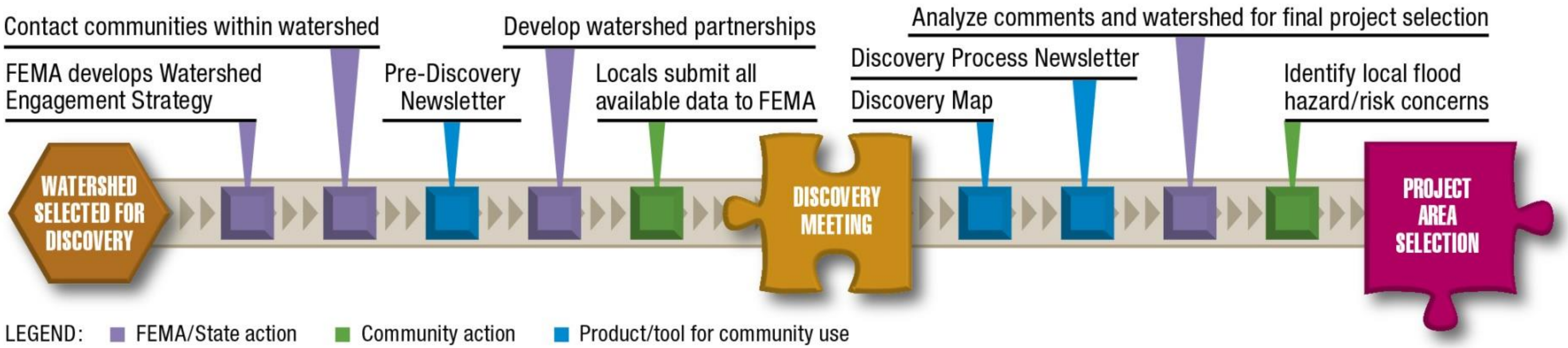
Discovery Activities

- Knowledge of Flood Risks and Past Flooding in your community
- Hazard Mitigation Projects – Identified, In Progress, or Complete?
- Master Drainage Plan(s), floodplain studies – completed or identified as needs
- Questions or Concerns regarding your current Digital Flood Insurance Rate Maps – Flood Study Needs
- Current Flood Risk Communication Process
- Dams and Levees – Questions or Concerns
- GIS data

Post-Discovery Actions

Post-Discovery Activities

- Post-Discovery Actions
  - Analyze data collected
  - Review findings with NCTCOG



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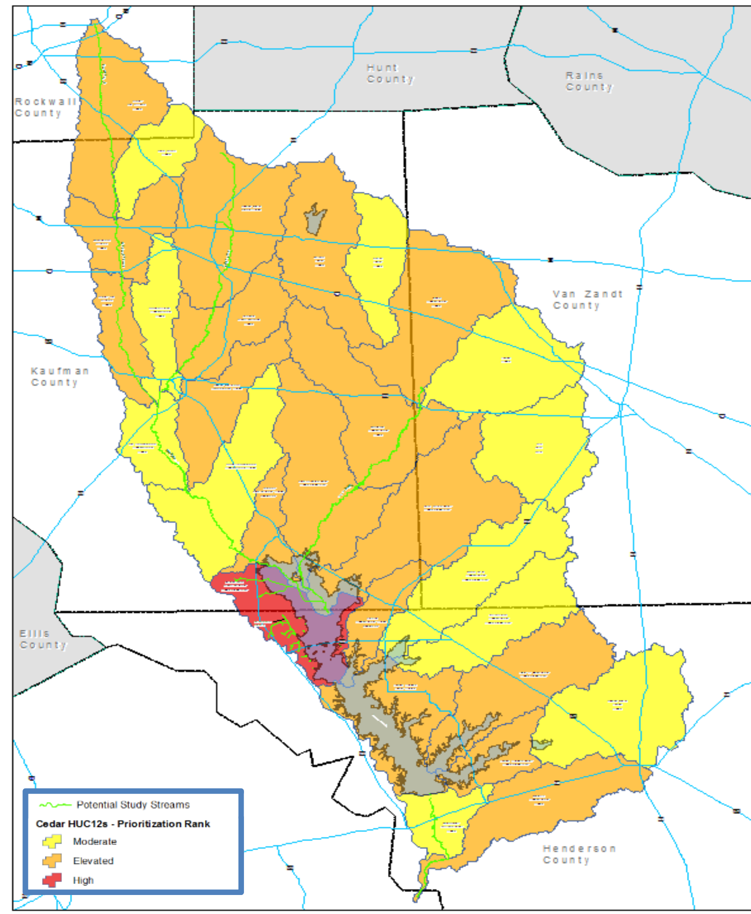
Post-Discovery Actions

Post-Discovery Activities

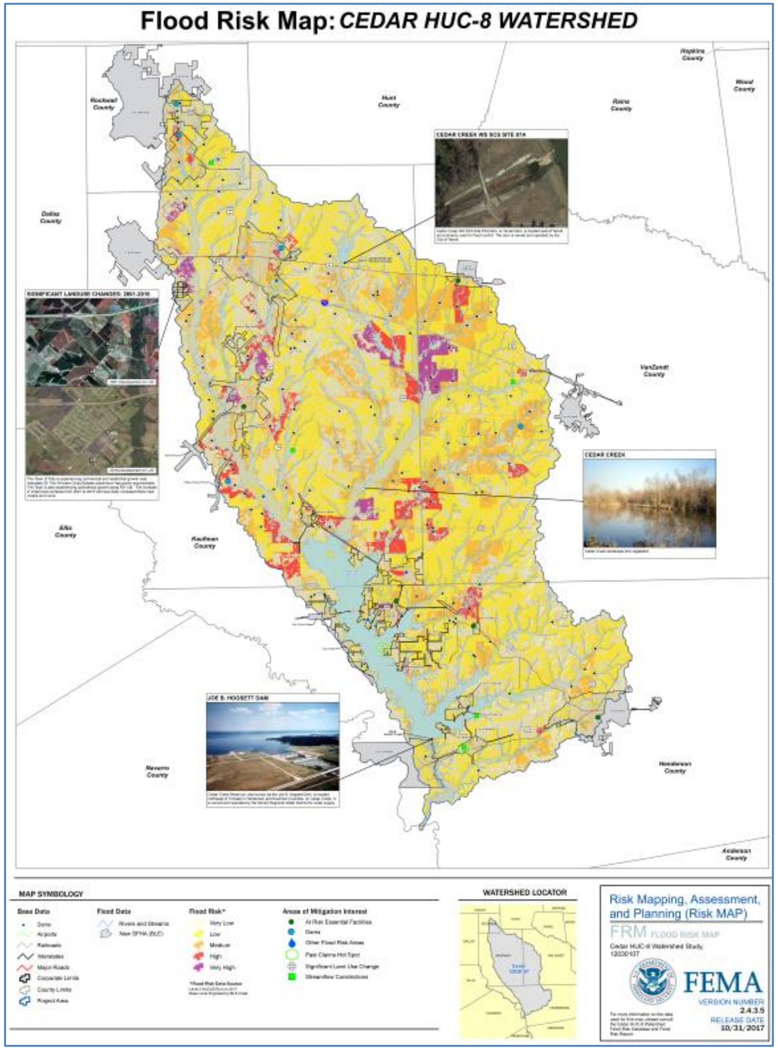
- Subbasin Prioritization

Criteria No.	Description	Max Weight
1	Population density (whole number)	10
2	Population change (decimal)	10
3	Predicted population growth (whole number)	10
4	History of flood claims (whole number)	10
5	History of flood events (whole number)	10
6	Number of Letters of Map Change (LOMR/LOMA) (whole number)	5
7	Available current topography (Y/N for LiDAR)	10
8	Age of technical data – hydrology (num. of years)	5
9	Age of technical data – hydraulics (num. of years)	5
10	Ability to leverage current studies (Y/N)	5
11	Potential for local funding (Y/N)	5
12	Potential for local “work in kind” (Y/N)	3
13	Previous contribution to a FEMA study (Y/N)	2
14	Stakeholder mapping request (number)	10



Post-Discovery Actions

Post-Discovery Activities



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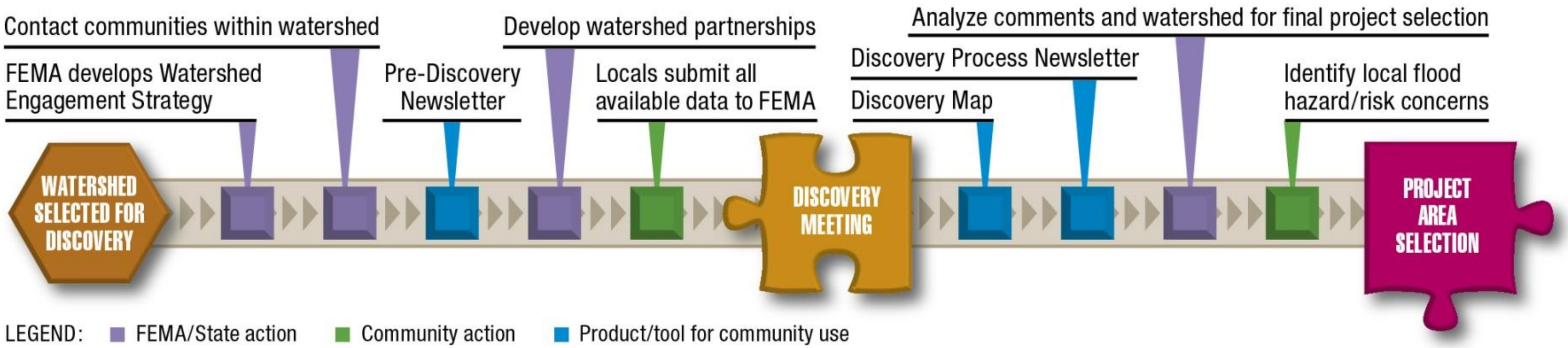
Post-Discovery Actions

Post-Discovery Activities

- Post-Discovery Actions
  - Preliminary project selections provided to communities
  - Evaluate community input
  - Discovery Report
- Findings Meeting – Spring 2020



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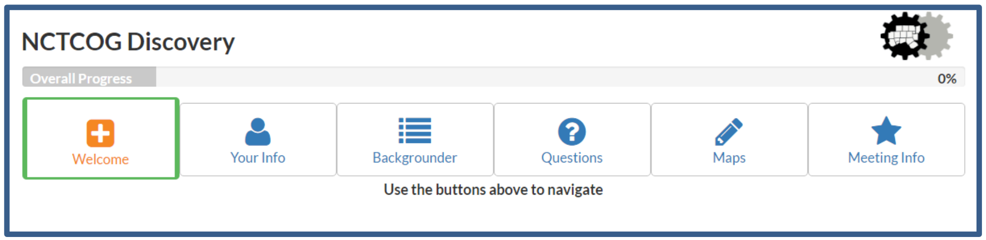
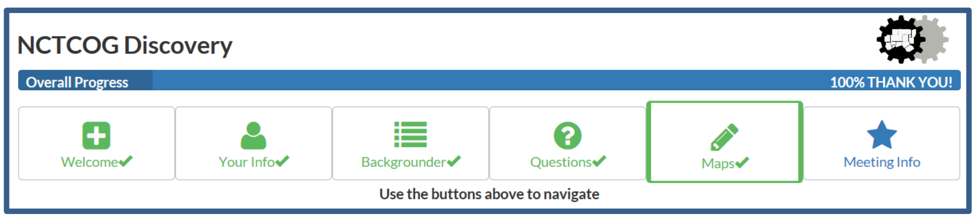
Enter Your Flood Risk Information on Our Website

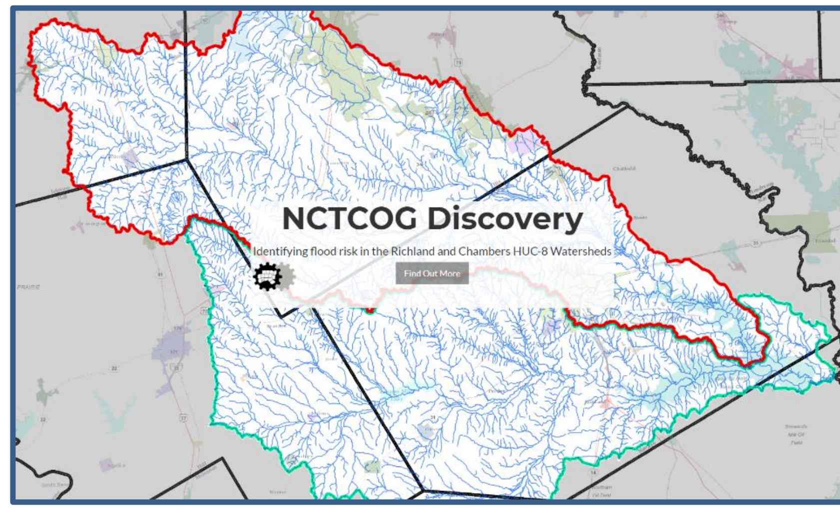
https://nctcogdiscovery.halff.com

Login: EMAIL ADDRESS

Password: NCTCOG_2019!







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Questions

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Questions

- NCTCOG:
  - Edith Marvin – EMarvin@nctcog.org
  - Mia Brown – MBBrown@nctcog.org
- Halff Associates:
  - Jarred Overbey – JOverbey@halff.com
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  - Alison Hanson– AHanson@halff.com
  - Katy Onley– KOnley@halff.com
- FEMA:
  - Alan Johnson – alan.johnson@fema.dhs.gov
- TWDB / TNRIS:
  - Manuel Razo – Manuel.Razo@twdb.texas.gov
  - Michael Segner – Michael.Segner@twdb.texas.gov

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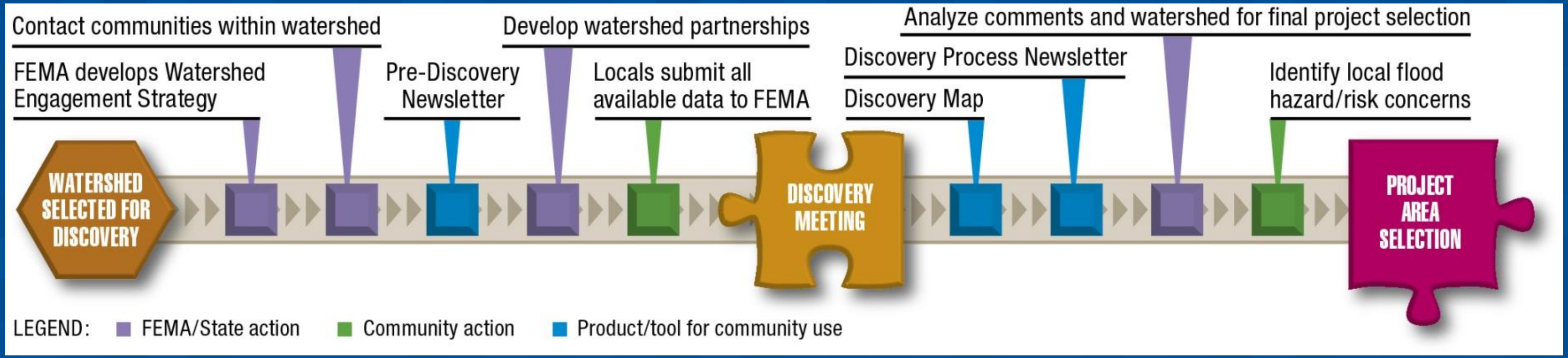
Discovery Findings Webinar Slides



NORTH CENTRAL TEXAS COUNCIL OF GOVERNMENTS

RICHLAND AND CHAMBERS WATERSHEDS DISCOVERY FINDINGS MEETING

North Central Texas Council of Governments

FEMA

HALFF

NCTCOG:

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TWDB:

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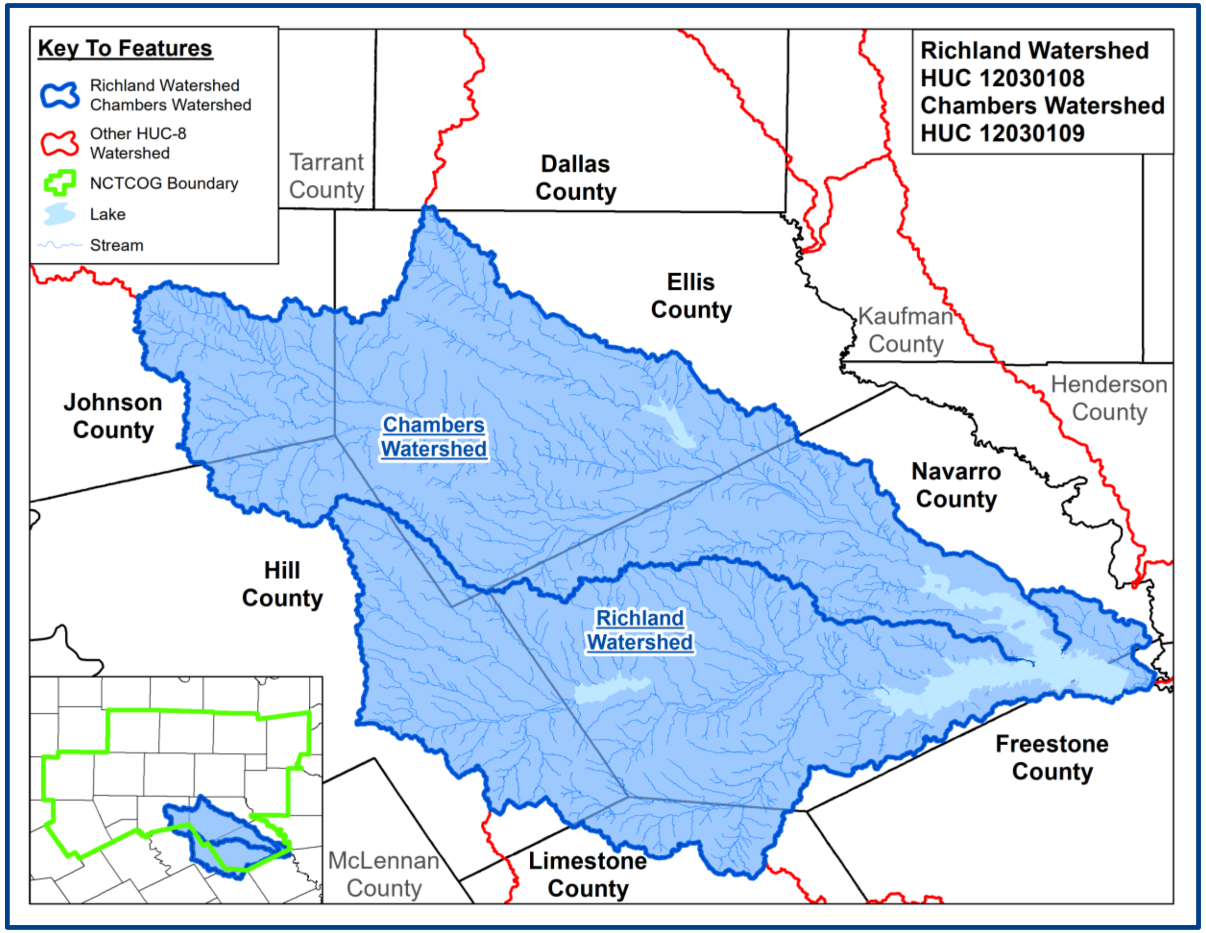
- Katy Onley – kOnley@halff.com

FEMA:

- Alan Johnson– alan.johnson@fema.dhs.gov

DISCOVERY | AGENDA

- NCTCOG Overview
- Risk MAP Overview
- Richland and Chambers Discovery
  - Activities
  - Findings
- Base Level Engineering
- Post Meeting Coordination

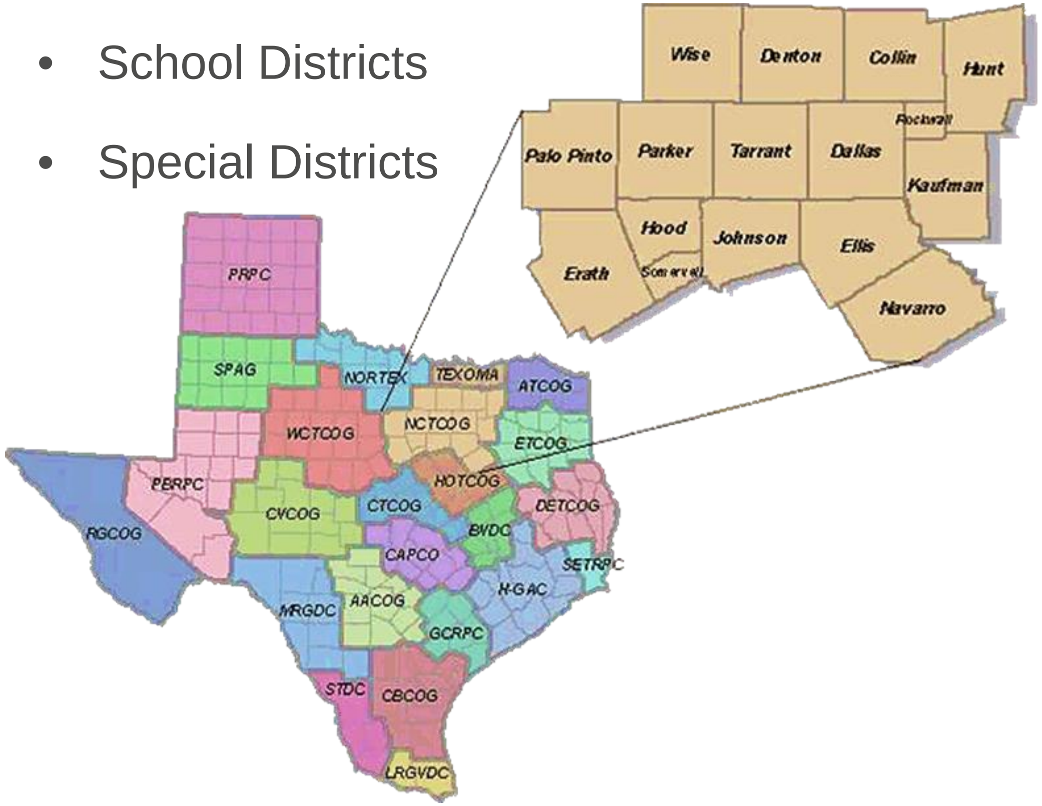


NCTCOG | WHAT IS NCTCOG'S ROLE?

VOLUNTARY ASSOCIATION OF, BY, AND FOR LOCAL GOVERNMENTS, ESTABLISHED IN 1966, TO HELP THEM:

- Plan for common needs
- Strengthen their individual and collective power
- Recognize regional opportunities
- Resolve regional problems
- Make joint decisions/cooperate for mutual benefit

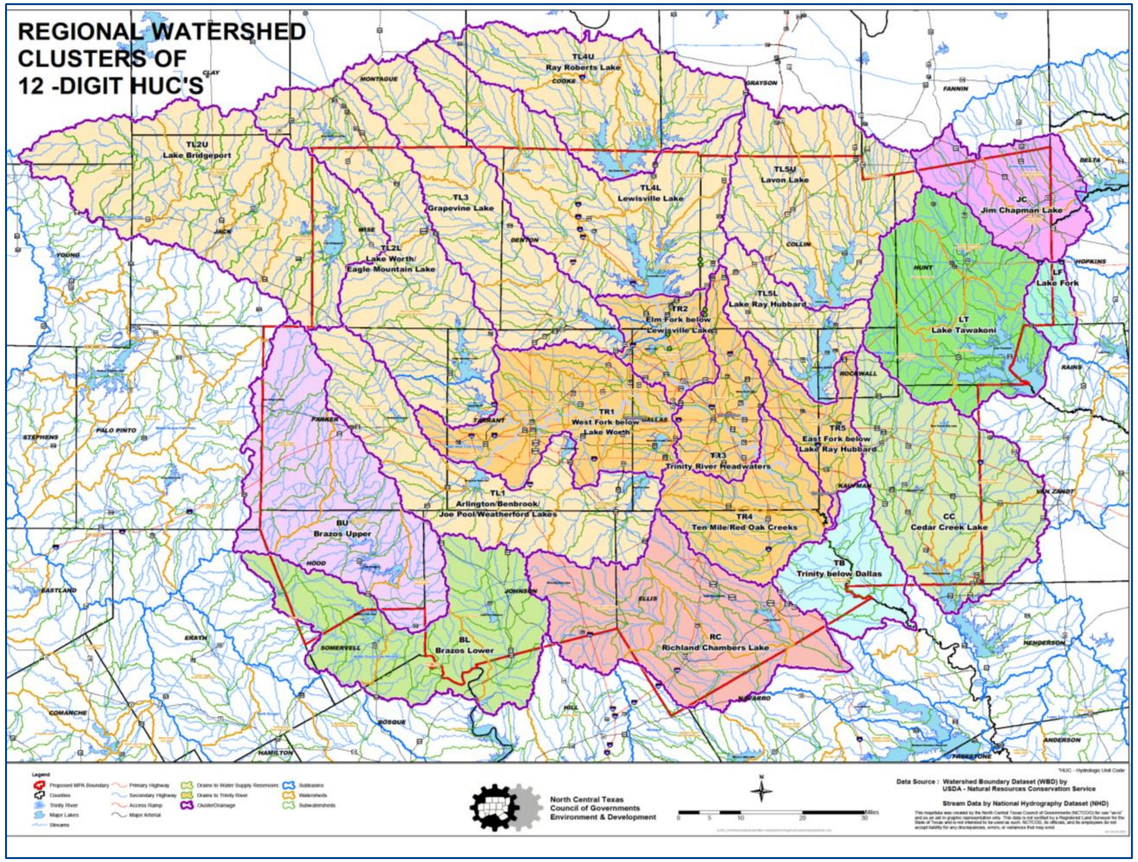
- 230+ Member Governments
  - Cities
  - Counties
  - School Districts
  - Special Districts



NCTCOG | WHAT IS NCTCOG'S ROLE?

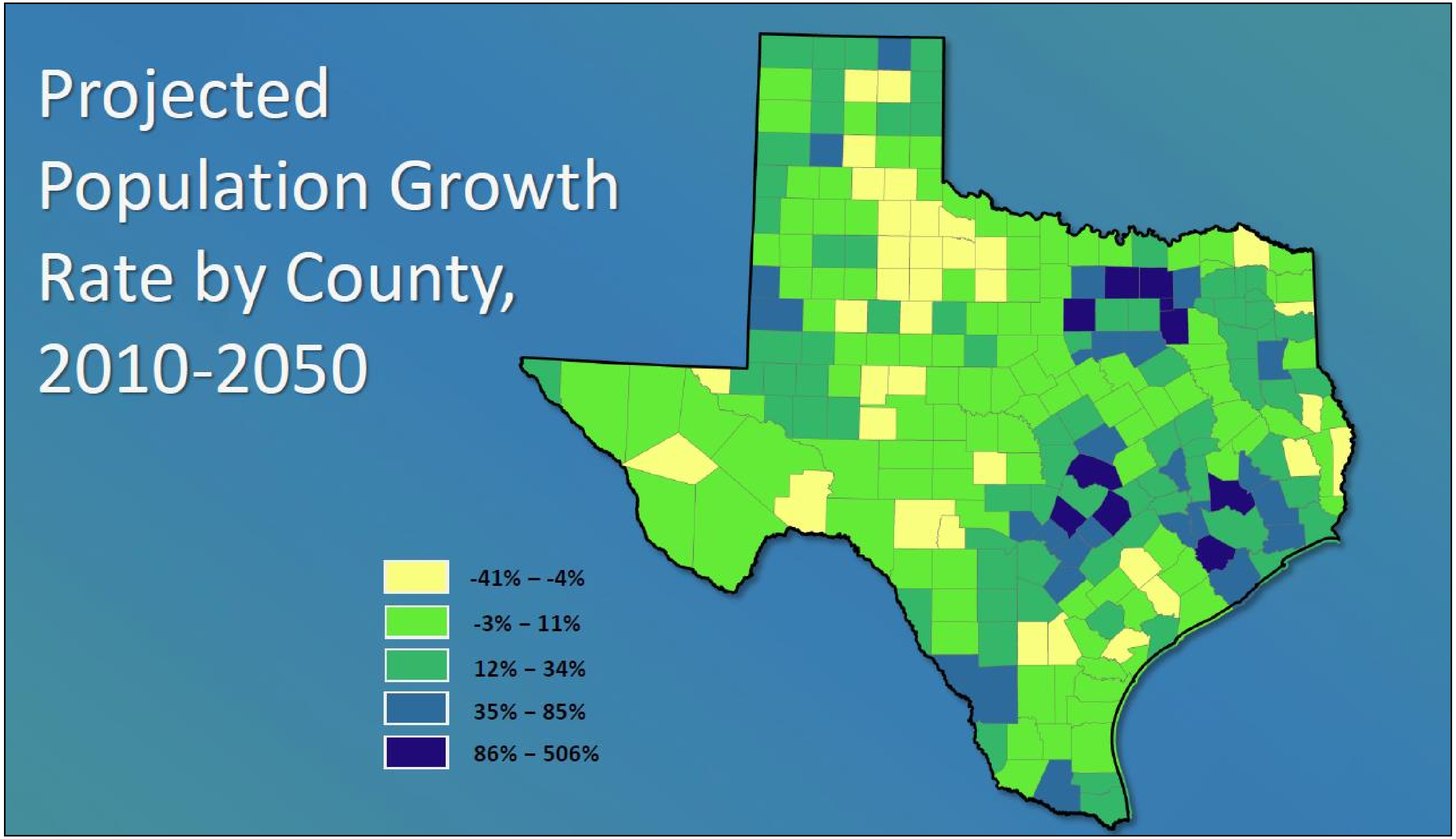
NCTCOG ENVIRONMENT AND DEVELOPMENT WATERSHED MANAGEMENT PROGRAM:

- Focus on water quality, stormwater, and floodplain topics/issues.
- Floodplain
  - NCT region does not have a flood control district. Lots of local/regional entities working in their own jurisdictions.
  - NCTCOG will never replace a flood control district, but as an agency, we work toward regional cooperation on flooding issues to help everyone accomplish common goals together.



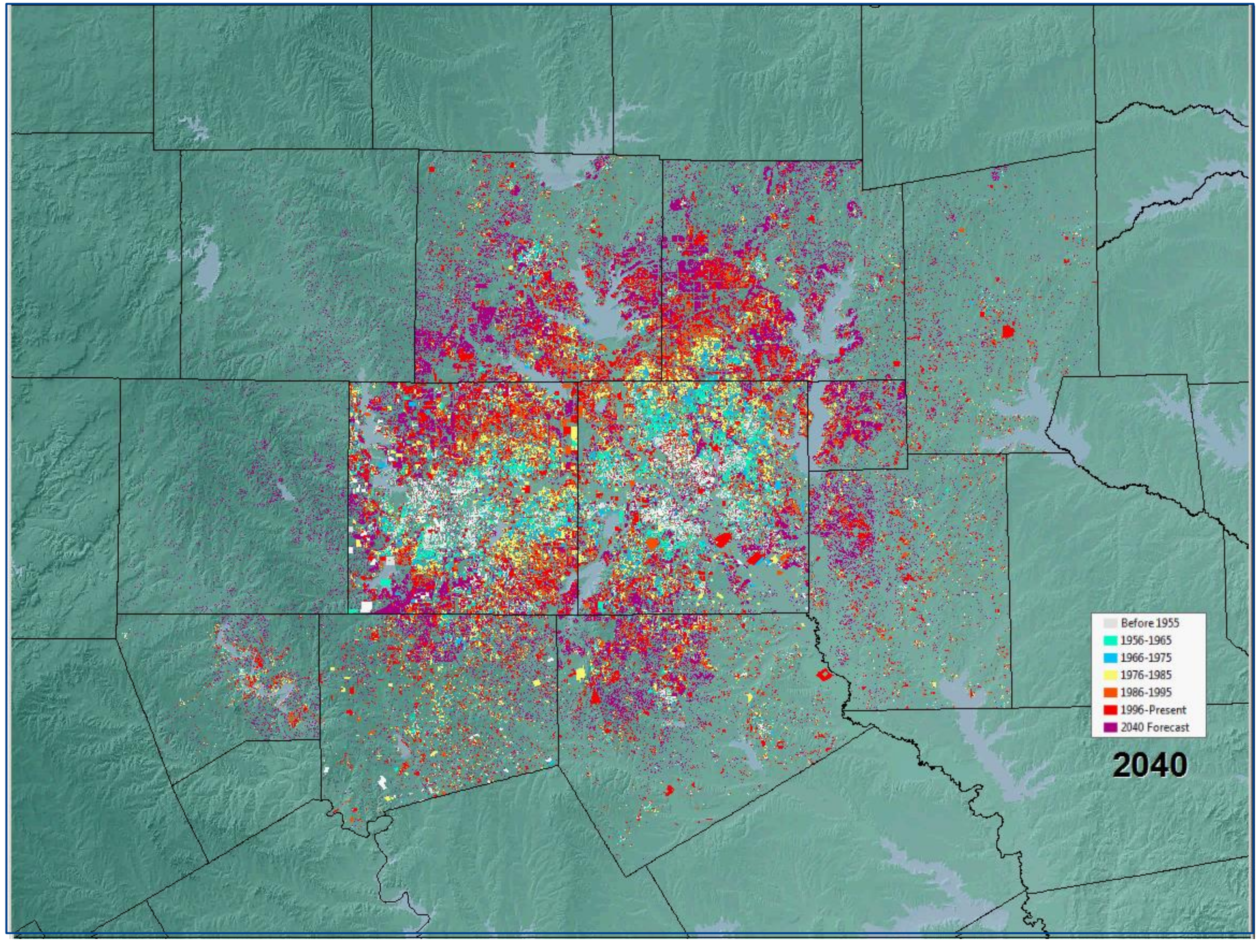
NCTCOG | WHAT IS NCTCOG'S ROLE?

Source : Dr. Lloyd Potter, Texas State Demographer



NCTCOG | WHAT IS NCTCOG'S ROLE?

NORTH CENTRAL TEXAS 1950-2040 GROWTH



NCTCOG | WHAT IS NCTCOG'S ROLE?

NCTCOG GOALS AS A COOPERATING TECHNICAL PARTNER

- Direct Goals:
  - Better data for better decision making
  - Coordination between communities and local/regional/state/federal organizations (what COGs do best!)
  - Partnerships
- Indirect Goals:
  - Higher Standards

FEMA'S RISK MAPPING, ASSESSMENT, AND PLANNING (MAP) PROGRAM

- Provide flood information and tools for better **protection**
- **Action-Driven** through local understanding and ownership of risk

FEMA'S RISK MAPPING, ASSESSMENT, AND PLANNING (MAP) PROGRAM

- Provide flood information and tools for better **protection**
- **Action-Driven** through local understanding and ownership of risk

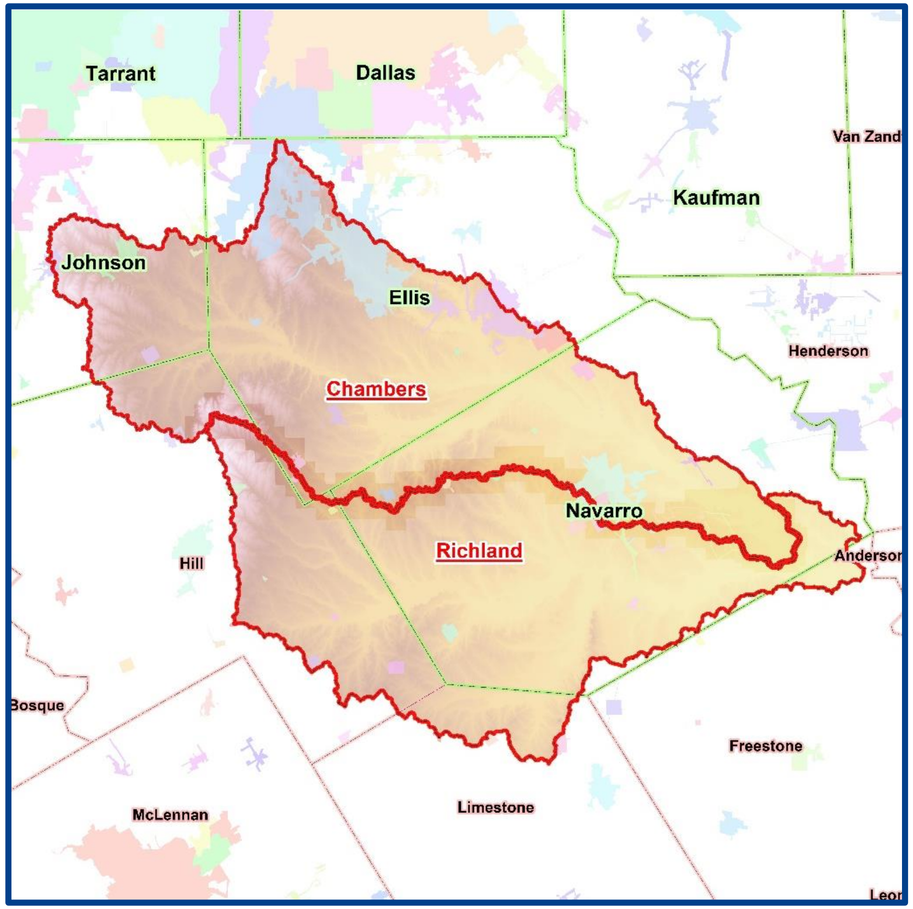
Discovery Process

And Base Level Engineering

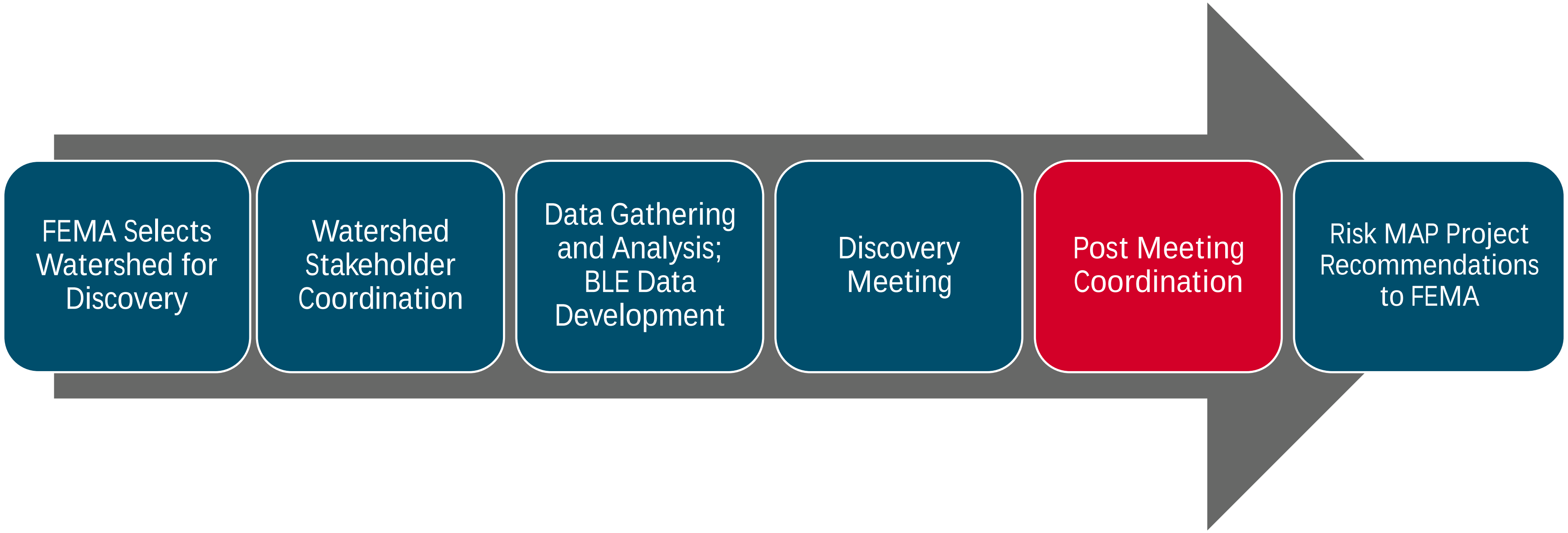
DISCOVERY | GOALS

NCTCOG LEADING RICHLAND AND CHAMBERS DISCOVERY

- Gather Information
  - Local flood risks and hazards
  - Current mitigation efforts
- Provide Information
  - Mitigation planning and actions
  - Risk communication



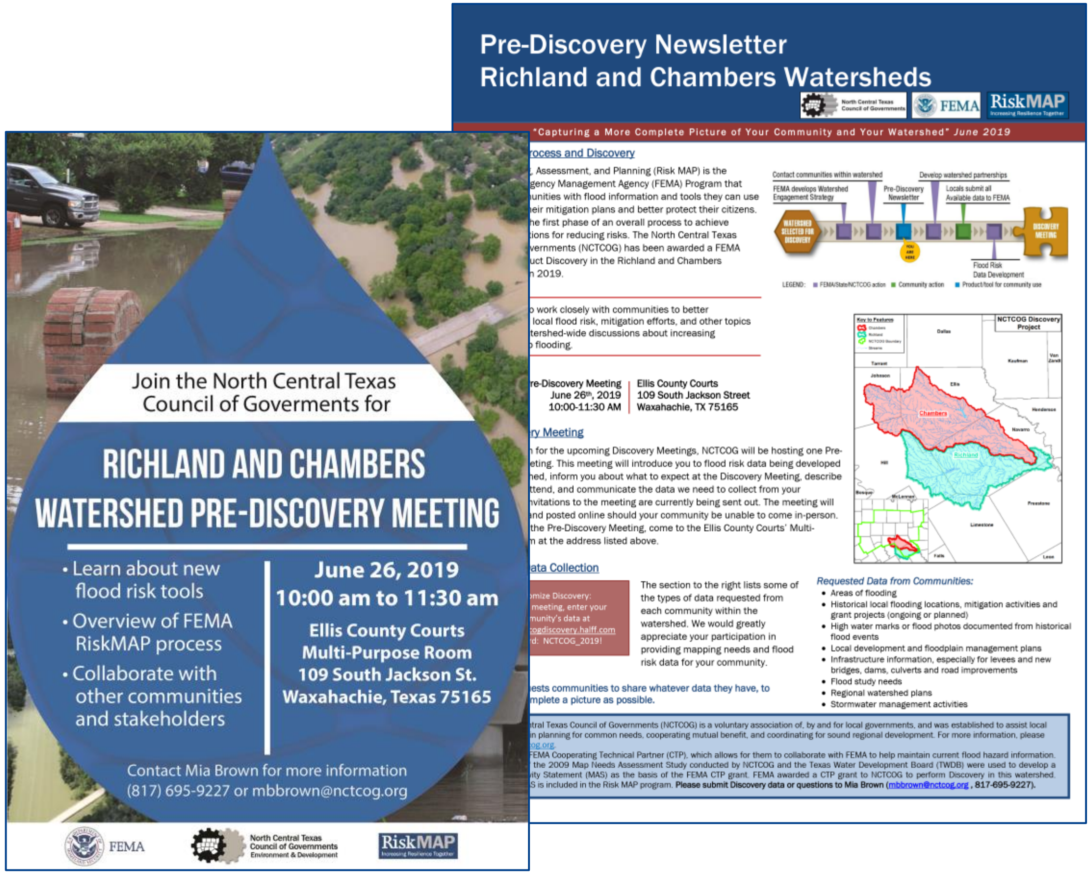
DISCOVERY | DISCOVERY PROCESS

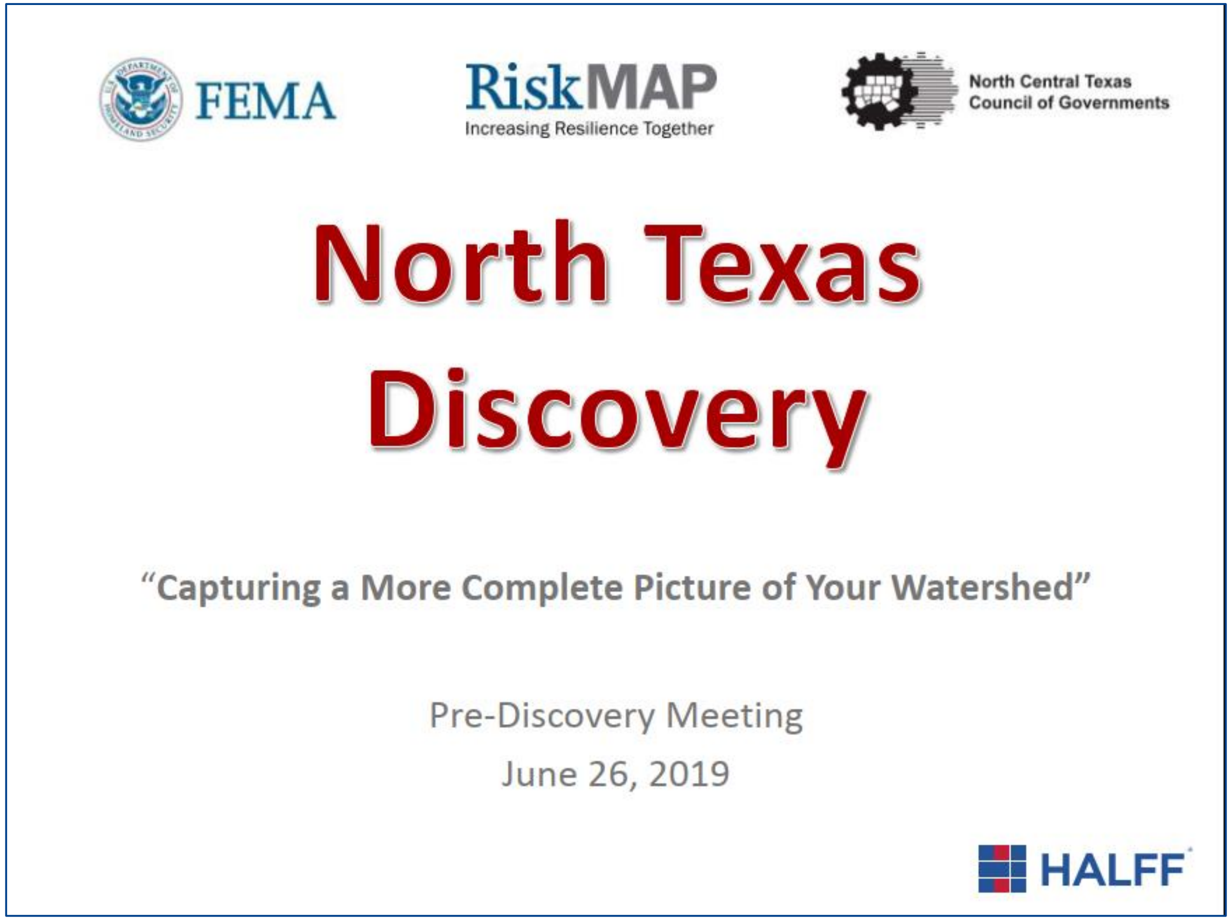


DISCOVERY | ACTIVITIES

PRE-DISCOVERY MEETING

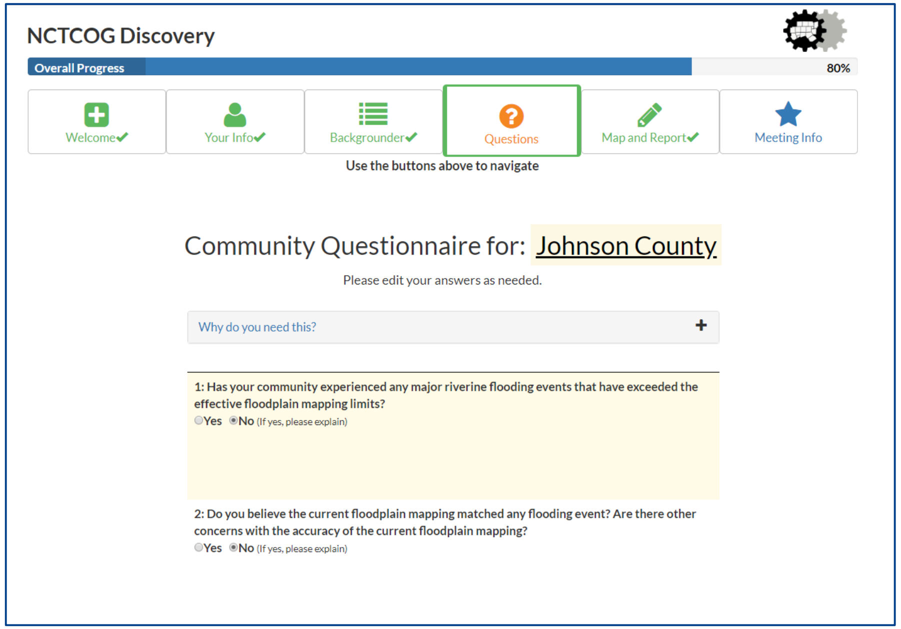
- Inform communities of process and timeline

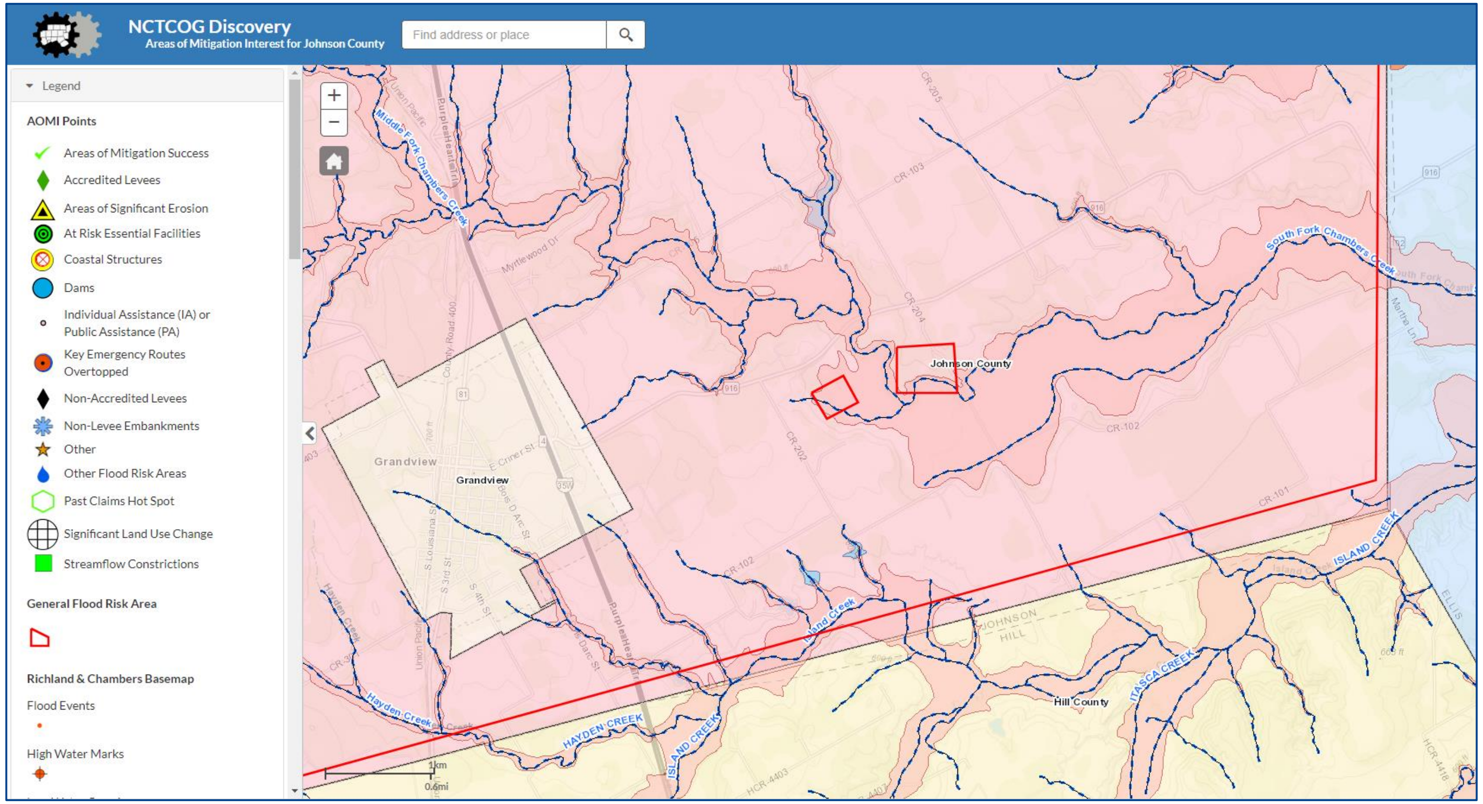




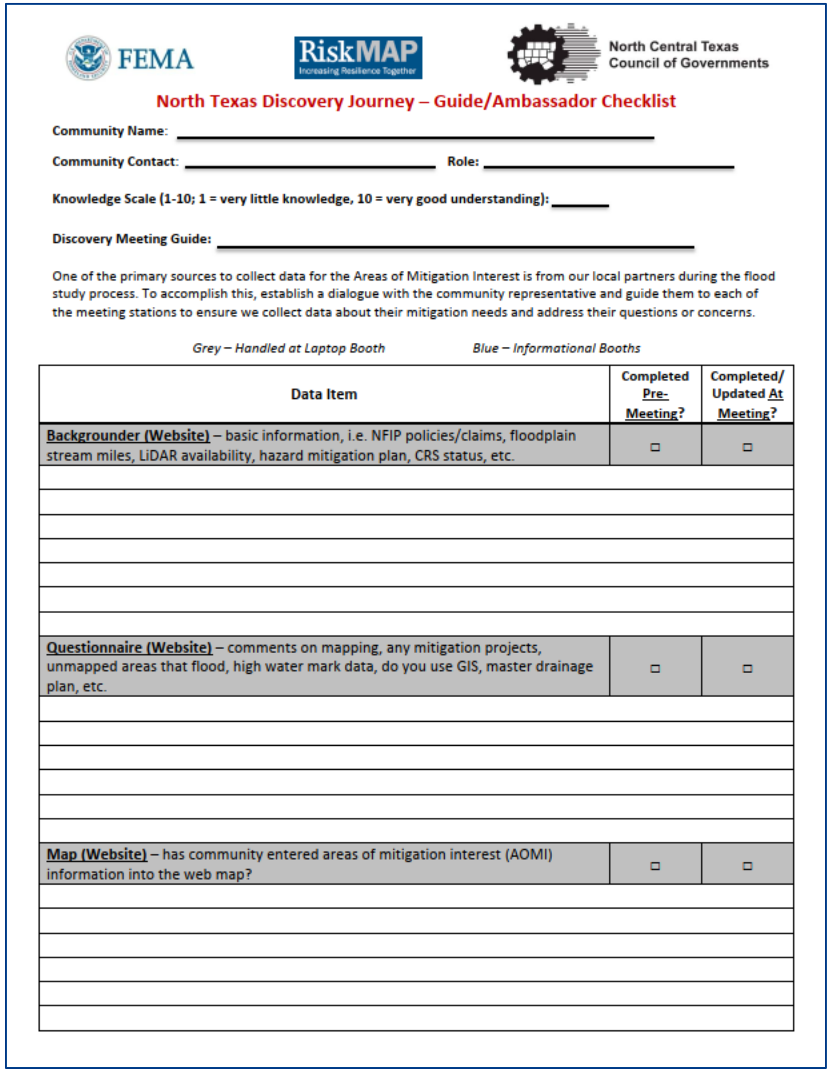
COMMUNITIES SUBMITTED FLOOD RISKS ONLINE

- Low Water Crossings
- Flooding Concerns
- Significant Land Use Change
- Issues with Effective Mapping





DISCOVERY | ACTIVITIES



North Central Texas Council of Governments

North Texas Discovery Journey – Guide/Ambassador Checklist

Community Name: ______________________

Community Contact: ____________ **Role:** ____________

Knowledge Scale (1-10; 1 = very little knowledge, 10 = very good understanding): ____

Discovery Meeting Guide: ______________________

One of the primary sources to collect data for the Areas of Mitigation Interest is from our local partners during the flood study process. To accomplish this, establish a dialogue with the community representative and guide them to each of the meeting stations to ensure we collect data about their mitigation needs and address their questions or concerns.

Grey – Handled at Laptop Booth *Blue – Informational Booths*

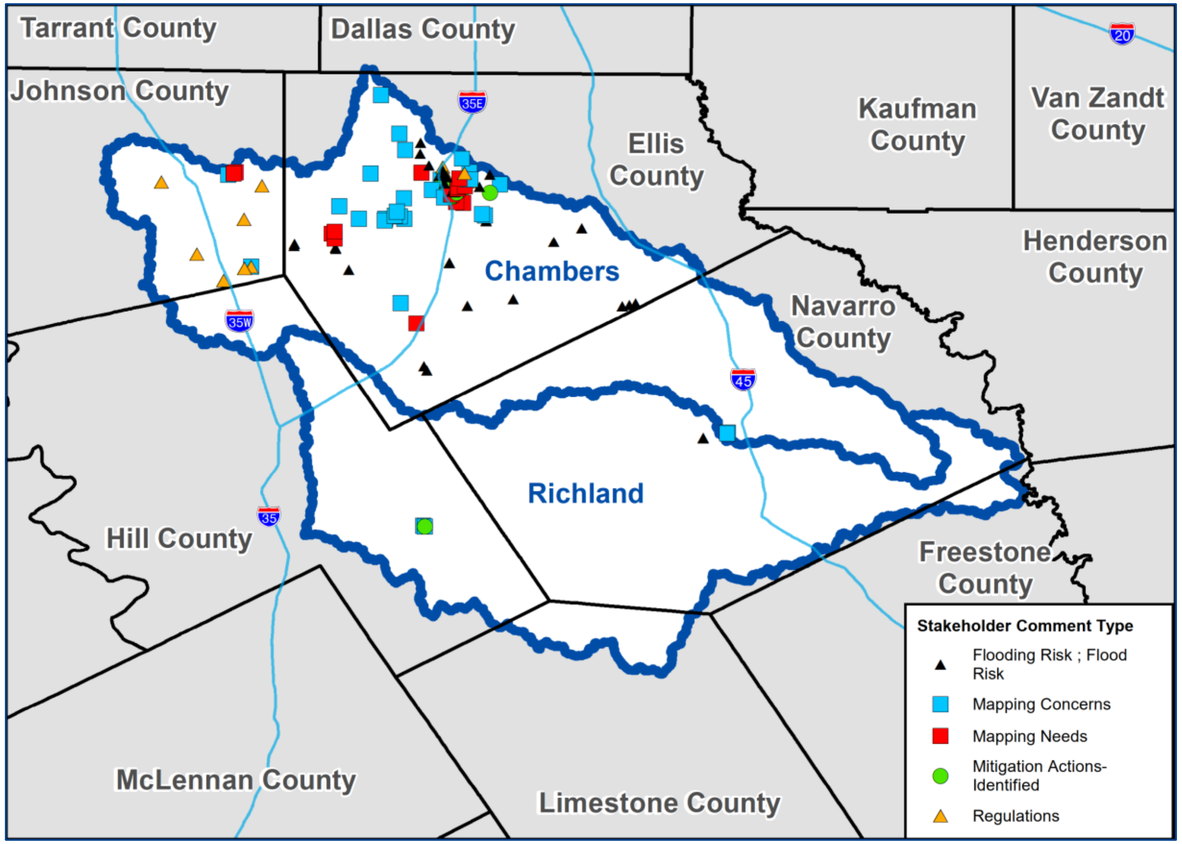
Data Item	Completed Pre-Meeting?	Completed/ Updated At Meeting?
Backgrounder (Website) – basic information, i.e. NFIP policies/claims, floodplain stream miles, LiDAR availability, hazard mitigation plan, CRS status, etc.	□	□
Questionnaire (Website) – comments on mapping, any mitigation projects, unmapped areas that flood, high water mark data, do you use GIS, master drainage plan, etc.	□	□
Map (Website) – has community entered areas of mitigation interest (AOMI) information into the web map?	□	□

DISCOVERY MEETING – DECEMBER 5TH

- Receive flooding issues
- Facilitate discussion among stakeholders

DISCOVERY | FINDINGS

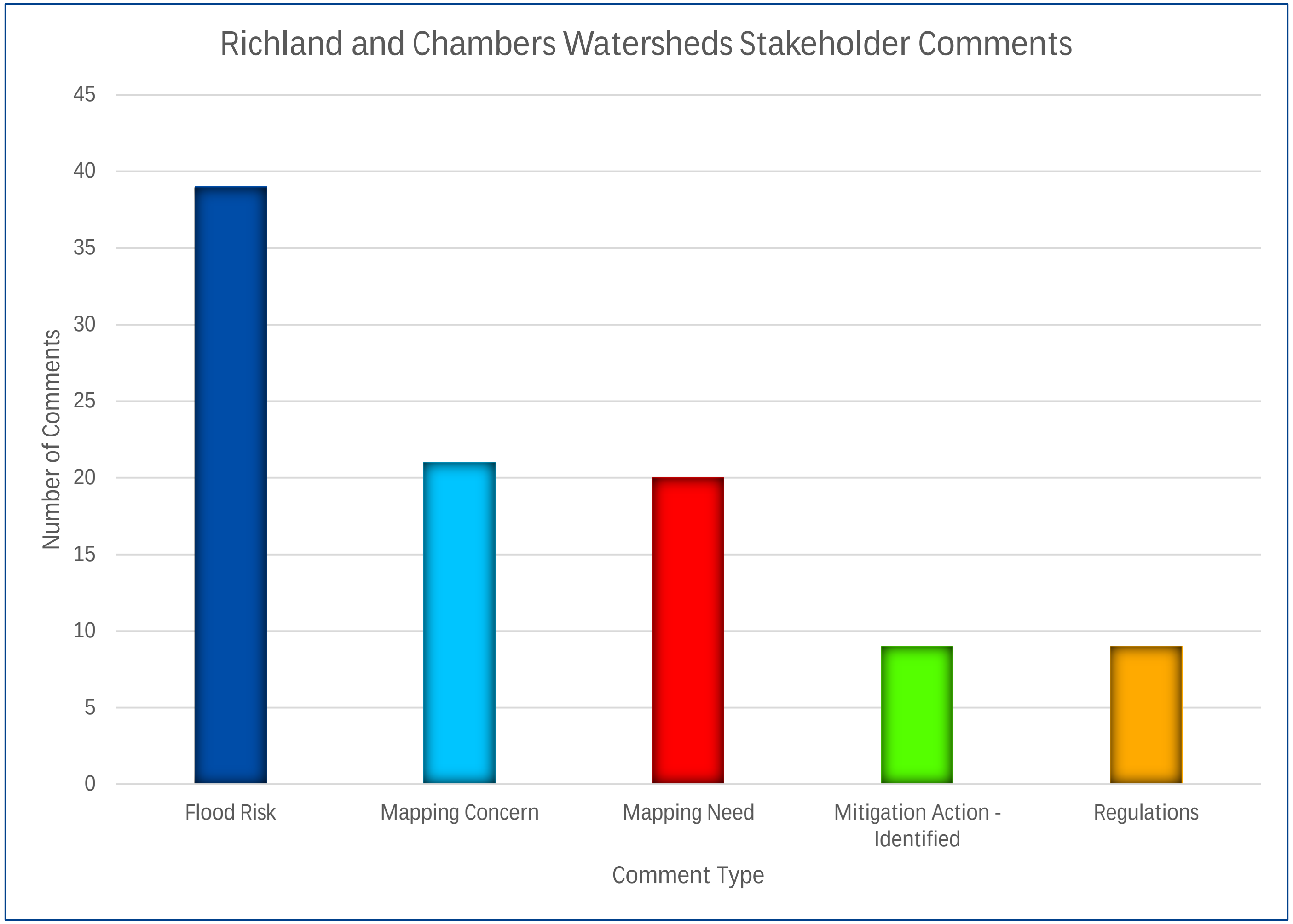
98 STAKEHOLDER MAP COMMENTS



Number of Comments	Community
1	Cedar Hill
28	Ellis County
5	Johnson County
2	Malone
4	Midlothian
3	Oak Valley
3	Retreat
52	Waxahachie

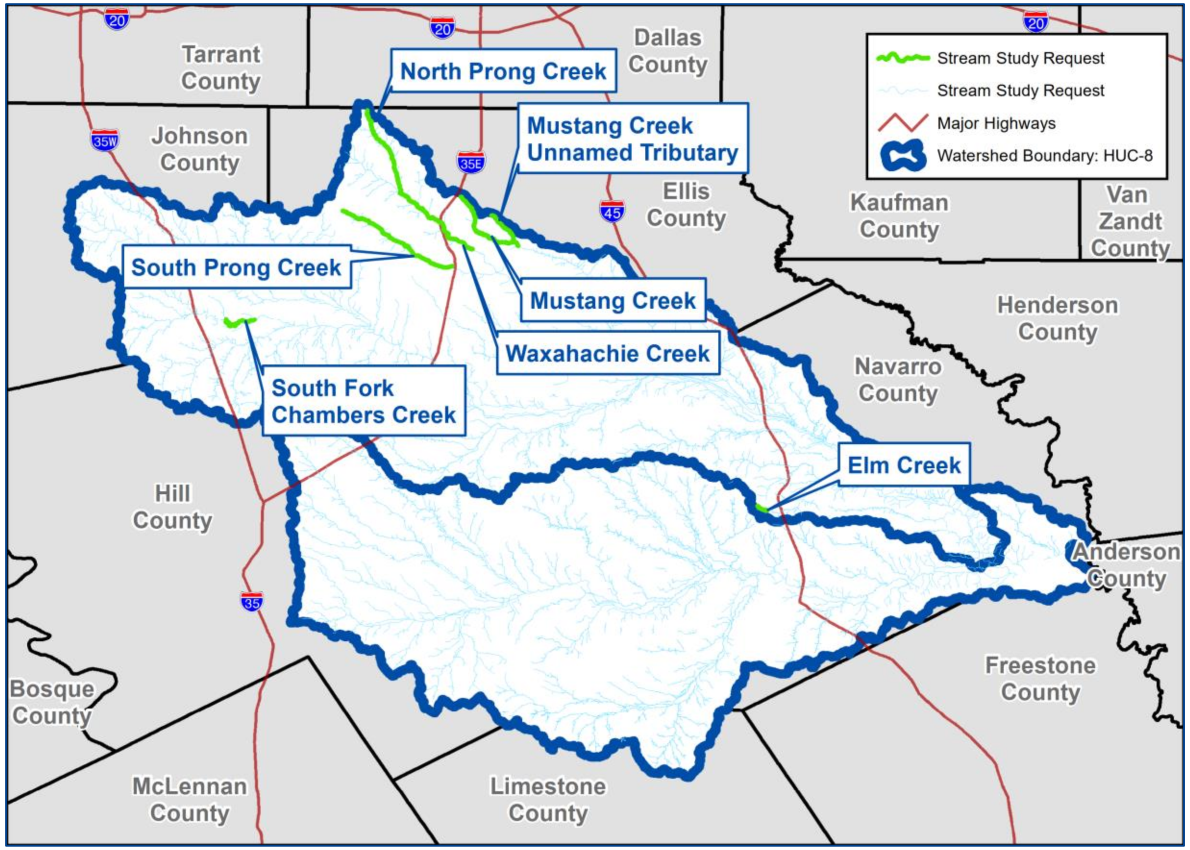
DISCOVERY | FINDINGS

STAKEHOLDER COMMENTS BY TYPE

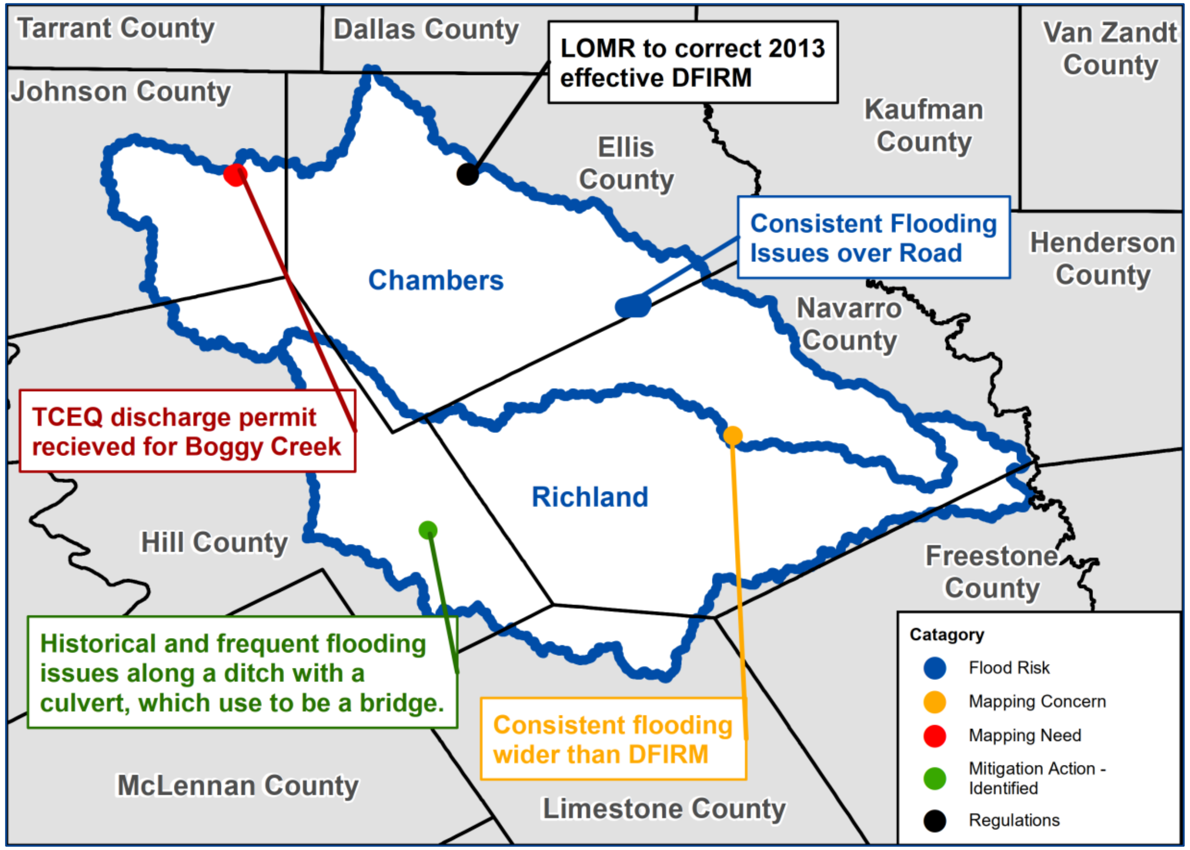


DISCOVERY | FINDINGS

REQUESTED STUDY STREAMS

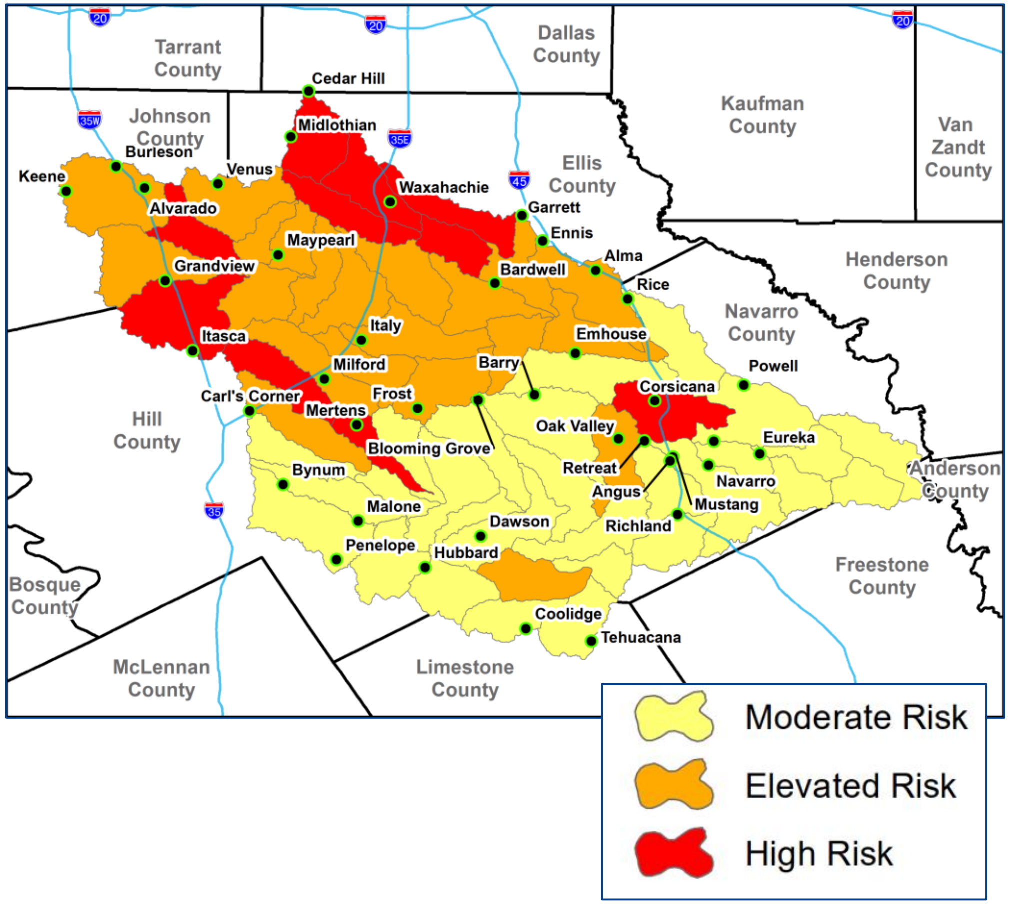


SAMPLE COMMENTS SUBMITTED



HUC-12 WATERSHED PRIORITIZATION

Criteria No.	Description	Max Weight
1	Population density	10
2	Population change	10
3	Predicted population growth	10
4	History of flood claims	10
5	History of flood events	10
6	Number of Letters of Map Change (LOMR/LOMA)	5
7	Available current topography (Y/N)	10
8	Age of technical data – hydrology (num. of years)	5
9	Age of technical data – hydraulics (num. of years)	5
10	Ability to leverage current studies (Y/N)	5
11	Potential for local funding (Y/N)	5
12	Potential for local “work in kind” (Y/N)	3
13	Previous contribution to a FEMA study (Y/N)	2
14	Stakeholder mapping request	10



DISCOVERY | FINDINGS

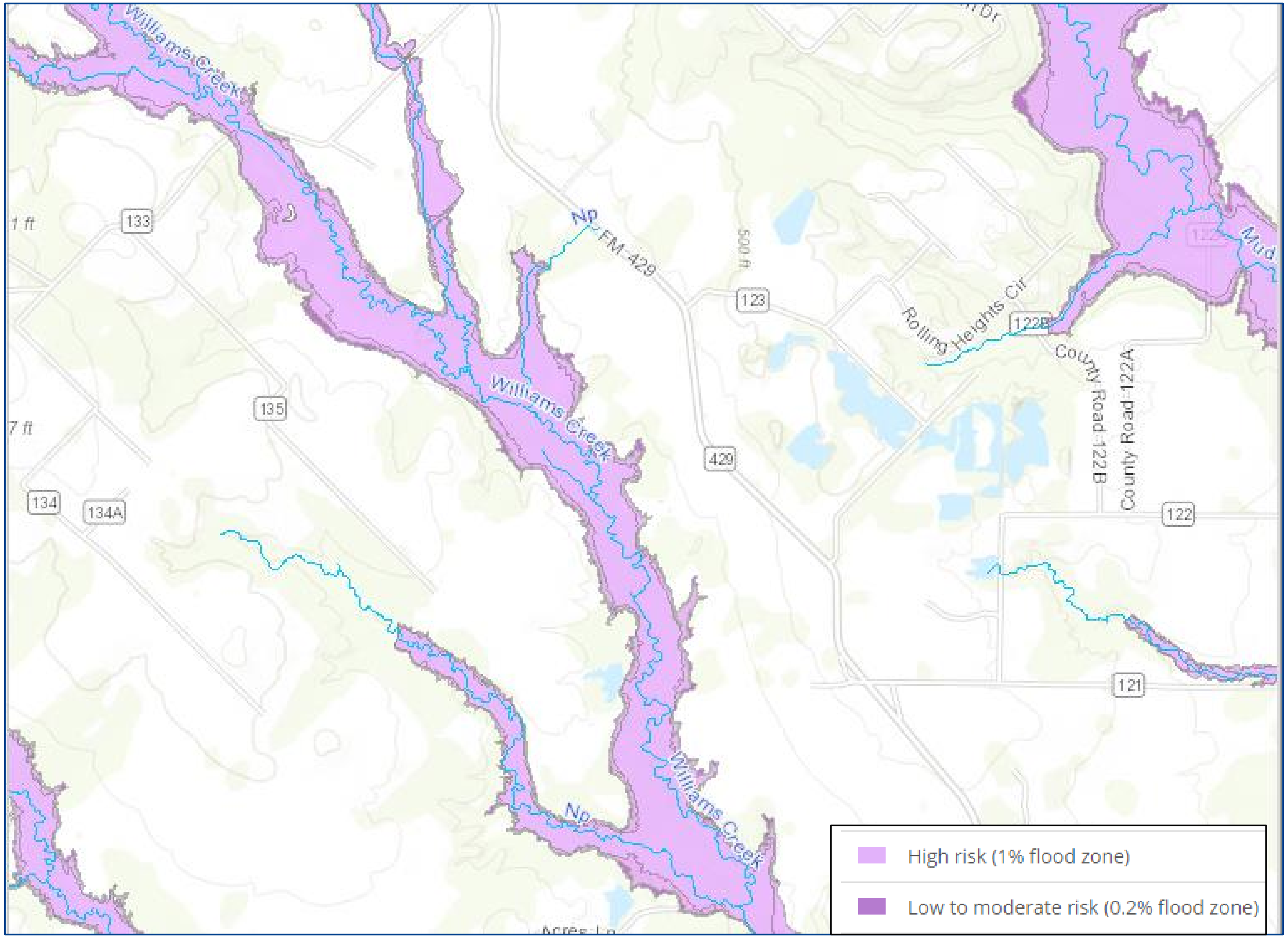
BASE LEVEL ENGINEERING

- Requires LiDAR
- Automated hydraulic modeling
- Model Review and Adjustments
- Gage Review included in hydrology

DISCOVERY | FINDINGS

BASE LEVEL ENGINEERING

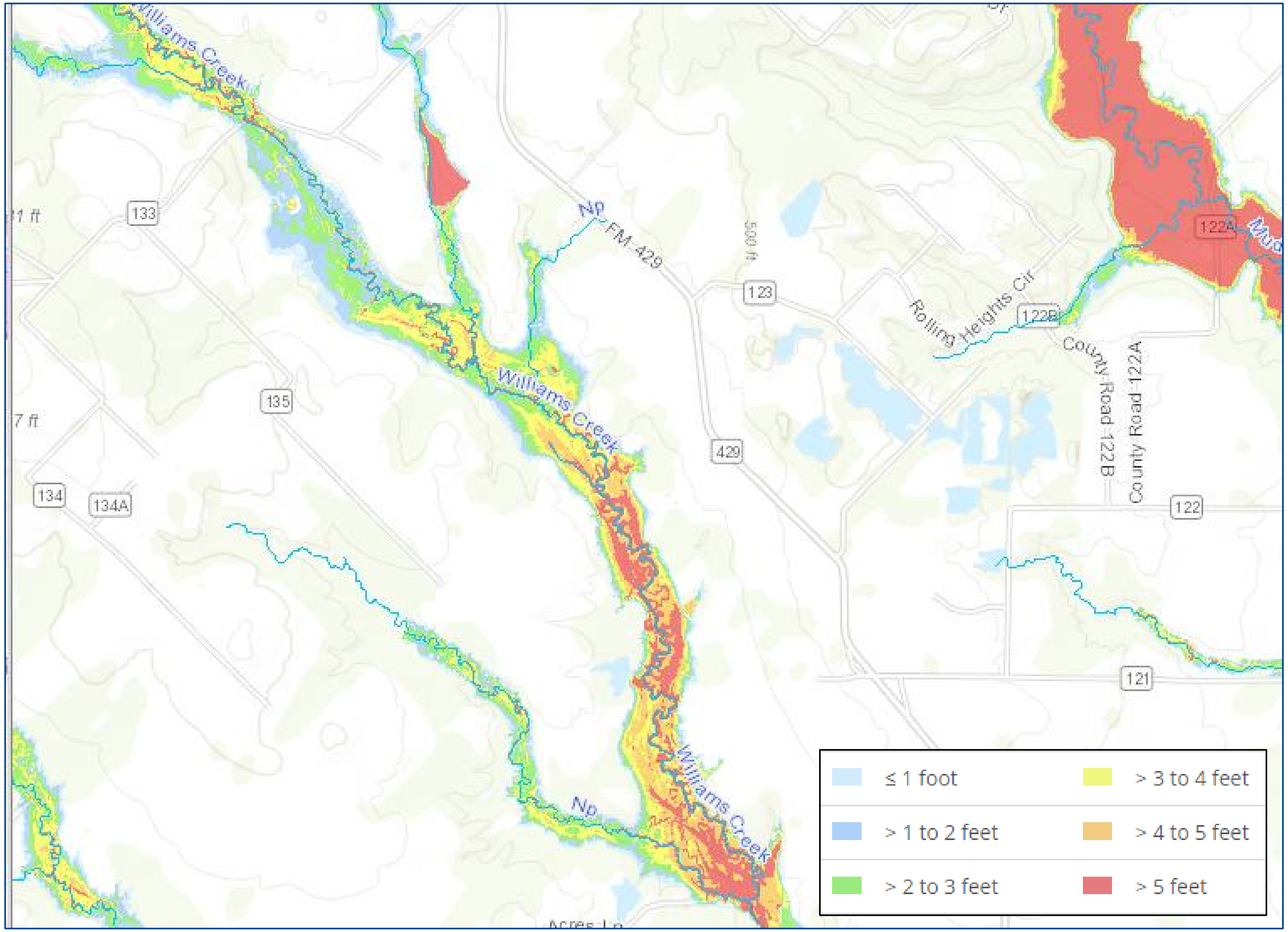
- Hydraulic modeling
  - 10%, 4%, 2%, 1% and 0.2% storm events
- Floodplain Boundaries
  - 10%, 1% and 0.2%



DISCOVERY | FINDINGS

BASE LEVEL ENGINEERING

- Depth and Analysis Grids
- Areas of Expanded Flood Risk
- Flood Risk Assessment



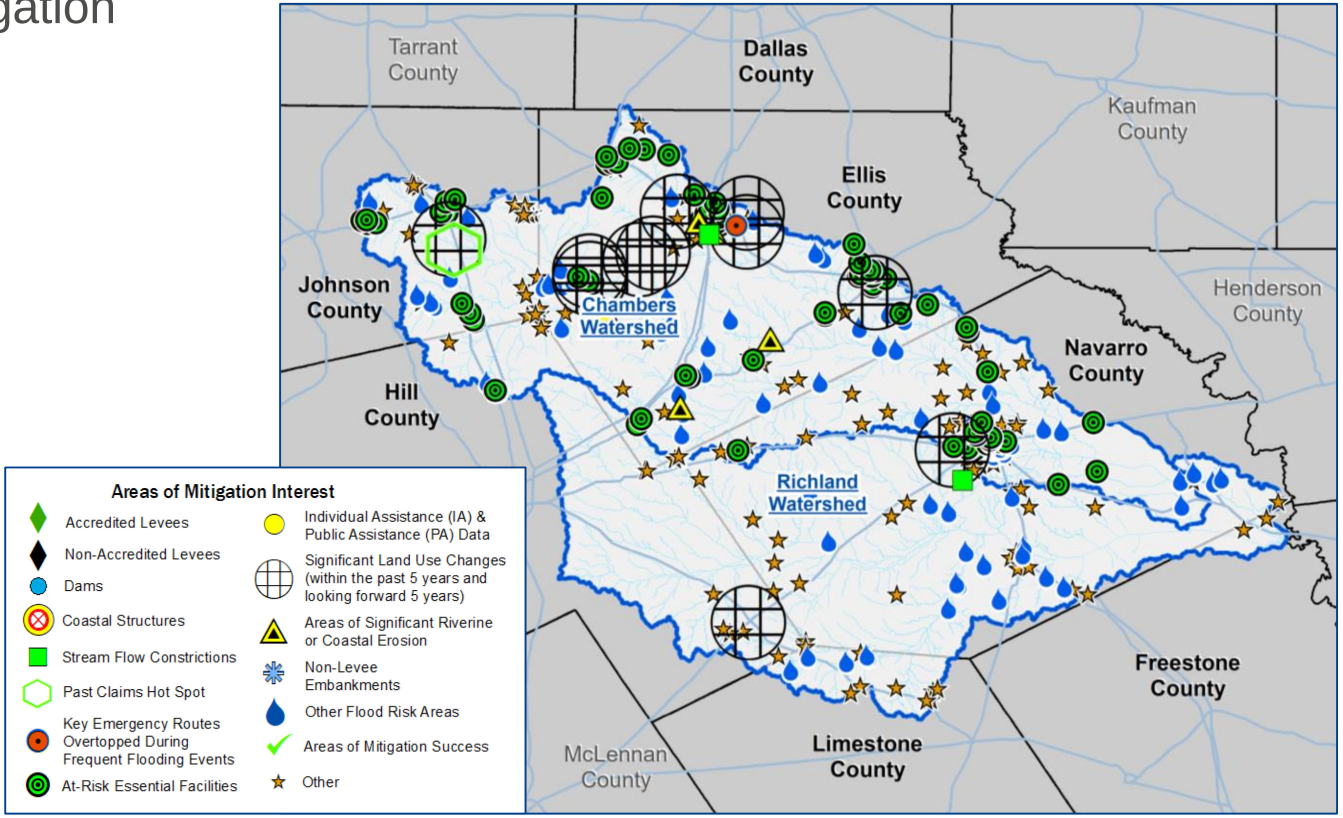
DISCOVERY | FINDINGS

AREAS OF MITIGATION INTEREST (AOMI)

- Structure inventory for future Discovery/Mitigation efforts
- Places with unknown or increased flood risk
- Identified by communities

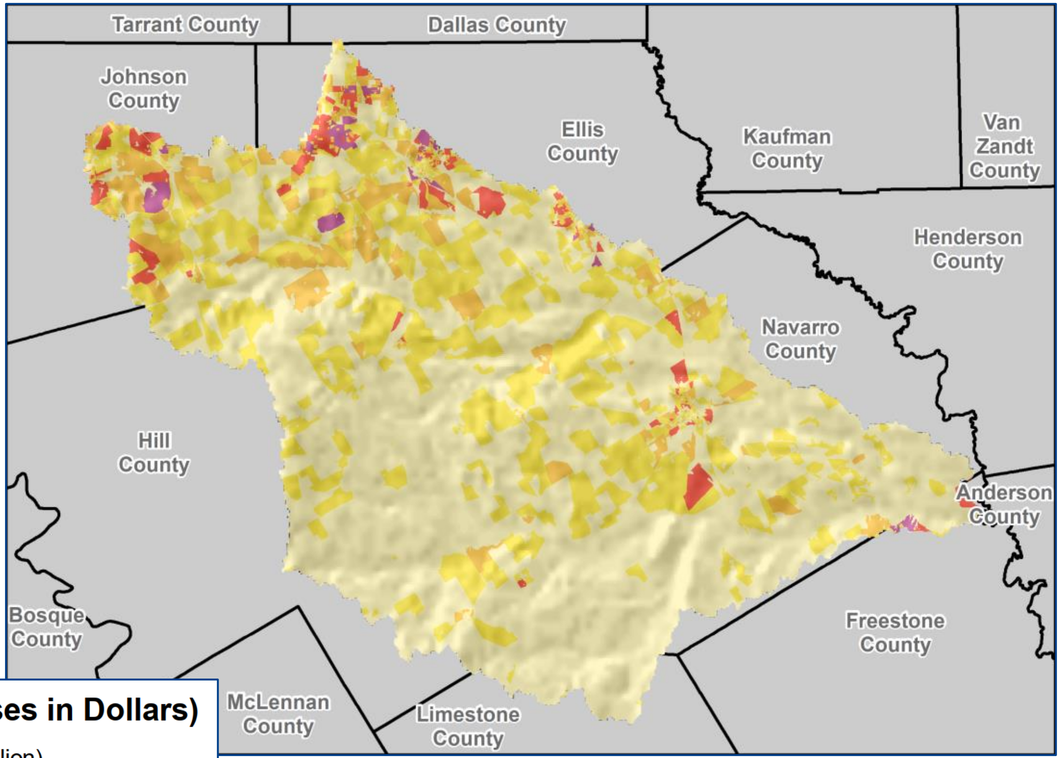
Key to Features

- AOMI Points
- Model Stream
- Mapping: 100-Year



HAZUS-BASED 100-YEAR POTENTIAL LOSS ESTIMATES

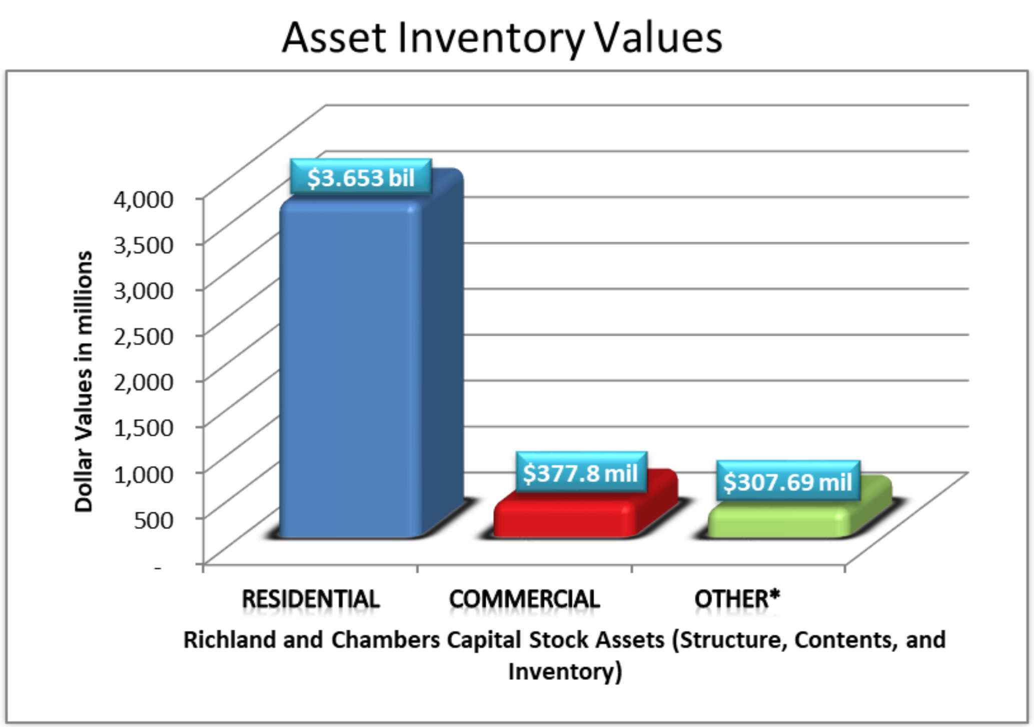
- Identify flooding consequences in damages and other losses
- Based on 100 Year Depth Grids and at-risk assets
- Can be further refined



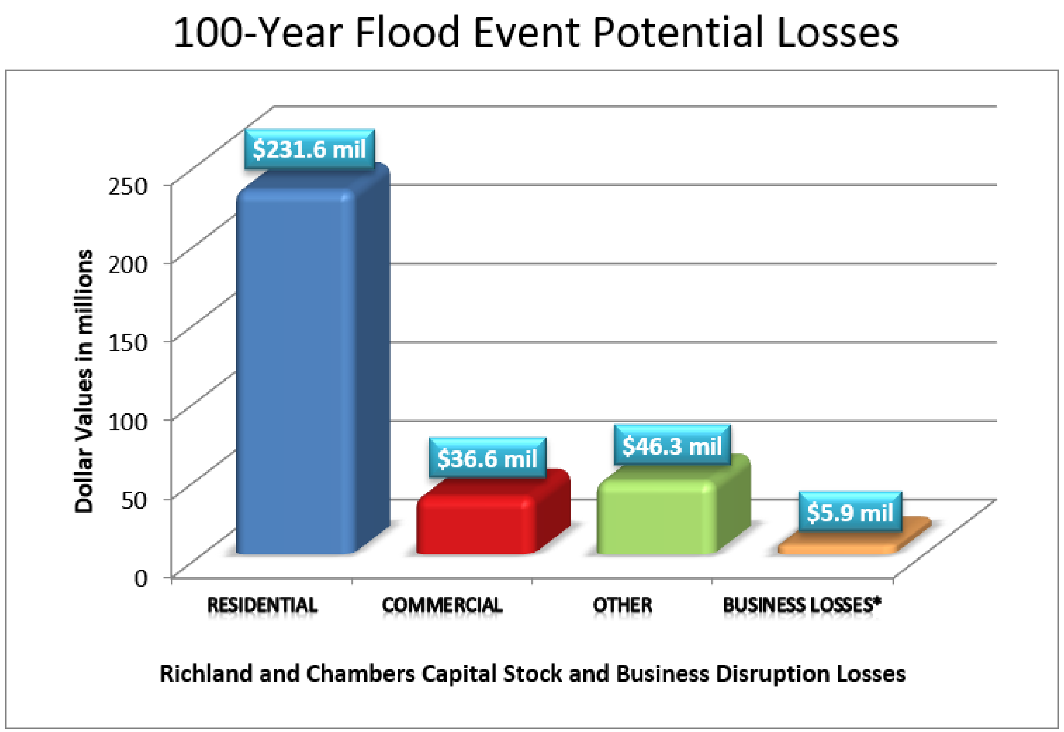
Flood Risk (Potential Losses in Dollars)

- Very Low Risk (Up to $3.3 Million)
- Low Risk (Up to $11.3 Million)
- Medium Risk (Up to $27.8 Million)
- High Risk (Up to $65.3 Million)
- Very High Risk (Up to $213.5 Million)

HAZUS-BASED 100-YEAR POTENTIAL LOSS ESTIMATES



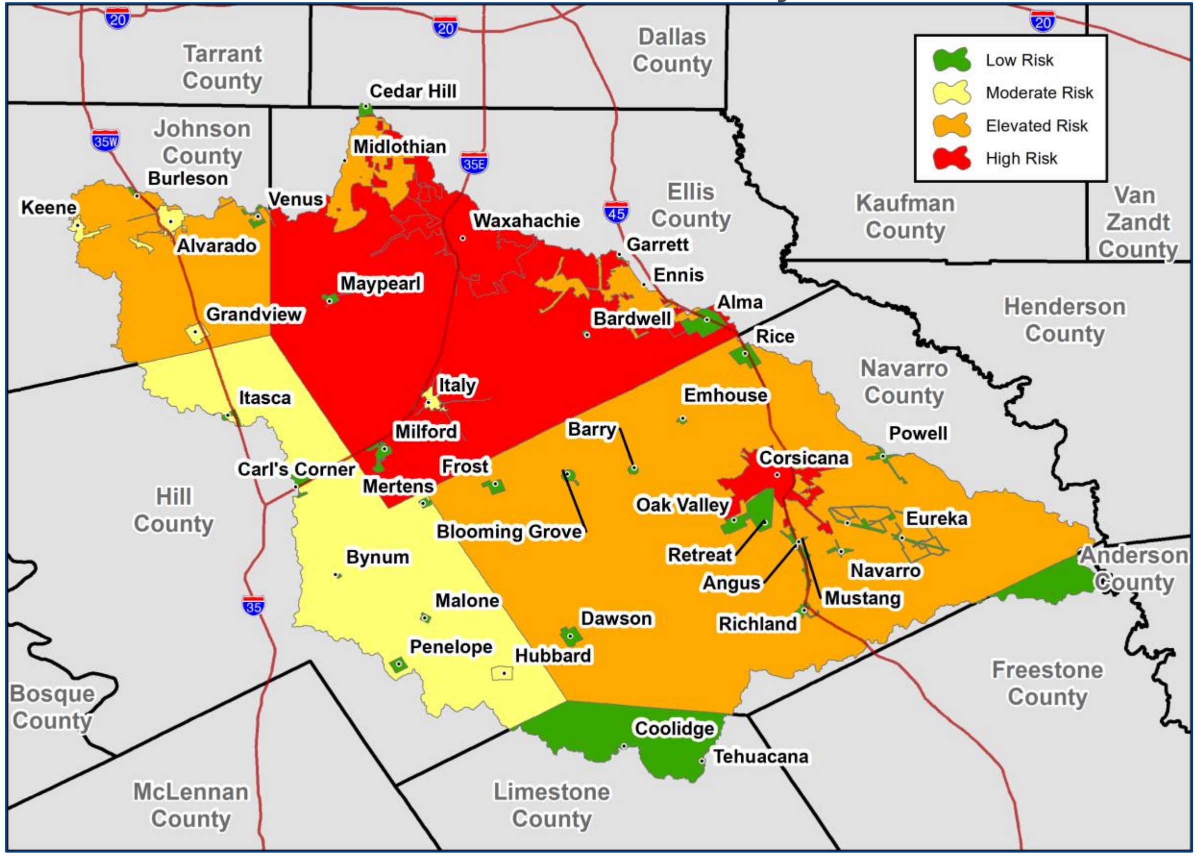
***Other** structure types include Industrial, Agricultural, Education, Religious and Government structures.



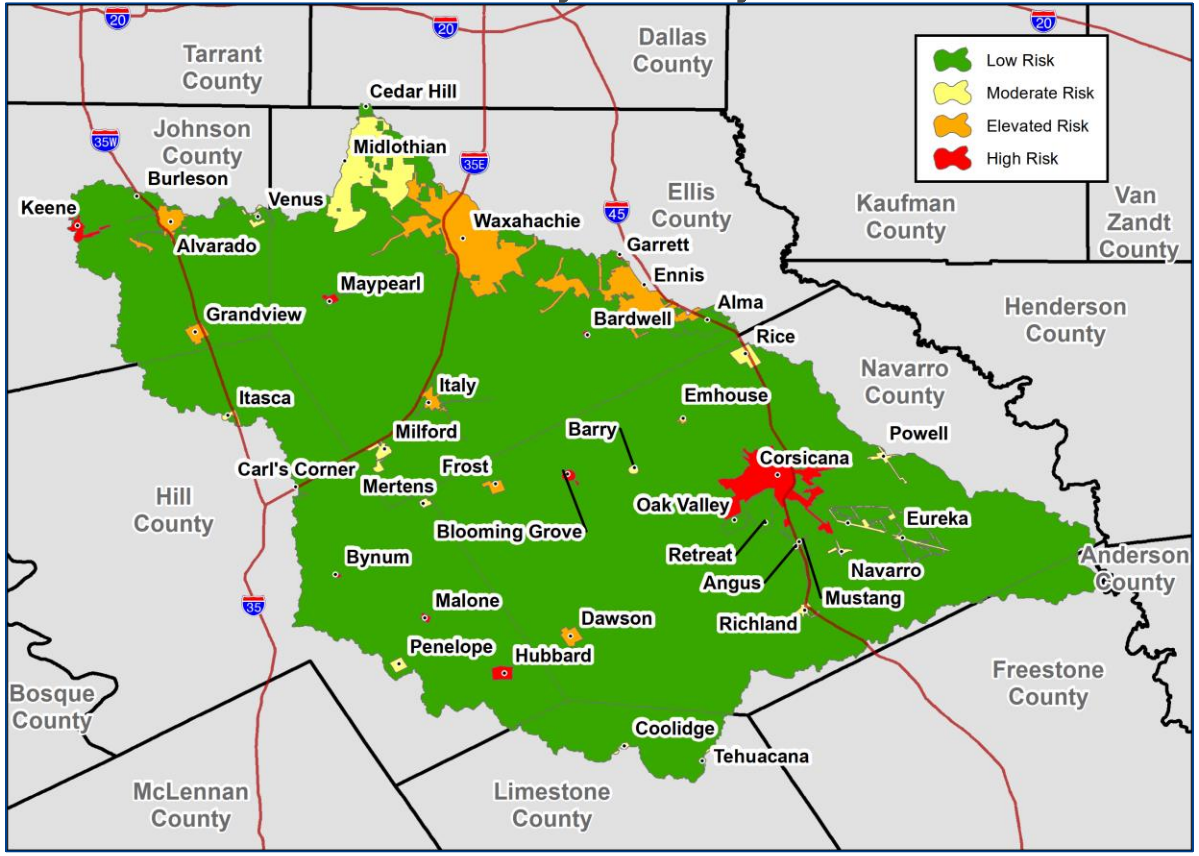
***Business Losses** are the sum of inventory Loss, Relocation Cost, Income Loss, Rental Income Loss, Wage Loss, and Direct Ouput Loss.

HAZUS-BASED 1% ANNUAL CHANCE LOSS ESTIMATES

Total Community Loss



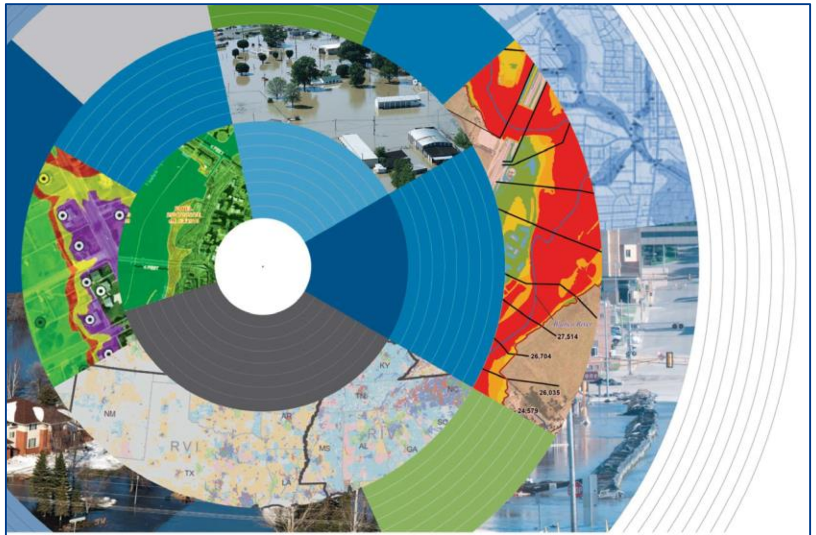
Community Loss by Area



DISCOVERY | POST MEETING COORDINATION

FLOOD RISK REPORT

- Prioritization Results
- Summary of Discovery Activities
- Historical Flooding
- Figures and Maps



Flood Risk Report

Richland Watershed and Chambers Watershed

HUC8s 12030108 and 12030109

June 2020

FEMA

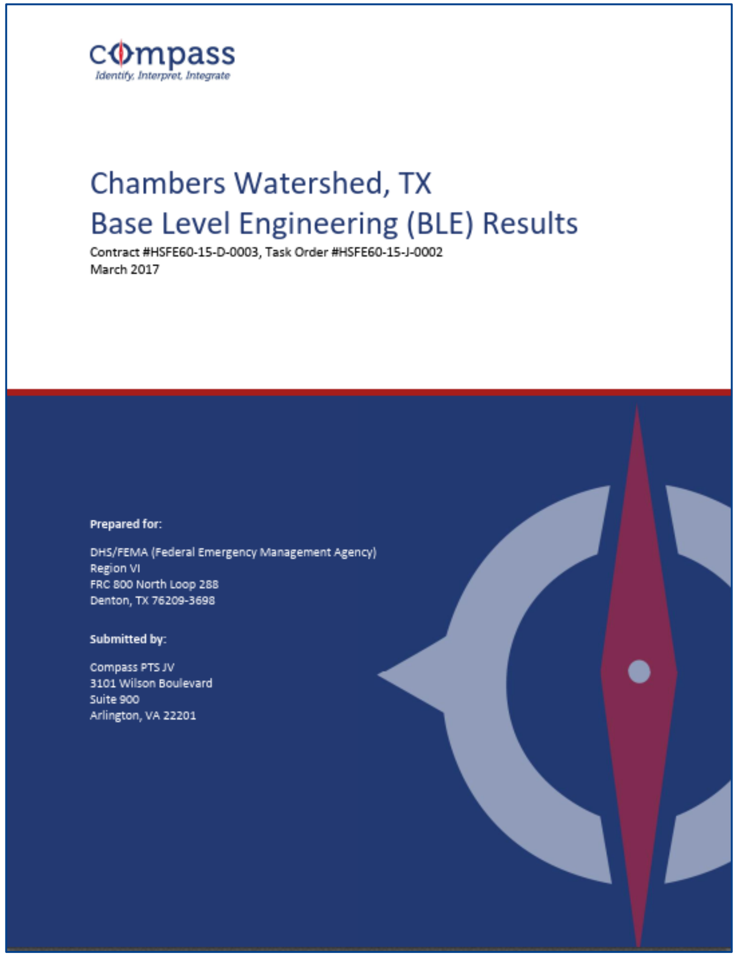
DISCOVERY | POST MEETING COORDINATION

FLOOD RISK REPORT

- Stakeholder Comments
- Community Snapshots
- BLE Report

DISCOVERY | POST MEETING COORDINATION

BLE DATASET AND REVIEW


compass
Identify, Interpret, Integrate

Chambers Watershed, TX
Base Level Engineering (BLE) Results
Contract #HSFE60-15-D-0003, Task Order #HSFE60-15-J-0002
March 2017

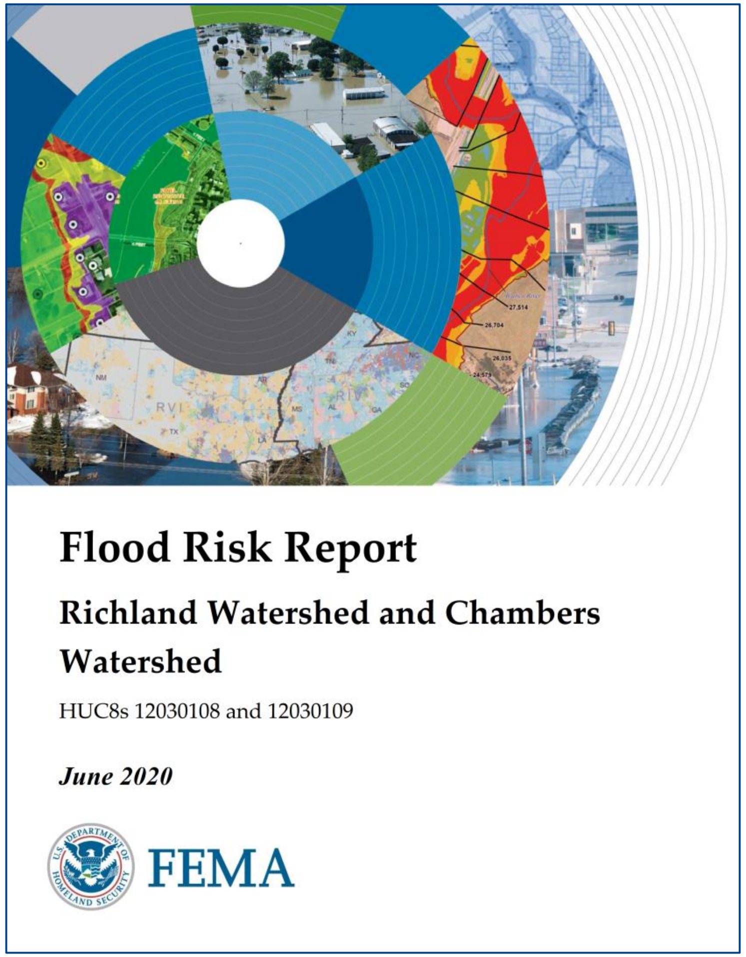
Prepared for:

DHS/FEMA (Federal Emergency Management Agency)
Region VI
FRC 800 North Loop 288
Denton, TX 76209-3698

Submitted by:

Compass PTS JV
3101 Wilson Boulevard
Suite 900
Arlington, VA 22201

FLOOD RISK REPORT


Flood Risk Report

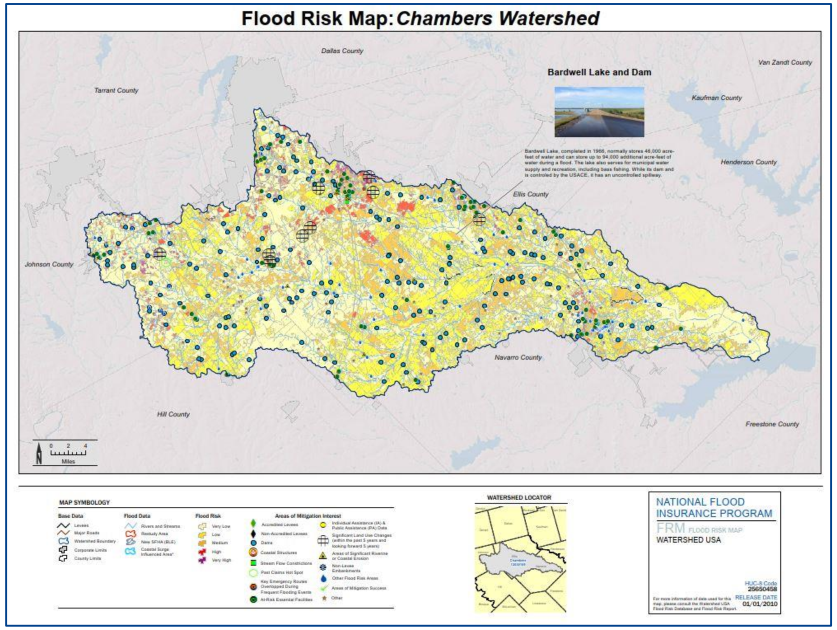
Richland Watershed and Chambers Watershed

HUC8s 12030108 and 12030109

June 2020

FEMA

FLOOD RISK MAP



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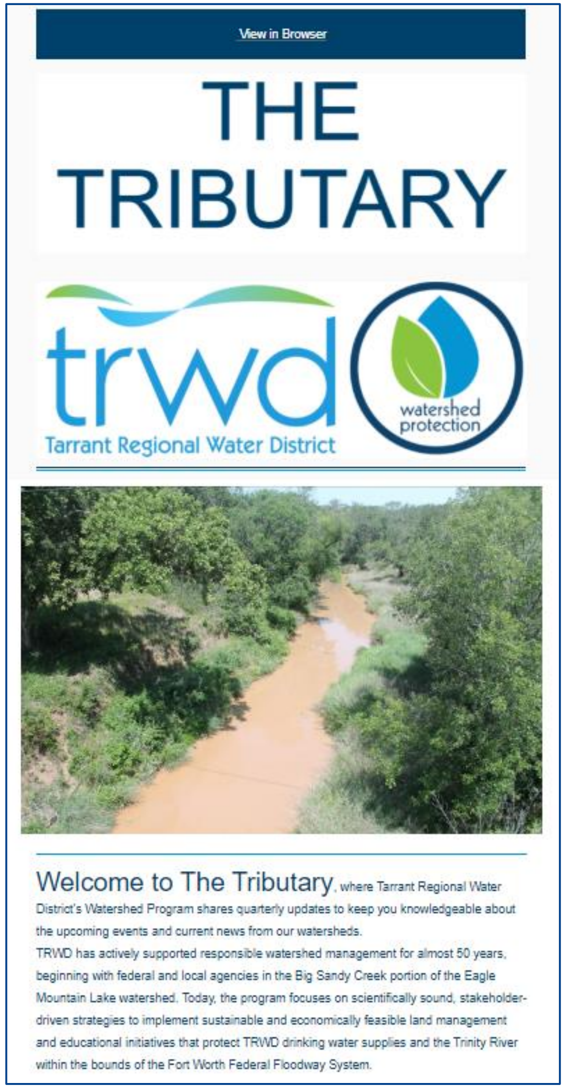
TRWD | NEWSLETTER

- Newsletter for Tarrant Regional Water District
- Discusses land management strategies and educational incentives
- Jurisdiction covers Richland-Chambers Reservoir and its watersheds
- Subscribe here:
  - https://trwd.us12.list-manage.com/subscribe?u=d62a6eab917276b12327e6786&id=bbe12d0ae4


View in Browser

THE TRIBUTARY

trwd

Tarrant Regional Water District

watershed protection

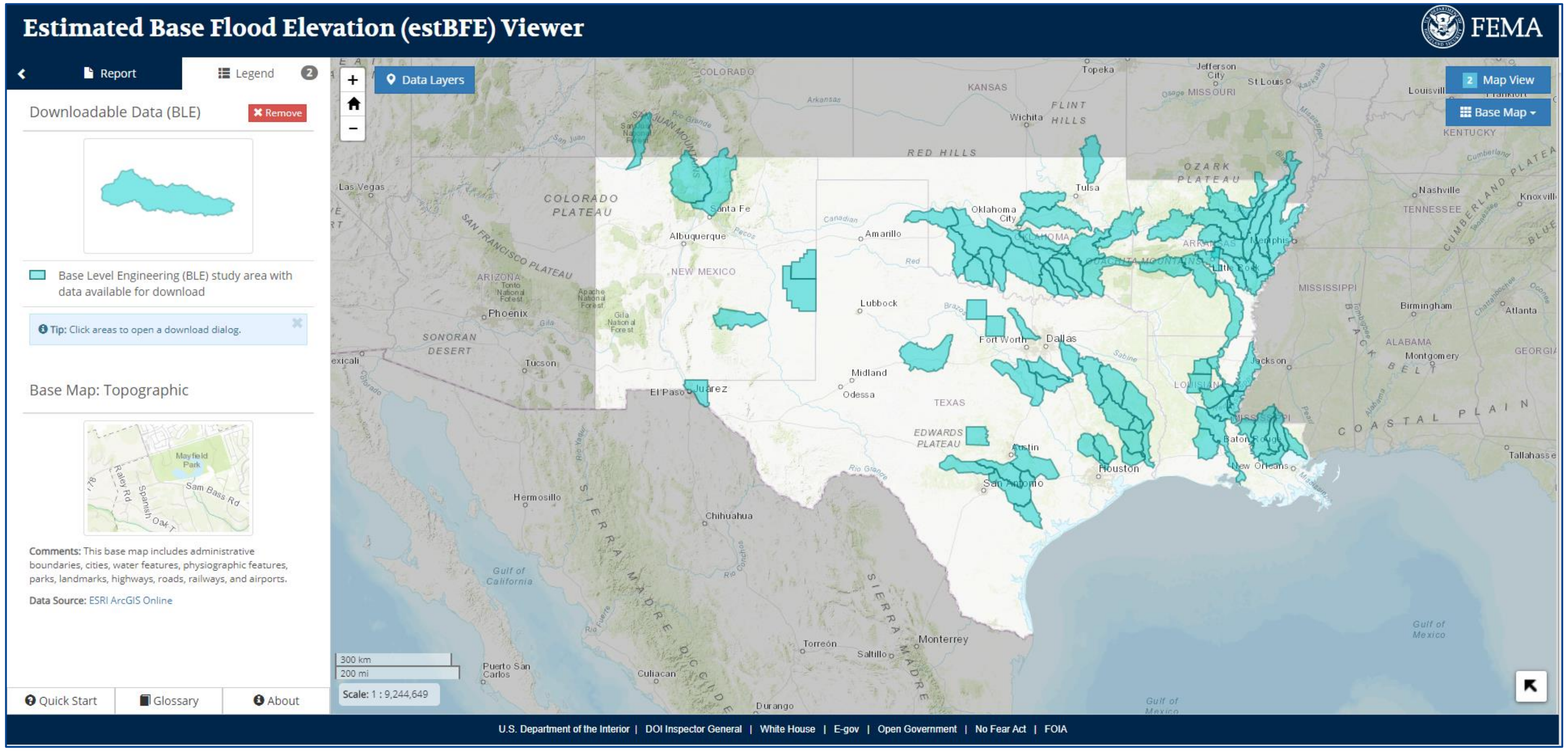
Welcome to The Tributary, where Tarrant Regional Water District's Watershed Program shares quarterly updates to keep you knowledgeable about the upcoming events and current news from our watersheds.

TRWD has actively supported responsible watershed management for almost 50 years, beginning with federal and local agencies in the Big Sandy Creek portion of the Eagle Mountain Lake watershed. Today, the program focuses on scientifically sound, stakeholder-driven strategies to implement sustainable and economically feasible land management and educational initiatives that protect TRWD drinking water supplies and the Trinity River within the bounds of the Fort Worth Federal Floodway System.

BLE OVERVIEW | BFE VIEWER

- View and download completed BLE data
- Useful for determining BFEs for development
- Demonstrated during Pre-Discovery Meeting
- Watch recording here: https://youtu.be/PWt3epwHofU
  - BFE Viewer Tutorial starts at minute 52:50

https://webapps.usgs.gov/infrm/estBFE/

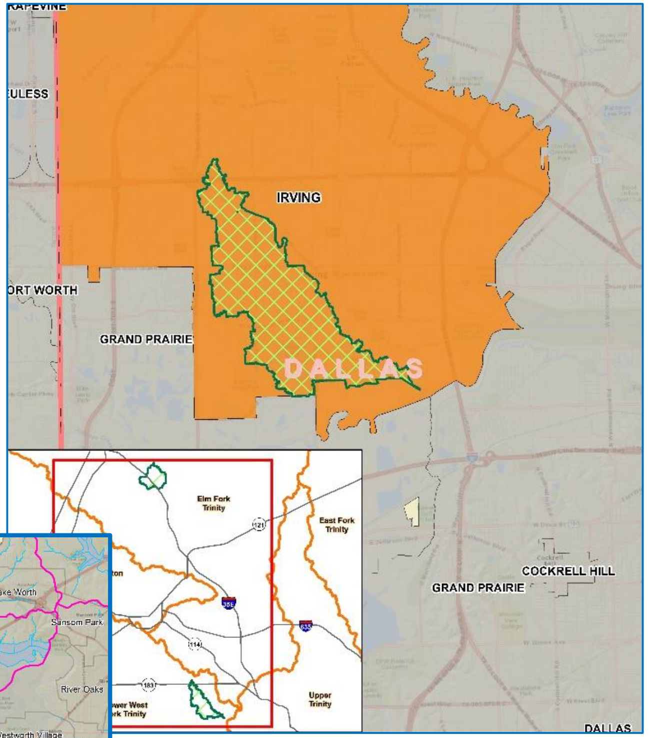


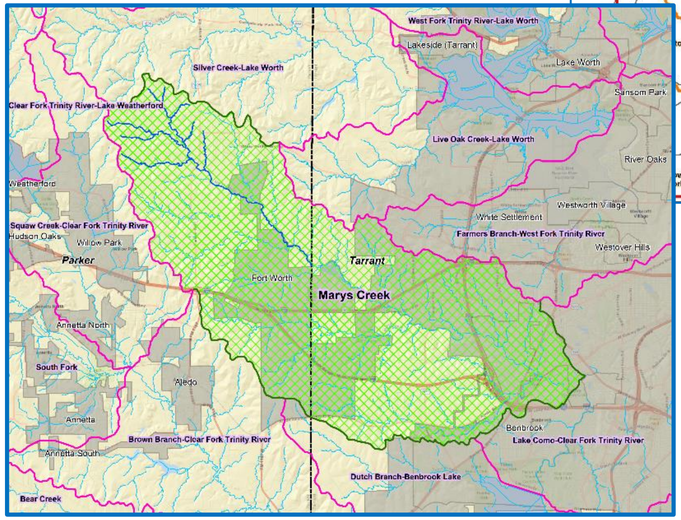
DISCOVERY | RISK MAP PROJECT RECOMMENDATIONS TO FEMA

RECOMMENDED STUDIES FROM DISCOVERY BECOME NEW PROJECTS

- 2013 Village Creek (Kennedale)
- 2014 Bear Creek (Southlake and Colleyville)
- 2015 Lynchburg Creek (Shady Shores and Corinth)
- 2015 West Irving Creek (Irving)
- 2016 McAnear Creek (Cleburne)
- 2016 Silver Creek (Tarrant County)
- 2017 Town Creek (Weatherford)
- 2017 Stream CF-5 (Benbrook)
- 2018 Mary's Creek (Parker County)

West Irving Creek (2015)





Mary's Creek (2018)

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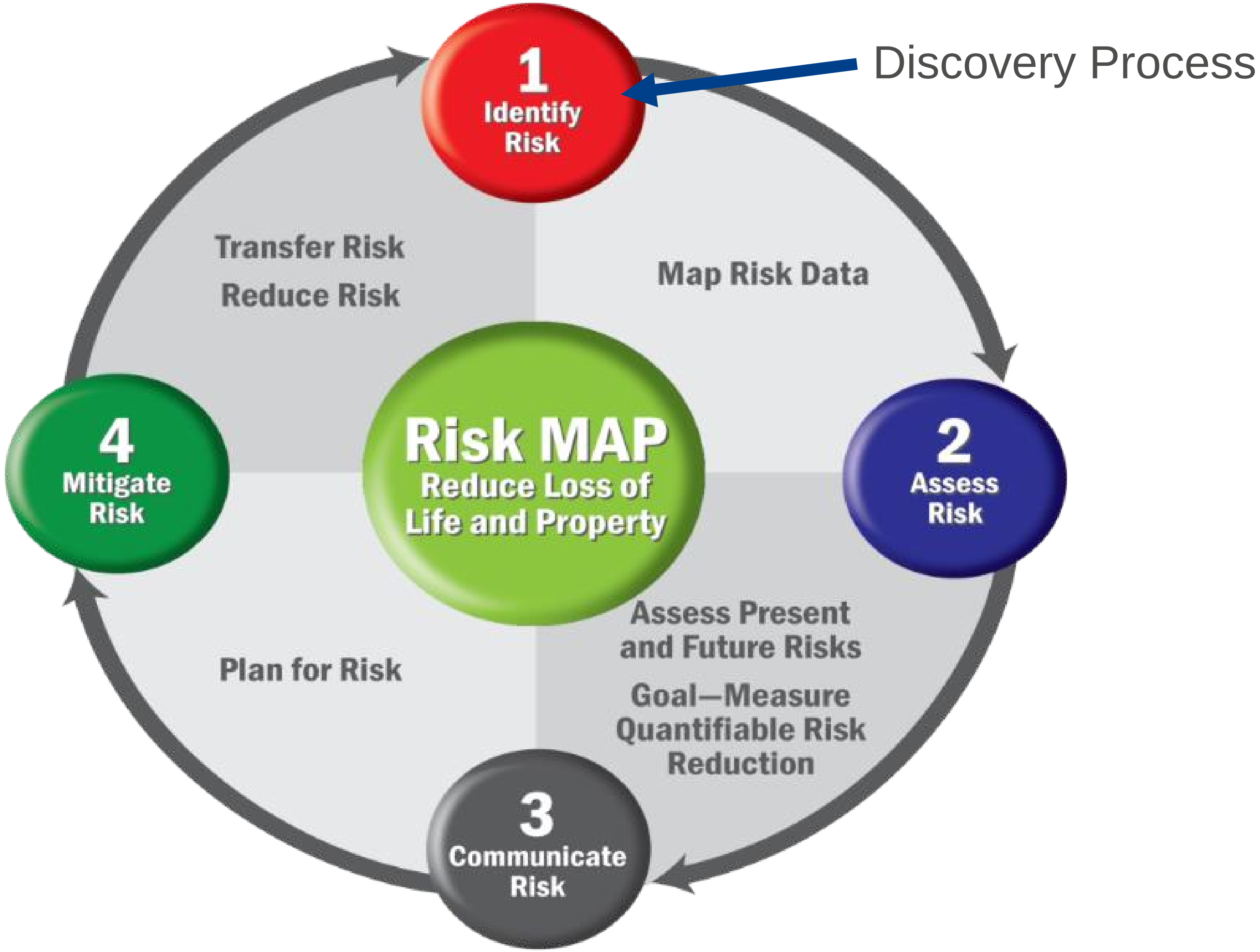
FEMA'S RISK MAPPING, ASSESSMENT, AND PLANNING (MAP) PROGRAM



QUESTIONS?

DISCOVERY | CONTACT

NCTCOG:

- Edith Marvin – EMarvin@nctcog.org
- Mia Brown – MBBrown@nctcog.org

TWDB:

- Manuel Razo – Manuel.Razo@twdb.texas.gov
- Paul Gutierrez – paul.gutierrez@twdb.texas.gov

Halff Associates:

- Jarred Overbey – jOverbey@halff.com
- Samuel Amoako-Atta – sAmoako-Atta@halff.com
- Alison Hanson– aHanson@halff.com

FEMA:

- Alan Johnson– alan.johnson@fema.dhs.gov

Appendix IV: Resources

Watershed Follow-up Points of Contact

Subject/Topic of Interest	Name	Contact Information
FEMA Region 6 Risk MAP Lead *Project Outreach*	Alan Johnson Risk Analysis Branch FEMA Region 6	Phone: 940-898-5171 Email: alan.johnson@fema.dhs.gov
FEMA Technical Monitor	Jennifer Knecht Risk Analysis Branch FEMA Region 6	Phone: (940) 898-5553 Email: jennifer.knecht@fema.dhs.gov
• Floodplain Management • Floodplain Ordinance • Community Assistance Visits • Higher Standards	John Bowman	Phone: 840-297-0185 Email: john.bowman@fema.dhs.gov
• Community Rating System • Flood Insurance	Diedra Mares	Phone: 830-832-3506 Email: dmares@iso.com
• How to find and read FIRMs • Letters of Map Change and Elevation Certificates • Flood zone disputes • Mandatory insurance purchase guidelines • Map Service Center (MSC) and National Food Hazard Layer	FEMA Map Information eXchange (FMIX)	Phone: 877-FEMA-MAP (336-2627) Email: FEMAMapSpecialist@Risk MAPcds.com Live Chat: https://www.floodmaps.fema.gov/fhm/fmx_main.html

State Partners

Organization/Title	Name	Partner Location	Contact Information
Texas Water Development Board (TWDB) State NFIP Coordinator (Interim)	Manuel Razo, CFM	P.O. Box 13231 Austin, TX 78711	Phone: 512-475-1850 Email: manuel.razo@twdb.texas.gov Web Page: https://www.twdb.texas.gov
Texas Division of Emergency Management (TDEM) State Hazard Mitigation Officer	Dave Jackson, CEM	P.O. Box 4087 Austin, TX 78773	Phone: 512-424-7820 Email: Dave.Jackson@tdem.texas.gov Web Page: https://tdem.texas.gov/hazard-mitigation
North Central Texas Council of Governments (NCTCOG) *Environment & Development Director*	Edith Marvin, P.E., CFM	616 Six Flags Drive Arlington, TX 76005	Phone: 817-695-9211 Email: emarvin@nctcog.org Web Page: https://www.nctcog.org/envir/index.asp
North Central Texas Council of Governments (NCTCOG) *Environment & Development Senior Planner*	Mia Brown, CFM	616 Six Flags Drive Arlington, TX 76005	Phone: 817-695-9227 Email: mbbrown@nctcog.org Web Page: https://www.nctcog.org/envir/index.asp

Texas Water Development Board

http://www.twdb.texas.gov/

Texas is a high-risk state for emergency events and disasters. The Governor's Office of Homeland Security and Emergency Preparedness (GOHSEP) is the agency responsible for coordinating the state's efforts throughout the emergency management cycle to prepare for, prevent where possible, respond to, recover from, and mitigate against hazards to lessen the effects of man-made or natural disasters that threaten the state. GOHSEP can save lives and reduce property damage by understanding risks and taking action to address those risks, as well as minimizing disaster impacts and increasing the resiliency in our communities, environment, and economy.

North Central Texas Council of Governments

http://nctcog.org/

The North Central Texas Council of Governments (NCTCOG) is a voluntary association of, by and for local governments, established to assist local governments in planning for common needs, cooperating for mutual benefit, and coordinating sound regional development. Serving a 16-county region of North Central Texas, NCTCOG is centered around the two urban centers of Dallas and Fort Worth. NCTCOG has over 230 member governments including 16 counties, numerous cities, school districts, and special districts. NCTCOG has been a Cooperating Technical Partner (CTP) with FEMA since 2004. From providing critical Light Detection and Ranging (LiDAR) data for Map Modernization (Map Mod) activities to offering up-to-date floodplain management training for floodplain managers and community leaders in the region, NCTCOG has served as a key stakeholder for risk reduction in North Texas.

NCTCOG FLOOD INFORMATION AND RESOURCES

NCTCOG is a proactive agency that has a long history of supporting floodplain management activities in the region. NCTCOG led and implemented new strategies over the past decades such as the Corridor Development Certificate for local floodplain permit decision making along the Trinity River Corridor since 1993. NCTCOG has been a Cooperating Technical Partner (CTP) with FEMA since 2004. From providing critical LiDAR data for map modernization activities to offering up-to-date floodplain management training for floodplain managers and community leaders in the region, NCTCOG has served as a key stakeholder for risk reduction in North Texas.

NCTCOG and TWDB worked hard to integrate our efforts with FEMA's Coordinated Needs Management Strategy (CNMS) to ensure that the work aligned with FEMA's Risk MAP goals and procedures.

POINTS OF CONTACT:

Edith Marvin
Director of Environment & Development
Phone: (817) 695-9211
Fax: (817) 640-7806
Email: emarvin@nctcog.org

Mia Brown
Planner II
Phone: (817) 695-9227
Email: mbbrown@nctcog.org

Texas Floodplain Management Association (TFMA)

The Texas Floodplain Management Association (TFMA) is an organization of professionals involved in floodplain management, flood hazard mitigation, the National Flood Insurance Program (NFIP), flood preparedness, warning and disaster recovery. The Association has become a respected voice in floodplain management practice and policy in Texas. The Association includes flood hazard specialists from local, state, and Federal government; the mortgage, insurance and research communities; and the associated fields of flood zone determination, engineering, hydraulic forecasting, emergency response, water resources, geographic information systems, and others.

Organization	Contact Information	Website
Texas Floodplain Management Association	Phone: 512-260-1366	https://www.tfma.org

Certified Floodplain Manager (CFM) Certification

The Association of State Floodplain Managers (ASFPM) established a national program for certifying floodplain managers. This program recognizes continuing education and professional development that enhances the knowledge and performance of local, state, Federal, and private-sector floodplain management professionals.

The role of the nation's floodplain managers is expanding due to increases in disaster losses, the emphasis on mitigation to alleviate the cycle of damage-rebuild-damage, and a recognized need for professionals to adequately address these issues. This certification program will lay the foundation for ensuring that highly qualified individuals are available to meet the challenge of breaking the damage cycle and stopping its negative drain on the nation's human, financial, and natural resources.

CFM® is a registered trademark and available only to individuals certified and in good standing under the ASFPM Certified Floodplain Manager Program.

For more information, you may want to review these available CFM Awareness Videos:

- What is the CFM Program?
- Who can be a CFM?
- What are the Benefits of a CFM?

Study materials for those interested in applying for the CFM certification can be found on the ASFPM Website at: http://www.floods.org/index.asp?menuID=215

Check the calendar on TFMA's website for in-person training sessions near you.

For information on becoming a member and the exam application process in the State of Texas visit http://www.tfma.org/?page=Renewal.

Interactive Preliminary Data Viewer

(maps.Risk MAP6.com)

To support community review of the study information and promote risk communication efforts, FEMA launched an interactive web tool accessible on-line at http://maps.Risk MAP6.com for the project areas.

For more information on the Interactive Preliminary Data Viewer, refer to the Region 6 Fact sheet: What is your Flood Risk?

Estimated Base Flood Elevation (BFE) Viewer

As a part of the Risk MAP process, FEMA is completing **Base Level Engineering (BLE)** to provide a complete picture of flood hazard throughout a watershed. The BLE analysis uses high resolution ground elevation data, flood flow calculations, and fundamental engineering modeling techniques to define flood extents for streams.

To provide a look at BLE data availability and relative engineering analysis, FEMA developed the through the **Estimated BFE Viewer** for community officials, property owners, and land developers to identify the flood risk (high, moderate, low), expected flood elevation, and estimated flood depth near any property or structure within watersheds where BLE has been prepared.

Visit the Estimated BFE Viewer **(**https://apps.femadata.com/estbfe) application to learn the status of BLE in your area of interest or surrounding communities, to view the flood hazard data developed, or to utilize the tool's flood risk reporting features for a location where BLE has been made available.

Map Service Center – Available Map Data

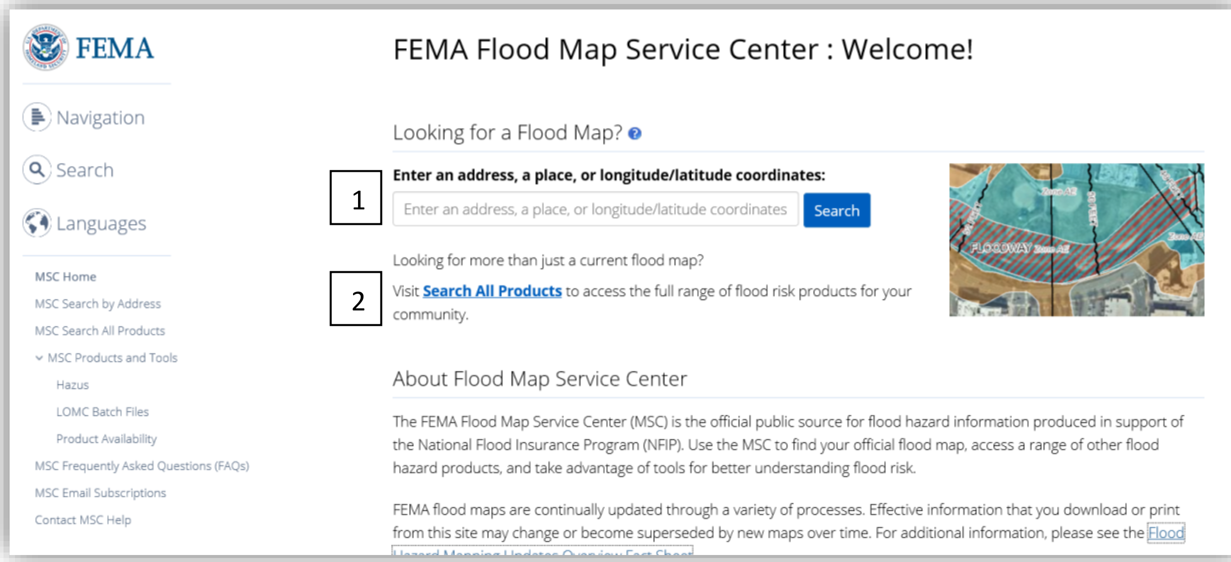
The FEMA Flood Map Service Center (MSC) is the official public source for flood hazard information produced in support of the NFIP. Use the MSC to find your official effective flood map, preliminary flood maps, and access a range of other flood hazard products.

FEMA flood maps are continually updated through a variety of processes. Effective information that you download or print from this site may change or become superseded by new maps over time. For additional information, please see the Flood Hazard Mapping Updates Overview Fact Sheet.

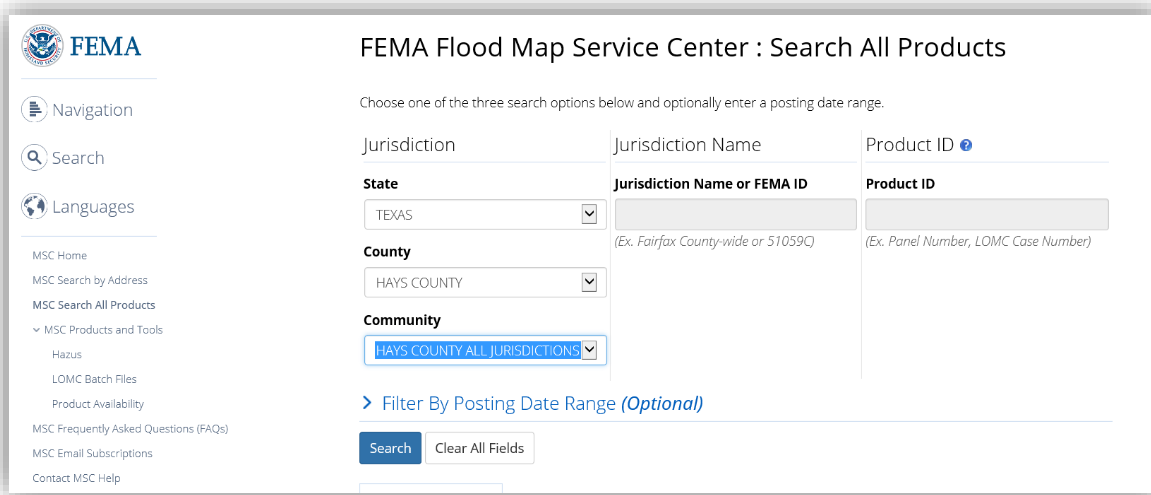
At the MSC, there are two ways to locate flood maps in your vicinity.

1. Enter an address, place name, or latitude/longitude coordinates and click search. This will provide the current effective FIRM panel where the location is shown.

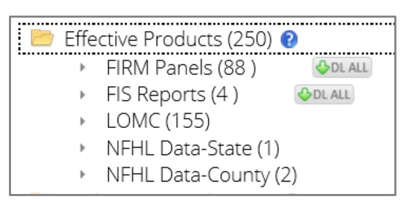
2. Or Search All Products, which will provide access to the full range of flood risk information available.



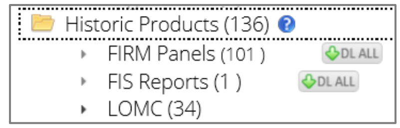
By using the more advanced search option, "Search All Products," users may access current, preliminary, pending, and historic flood maps. Additionally, GIS data and flood risk products may be accessed through the site with these few steps.



Using the pull down menus, select your state, county, and community of interest. For this example, we selected Hays County - All Jurisdictions. After the search button is selected, the MSC will return all items in the area. There are five types of data available.



Effective Products. The current effective FIS, FIRM, and DFIRM database (if available) is available through the MSC. If users click on the available effective products, they are presented a breakdown of the available products. FIRM panels, FIS reports, LOMRs, statewide National Flood Hazard Layer (NFHL) data, and countywide NFHL data may be available, as indicated in the breakdown on the right of the page.



Historic Products. A range of historic flood hazard maps, FIS texts, and Letters of Map Change are available through the MSC.

Flood Risk Products. The Flood Risk Report, Flood Risk Map, and Flood Risk Database will be made available through the MSC once they have been compiled and completed. These products are made available after the flood study analysis and mapping have been reviewed and community comments incorporated.