DRAFT

2023 REGIONAL FLOOD PLAN
REGION 15
LOWER RIO GRANDE

VOL. 1

Texas Water Development Board

REGION 15 Lower Rio Grande Regional Flood Planning Group

July 29, 2022

Mr. Jeff Walker, Executive Administrator
Texas Water Development Board
Stephen F. Austin Building
1700 N. Congress Avenue, 6th Floor
Austin, Texas 78701

RE: Lower Rio Grande Region 15 Draft Regional Flood Plan and Completeness Checklist

Dear Mr. Walker:

On behalf of the Lower Rio Grande Regional Flood Planning Group (RFPG), I am pleased to submit the Draft Regional Flood Plan (RFP) for the Lower Rio Grande Regional Flood Planning Region (Region 15) in accordance with Texas Administrative Code §361.50. The submission of this complete Draft RFP was formally approved and adopted at the July 21, 2022, meeting of the Lower Rio Grande RFPG. The meeting was conducted in accordance with applicable laws, regulations, and TWDB requirements. The content of the Draft RFP complies with the provisions of Section II, Article II, Paragraph A of the project contract between the Texas Water Development Board (TWDB) and Hidalgo County Drainage District No. 1, designated by the Lower Rio Grande RFPG as its representative and sponsor.

As required, the submittal includes two (2) double-sided hard copies and two (2) electronic copies (one in searchable PDF and one in Microsoft Word format). The Draft RFP is also accessible to the public via the Lower Rio Grande RFPG's website (www.region15lrg.org). Attached to this transmittal letter is a completed TWDB checklist with additional explanatory notes for each checklist item as appropriate.

If you have any questions regarding any part of this Draft RFP submittal package, please contact our technical consultant, Kristina Leal, at kleal@halff.com or by phone at 956-867-3400. You may also reach me at jaime.salazar@hcdd1.org or by phone at 956-292-7080, extension 5811. We look forward to TWDB's feedback on the Draft Regional Flood Plan.

Sincerely,

Jaime J. Salazar, Hidalgo County Drainage District No. 1
Region 15 RFPG Sponsor

Attachment – Completeness Checklist

c: Reem Zoun, TWDB Director of Flood Planning
Megan Ingram, TWDB Project Manager for the Lower Rio Grande Flood Planning Region
Lower Rio Grande Regional Flood Planning Group Members
Raul E. Sesin, PE, CFM, District General Manager for the Hidalgo County Drainage District No. 1
Kristina Leal, Halff Associates, Technical Consultant

2023 REGIONAL FLOOD PLAN DRAFT
Region 15
Lower Rio Grande

July 2022

Prepared for:

Texas Water Development Board

Prepared by:

Lower Rio Grande Region 15 Regional Flood Planning Group (RFPG)

With assistance from:

Hidalgo County Drainage District No. 1, RFPG Sponsor
Halff Associates, Inc., Technical Consultant

Preliminary – For Interim Review Only

These documents are for interim review purposes only. They were prepared by, or under the supervision of the following:

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Chapter 1

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INTRODUCTION

In 2019, the 86th Texas Legislature passed Senate Bill 8, which authorized the creation of the first-ever State Flood Plan for Texas. Sections §16.061 and §16.062 were added to the Texas Water Code. They established the regional and state flood planning process, which is to be led and administered by the Texas Water Development Board (TWDB). The legislation provided that the TWDB shall prepare and adopt a comprehensive state flood plan incorporating the regional flood plan approved under §16.062.

Per Texas Water Code Section §16.061, the State Flood Plan must (1) provide for orderly preparation for and response to flood conditions to protect against the loss of life and property, (2) be a guide to state and local flood control policy, and (3) contribute to water development where possible. The State Flood Plan follows a similar planning approach that has been used for water supply planning for over 20 years. Similar to the State Water Plan, future regulatory and financing decisions by the TWDB for strategies and other efforts to mitigate flood risks may need to be consistent with the approved State Flood Plan.

Per Texas Water Code Section §16.062, Regional Flood Plans must (1) use scientific data and updated mapping, (2) include a general description of the condition and functionality of flood control infrastructure in the flood planning region, (3) identify flood control projects under construction or in the planning stage, (4) provide information on land use changes and population growth in the flood planning region, (5) identify areas in the flood planning region that are prone to flood, and (6) identify flood control solutions for those areas. The regional flood plan should indicate whether the identified flood control solution meets an emergency need, uses federal money as a funding component, and may also serve as a water supply source.

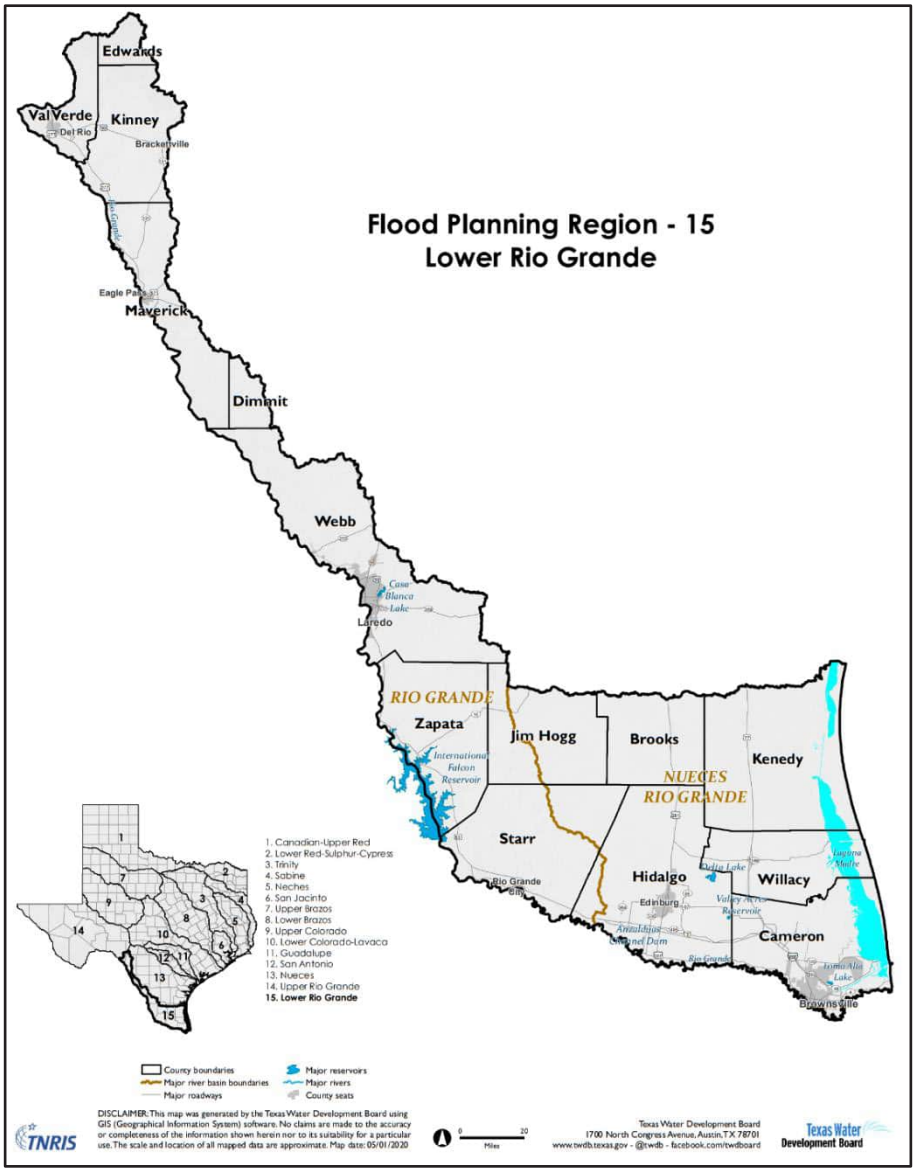
On May 21, 2020, the TWDB approved the final administrative rules related to Regional and State Flood Planning: 31 Texas Administrative Code Chapters 361 and 362. On April 9, 2020, TWDB designated 15 flood planning regions based on the State's major river basins. On October 1, 2020, the TWDB created the regional flood planning groups to oversee preparing the first regional flood plans. The first regional flood plans are to be submitted to the TWDB by January 10, 2023, and the first state plan is due September 1, 2024. An amended regional flood plan that meets the requirements contained in Texas Water Code § 16.062 and 31 Texas Administrative Code Chapters 361 and 362 shall be adopted by the Regional Flood Planning Groups by July 14, 2023. An updated version of the regional flood plans will be due every five years thereafter.

Overview of Flood Planning Region 15

The Lower Rio Grande River Basin, also known as Flood Planning Region 15, covers the southern half of the Rio Grande River Basin within Texas. This region begins at International Amistad Reservoir in Val Verde County. It extends along the Rio Grande River to the Gulf of Mexico, encompassing all or parts of 14 counties along the way. Because the river itself forms the international boundary between Mexico and the United States in the state of Texas, this regional flood planning group is only planning for

roughly one-quarter of a watershed. **Figure 1.1** shows a map of the Lower Rio Grande Region 15-Regional Flood Planning Area.

Figure 1.1 Map of Region 15 Regional Flood Planning Basin, showing counties included



Source: TWDB Flood Planning website

Region 15 represents the following 14 counties:

- Brooks*
- Cameron
- Dimmit*
- Edwards*
- Hidalgo
- Jim Hogg*
- Kenedy*
- Kinney*
- Maverick*
- Starr
- Val Verde
- Webb*
- Willacy
- Zapata

The "*" by the County name in the list above indicates that this county is partially within this RFPG and is represented by at least one other RFPG.

Known as "Big River" in Spanish, the Rio Grande River has its headwaters in Colorado, flowing through New Mexico, and the confluence with the Rio Concho in Mexico. With an extremely arid climate, the Lower Rio Grande Basin has a substantially low watershed yield from year to year. Other streams of note within the basin are the Devils River, Pecos River, Arroyo Colorado, Mud, and Pinto Creeks. This region apportions surface water between New Mexico and Texas through the Pecos River Compact. Similarly, surface water from the Rio Grande is apportioned between Colorado, New Mexico, and Texas through the Rio Grande Compact and across international boundaries through the United States and Mexico Water Treaty of 1944. Falcon International Reservoir and Amistad International Reservoir are two reservoirs within this region that border the U.S. and Mexico.

The Lower Rio Grande Region is directly exposed to hurricane events in the south and tropical storms, depressions, or related events (hail, high winds, etc.) in the north. Intense, localized thunderstorms and frontal-type storms in spring and summer cause most of the flooding in this region.

The Regional Flood Plan for the Lower Rio Grande Basin will be incorporated into the first State Flood Plan, along with the regional plans from the other fourteen regions across the state.

Regional Flood Planning Group

The TWDB has appointed Regional Flood Planning Groups (RFPG) for each region and has provided them with funding to hire a technical consultant to prepare their plans. The TWDB administers the regional planning process members through a contract with the planning group's sponsor, who the RFPG selects. The Lower Rio Grande Regional Flood Planning Group chose the Hidalgo County Drainage District 1 (HCDD1) to serve as its sponsor. The sponsor's role is to provide support for meetings and communications and to manage the technical consultant contract. The RFPG selected the Halff Associates Team (Halff) as their technical consultant to prepare this plan.

As project sponsor, HCDD1's responsibilities include directing the work of the Halff Associates technical consulting team, soliciting and considering public input, identifying specific flood risks, and identifying and recommending flood management evaluations, strategies, and projects to reduce risk in their regions. To ensure a diversity of perspectives are included, members represent a wide variety of stakeholders potentially affected by flooding, including:

- Agriculture
- Counties
- Electric Generation Utilities
- Environmental Interests
- Flood Districts
- Industry
- Municipalities
- Public
- River Authorities
- Small Businesses
- Water Districts
- Water Utilities

Region 15's Regional Flood Planning Group is led by the following executive committee members:

Table 1.1 Executive Committee Members for the Lower Rio Grande Regional Flood Planning Group

Name	Position	Entity
David A. Garza	Chair	Cameron County
David L. Fuentes	Vice-Chair	Hidalgo County Drainage District No. 1
Sonia Lambert	Secretary	Cameron County Irrigation District #2

Region 15's Regional Flood Planning Group is composed of the following voting members:

Table 1.2 Lower Rio Grande Regional Flood Planning Group Voting Members

Name	Interest Category	Entity
Jose Hinojosa	Agricultural	Santa Cruz Irrigation District No. 15
David A. Garza	Counties	Cameron County
Raul Pena Jr.	Counties	Starr County
Eduardo Gonzalez	Counties	Willacy County
Daniel Lucio	Electric Generating Utilities	AEP Texas
Hudson DeYoe	Environmental	University of Texas Rio Grande Valley
Alan Moore	Flood Districts	Cameron County Drainage District No. 5
David L. Fuentes	Flood Districts	Hidalgo County Drainage District No. 1
Joey Trevino	Industries	Rio Grande Valley Chapter of Associated General Contractors of America
Rene Estrada	Municipalities	City of Combes
Joe Califa	Public	Self
Jose Caso	Small Business	Caso Law Firm, PLLC
Sonia Lambert	Water Districts	Cameron County Irrigation District #2
Riazul Mia	Water Utilities	City of Laredo

Region 15's Regional Flood Planning Group is composed of the following non-voting members:

Table 1.3 Lower Rio Grande Regional Flood Planning Group Non-Voting Members

Name	Title	Entity
Megan Ingram	Regional Flood Planner	Texas Water Development Board
Ramon Macias III	Principal Engineer	IBWC, US Section
Shonda Mace	Planner	General Land Office
Willy Cupit	Natural Resources Specialist	Texas Parks and Wildlife Department
Lupita Trinidad- Ramos	Homeland Security Planner III	South Texas Development Council
Brian Hurtuk	Hazard Mitigation Planner	Texas Division of Emergency Management
Nelda Barrera	Field Representative	Texas Department of Agriculture
Adrian Perez	Field Representative	Texas State Soil and Water Conservation Board
Manny Cruz	Executive Director	Lower Rio Grande Valley Development Council
David Ramirez	Area Director – Border & Permian Basin	Texas Commission on Environmental Quality
Nick Gallegos	Executive Director	Middle Rio Grande Development Council

Even though each basin has a different leadership team, the TWDB provided detailed specifications to guide the preparation of the flood plans for each basin. When complete, the Region 15 Regional Flood Plan will outline a path forward to reducing existing risk to life and property in the Lower Rio Grande River Basin. The Plan will also include improved floodplain management data, recommend floodplain management practices, and identify potential Flood Management Evaluations (FMEs), Flood Management Strategies (FMSs), and Flood Mitigation Projects (FMPs) for future study and funding.

Chapter 1: Planning Area Description

The goal of this chapter is to describe the Region 15 Lower Rio Grande Planning Region's (1) social and economic character, (2) major flood risks to life and property, (3) historical flood events, (4) political subdivisions with flood-related authority, (5) general extent of flood risk-related regulations, (6) agricultural and natural resources impacted by flooding, and (7) any existing flood mitigation planning efforts underway within the region. This chapter also includes an (8) inventory and assessment of existing natural features and constructed major flood infrastructure information and a (9) summary of proposed and ongoing flood mitigation projects in the region. A more detailed discussion of each of these topics is included below.

1.1. Social and Economic Character

Texas grew approximately 15 percent in the last decade, and research by the Texas Land Trends project found that in the Lower Rio Grande Region alone, the population grew by over 200,000 residents between 1997 and 2017. Although population growth and development has largely occurred in the lower four counties of Cameron, Hidalgo, Willacy, and Starr, as well as in Webb County, its effects can be felt throughout the region. Land once reserved for cropland or grazing has declined during this period, with over 50,000 acres of cropland and over 100,000 acres of rangeland being converted to other uses across the region (Texas A&M Natural Resources Institute, 2021). As shopping centers occupy former pastures and row crops are replaced by subdivisions, the increase in paved surfaces reduces the absorption of rainwater. Urban drainage networks also tax the capacity of the Rio Grande's creeks and tributaries. Population growth and the outward expansion of metropolitan areas into what was formerly open space has increased the pressure on the region's flood control network and are exposing a growing number of residents to flood risk.

1.1.a. Development and Population

Development

The Lower Rio Grande Region covers an area of approximately 43,204 square miles from Val Verde and Edwards County on the north down to Cameron County at its southernmost extent. This region represents 14 counties (or parts thereof), 54 municipalities, and 46 other special districts. Although most of the region is composed of rural, undeveloped land, it contains eight core-based statistical areas, or geographic areas with populations over 10,000 that are tied to an urban center and share socioeconomic characteristics, as defined by the United States Office of Management and Budget (OMB). **Table 1.4** below shows these core-based statistical areas and their rank by population (*Estimated population, United States Census Bureau, 2021*). A metropolitan statistical area (MSA) is a geographical region with a population of at least 50,000 at its core that has close economic ties throughout the area (Metropolitan statistical area - Wikipedia). Similarly, micropolitan statistical areas (μSAs) are labor market and statistical areas with a population of at least 10,000 to 50,000 people (Micropolitan statistical area - Wikipedia).

Table 1.4 Core-based Statistical Areas within the Lower Rio Grande Planning Region

Core-based Statistical Area (CBSAs)	County	Rank in Texas	National Rank	2021 Population estimate
McAllen–Edinburg–Mission, TX MSA	Hidalgo	5 of 25	65 of 384	880,356
Brownsville–Harlingen, TX MSA	Cameron	8 of 25	131 of 384	423,029
Laredo, TX MSA	Webb	16 of 25	186 of 384	267,945
Rio Grande City, TX µSA	Starr	4 of 46	114 of 543	66,049
Eagle Pass, TX µSA	Maverick	8 of 46	159 of 543	58,056
Del Rio, TX µSA*	Val Verde	14 of 46	234 of 543	47,564
Raymondville, TX µSA	Willacy	36 of 46	515 of 543	20,316
Zapata, TX µSA	Zapata	44 of 46	539 of 543	13,908

** Del Rio, TX µSA is also partially located in Region 14- Upper Rio Grande Planning Area*

Table 1.1 shows that the most populated areas are located in the lower half of the region. The following sections will discuss the populations and economic sectors of the region in greater detail.

Population

Region 15 is the state's sixth (6th) most populous flood planning area, with an estimated 2,000,000 residents living within a 12,000 square mile area. The vast majority of the region's population live within one of the major cities close to the Unites States-Mexico border. The northern counties feature population centers within Del Rio and Eagle Pass. Laredo serves as the population center in the middle of the basin. In the southern part of the region, populations are generally concentrated within the lower four counties.

Table 1.5 below shows the estimated populations for the 14 counties, or parts thereof, located within the Lower Rio Grande Region for the year 2020 and projected populations for the year 2050. These populations are based on Water User Group and HUC (Hydrologic Unit Codes)-8 population projections provided by the Texas Water Development Board (TWDB) from the 2022 State Water Plan. It is estimated that the population in this region will increase by 62.3% over the next 30 years.

The 2019 Five-Year American Community Survey estimates that about 7 percent of Texas residents currently reside in the Lower Rio Grande Region. Within the region, there are 54 local communities. Twenty-one of these 54 local communities have a population of greater than 20,000 people. These large communities lie within the three MSAs listed in **Table 1.4** and are generally located in Hidalgo, Cameron, and Webb counties. The current growth patterns in the Lower Rio Grande Region are generally projected to continue over the next 30 years, with greater concentration in urban areas and declining population in some rural counties. From 2020 to 2050, the number of communities with populations

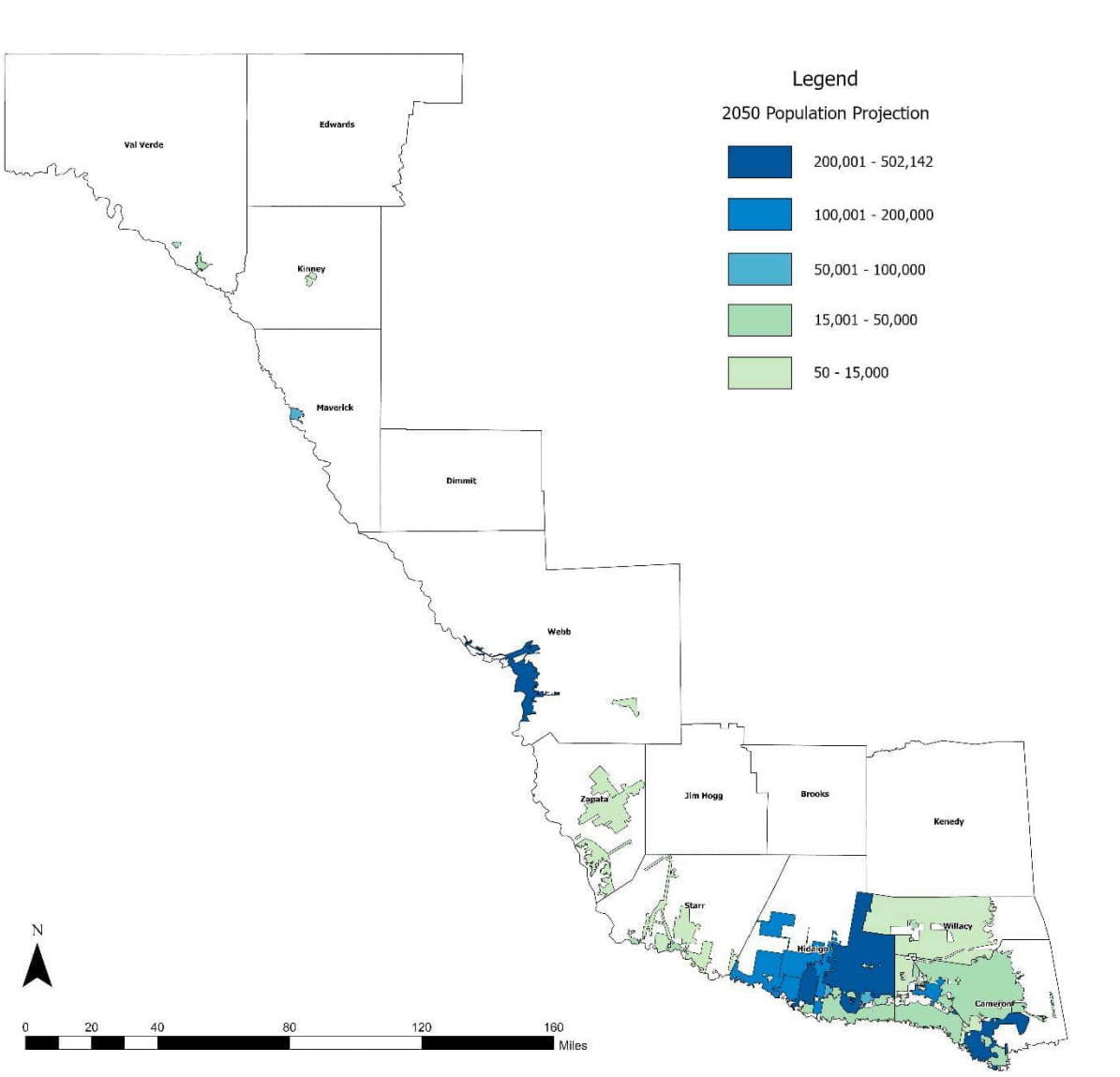
over 20,000 is likely to increase to 24 communities. Most of these communities are still within the lower counties of the region.

Table 1.5 Population Estimates of Region by County for 2020 and 2050

County	2020 Population, estimated	% of Total Population of Region	2050 Population, projected
Brooks*	7,783	0.38%	9,181
Cameron	478,974	23.47%	729,461
Dimmit*	10,875	0.53%	12,825
Edwards*	2,123	0.10%	2,123
Hidalgo	981,890	48.12%	1,696,257
Jim Hogg*	5,853	0.29%	7,274
Kenedy*	463	0.02%	507
Kinney*	3,695	0.18%	3,720
Maverick*	63,107	3.09%	90,304
Starr	70,803	3.47%	97,107
Val Verde	54,694	2.68%	71,566
Webb*	318,028	15.59%	530,330
Willacy	25,264	1.24%	34,840
Zapata	16,819	0.82%	26,365
Total	**2,040,371**	**100**	**3,311,860**

Figure 1.2 shows the community population projections for 2050. The shading on the map indicates the population per community divided into five size categories: 0-15,000; 15,001-50,000; 50,001-100,000; 100,001-200,000; 200,000 – 502,142. The communities with the largest populations are Laredo, Brownsville, and McAllen.

Figure 1.2 2050 Population Projection for Communities within the Lower Rio Grande Planning Region



The top 10 fastest-growing communities are displayed in **Table 1.6**. Every one of these communities is located within Hidalgo County. Hidalgo County is characterized by intense urban agglomeration driven by the rapid acceleration of population growth and is projected to experience over 72 percent population growth from 2020 to 2050. While the City of McAllen, Edinburg, and Pharr will experience large nominal growth, the higher percentage growths are expected to happen in the counties' smaller communities.

Table 1.6 Top 10 Fastest Growing Communities in the Basin

Community (WUG)	Population 2020	Population 2050	Percent Change (%)
Weslaco	44,194	80,515	82.19
Edcouch	3,837	6,629	72.77
Hidalgo	14,191	24,516	72.76
Mercedes	19,732	34,088	72.75
Alamo	23,259	40,181	72.75
McAllen	169,099	292,126	72.75
San Juan	34,508	59,614	72.75
Edinburg	96,678	167,015	72.75
Pharr	89,220	154,131	72.75
Donna	20,021	34,587	72.75

1.1.b. Economic Activity and High Flood Risk Sectors

Commercial Activity

To understand the economic risk that the region faces from flood events, this study identified the most significant industries within the region by three factors:

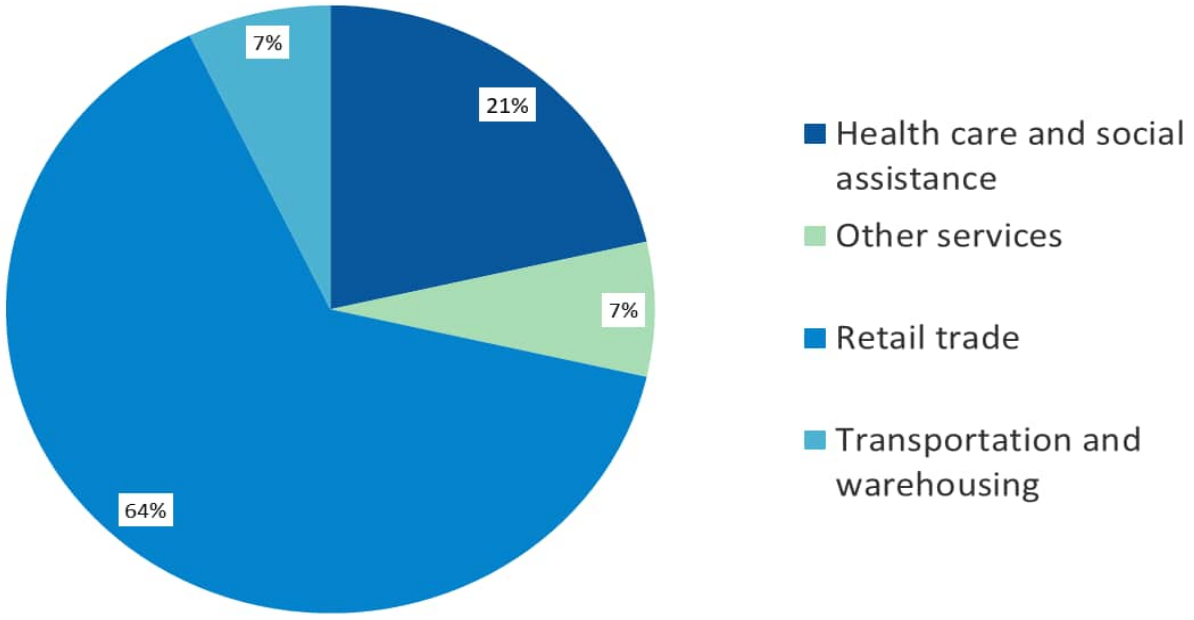
- number of establishments
- annual payroll
- total annual revenue

Data from the 2017 Economic Census was utilized to identify the predominant industries within the basin. Industries were divided in accordance with the North American Industry Classification System (NAICS), which classifies all business establishments to facilitate the publication of statistical data related to the United States economy. This section of the report identified the largest industry per county, as measured by the three factors above. By identifying the dominant industries in each category, the figures within this section identify the economic sector with the highest potential economic impact in the event of a flood. The largest industry for all the counties within the basin is aggregated by each of the different measures to give a picture of the magnitude of potential flood impact for each identified sector of the economy.

Number of Establishments

The total number of establishments for every industry within the Lower Rio Grande Basin is 24,077. Retail trade was the predominant industry for this measure throughout the basin regarding the number of establishments in almost 65 percent of the counties. Retail trade was followed by health care and social assistance as the second most important industry within the basin. **Figure 1.3** shows the region's major industries by county, as determined by the number of establishments.

Figure 1.3 Major Industry by County, as determined by the number of establishments



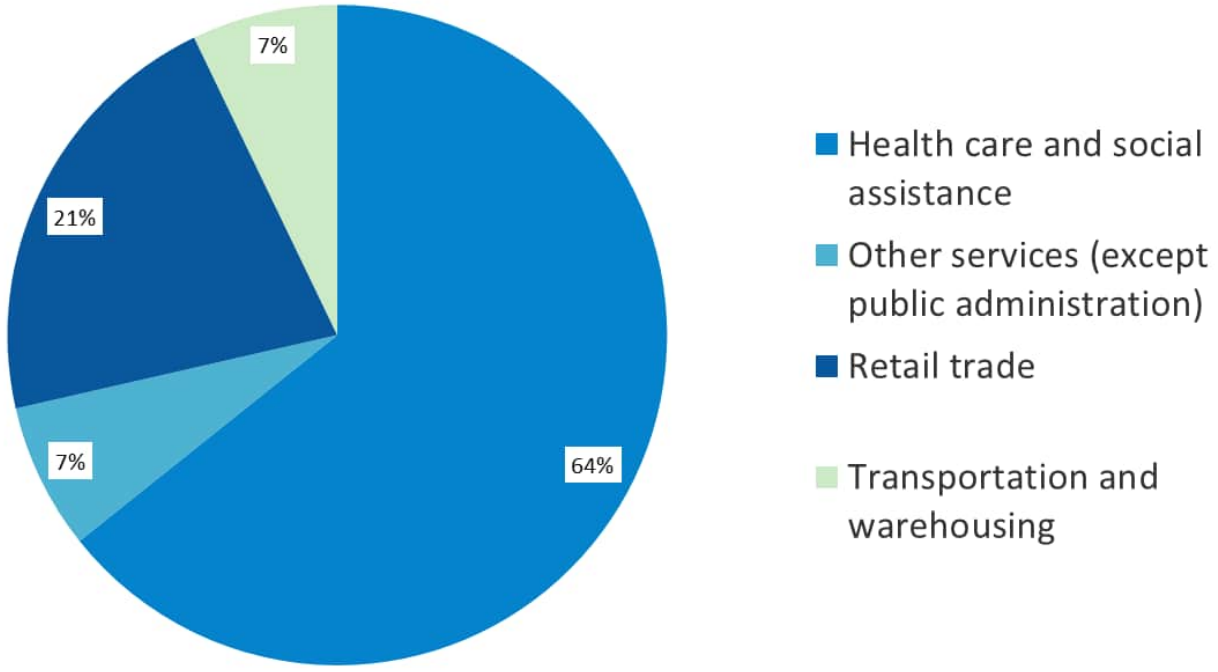
Source: United States Census Bureau Table: EC1700Basic (2017)

Each business contributes to the tax base of their community, and most employ workers who depend on them as a sole source of income. If damaged or forced to close for an extended period, these businesses may each need financial and technical support to recover. The Federal Emergency Management Agency (FEMA) reports that roughly 40 percent to 60 percent of small businesses never reopen their doors following a disaster. The impact of business interruption on each individual business is significant. However, it is important to note the possibility that many of these retail establishments are smaller businesses, and this measure may not fully capture the impact of a particular economic sector on the overall regional economy.

Annual Payroll

The total annual payroll in the Lower Rio Grande Basin is $10,709,634,000. Health care and social assistance and retail trade represent the largest share of all industries by payroll. Considering the dominant industry in each county, these sectors represent 65 percent and 21 percent, respectively. This is not surprising as both manufacturing and health care are among the highest-paying industries nationwide. **Figure 1.4** shows the major industries by county, as determined by annual payroll amounts reported.

Figure 1.4 Major Industry by County, as determined by annual payroll amounts



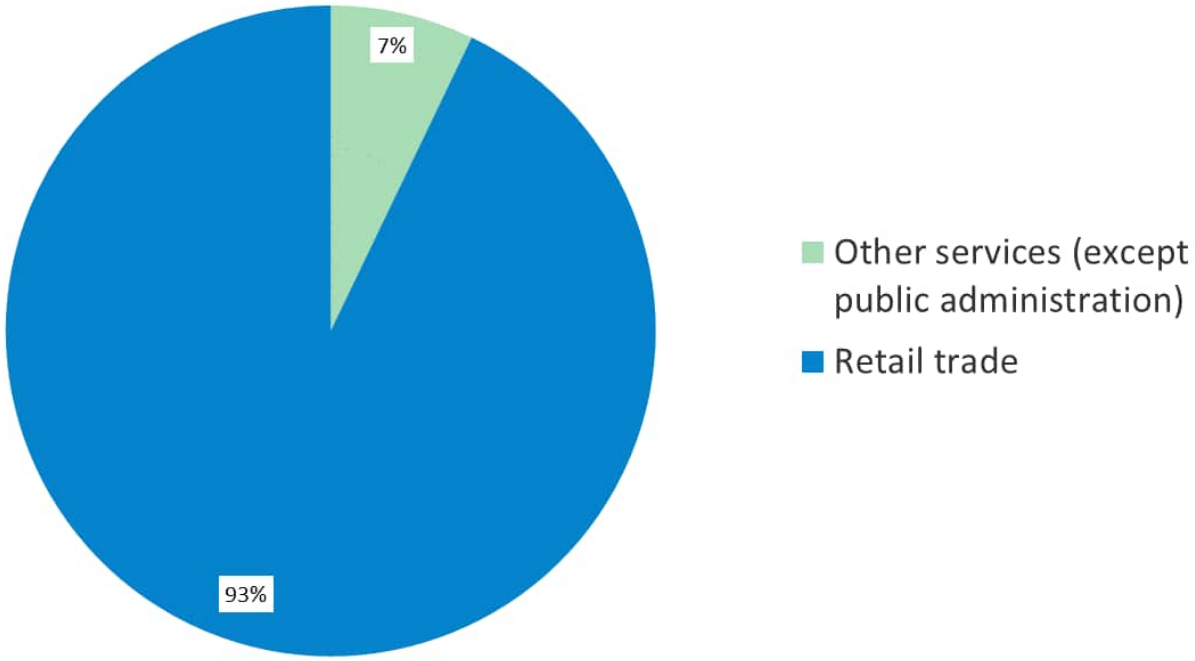
Source: United States Census Bureau Table: EC1700Basic (2017)

With regards to the share of payroll for the whole basin, health care and social assistance have an annual payroll of $3,514,799,000. One measure that tracks the impact of lost income is the Social Vulnerability Index (SVI). This nationally accepted method for predicting vulnerability to hazards identifies loss of income as one of the greatest predictors of future vulnerability for individuals and communities. The SVI uses 15 different census variables to help identify communities that may need support before, during, and after a disaster. A severe flood event affecting income streams in the health care and social assistance and retail trade sectors is likely to heavily impact those vulnerable populations.

Annual Revenue

Of these three measures, however, the total revenue by industry provides useful insight into the potential economic disruption of a major flood event by indicating the sectors most likely to be exposed to this risk. This measure gives the best analysis regarding the largest industry to be impacted by flooding within the region, as it serves as a good indicator of which industries have the greatest economic impact in each county. **Figure 1.4** shows the major industries by county, as determined by annual revenue reported.

Figure 1.5 Major Industry by County, as determined by annual revenue

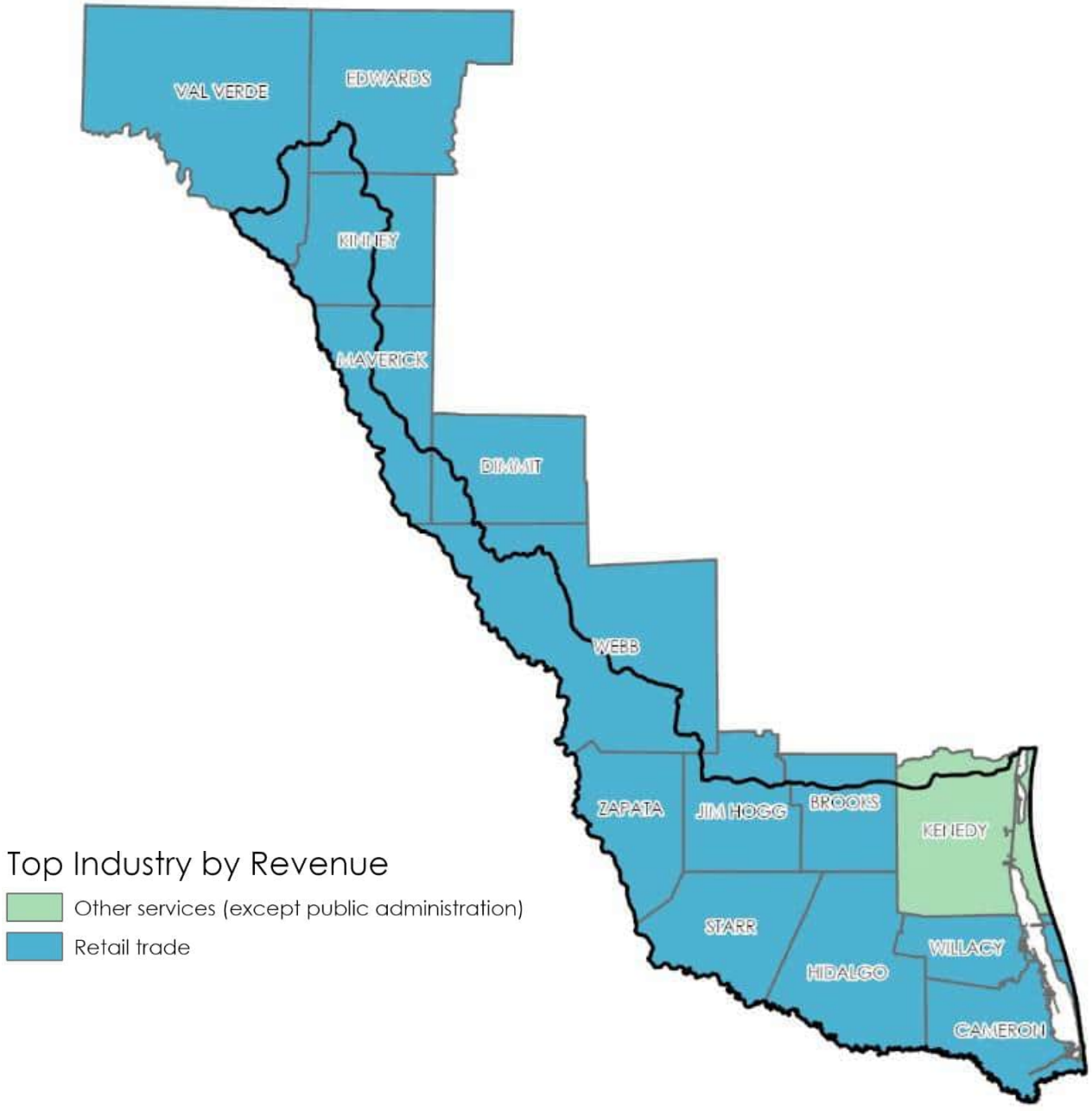


Source: United States Census Bureau Table: EC1700Basic (2017)

Retail trade remains the dominant industry in this area, followed by "other services (except public administration)." Retail trade is the largest industry by annual revenue in 13 out of 14 counties, with other services accounting for Kenedy County. The total revenue for all industries in the Lower Rio Grande basin is $56,260,657,000. The largest three revenue generators by dollar value are:

- retail trade generating $20,146,906,000
- wholesale trade generating $10,615,511,000
- health care and social assistance generating $8,454,105,000

Figure 1.6 Industry Sector with Largest Share of Annual Revenue, per county.



These three industries alone make up 70 percent of the basin's total annual revenue. Retail trade generates almost double the revenue of the next leading industry. With much of the commercial activity happening in the border cities, it is important to note that there are extensive international commerce implications as Mexican nationals often travel across the border for retail activities. According to a study by the Federal Reserve Bank of Dallas, Mexican shoppers make up 20 to 30 percent of retail sales in the Brownsville, McAllen, and Laredo Metropolitan Statistical Areas. To extend the industry assessment to

the County level, **Figure 1.6** identifies which industry sector makes up the largest share of annual revenue in each county in the basin to provide some perspective on the benefit of developing flood mitigation strategies that reduce future economic impact. As stated previously, retail trade represents the largest revenue generator in all but one of the counties in the basin.

Agricultural and Ranching Activity

While urban development is generally concentrated along the US-Mexico border, the waters of the Rio Grande also traverse an extremely productive agricultural region with a rich farming and ranching heritage. Although the census did not record agriculture as one of the region's top economic drivers, it is still an integral component of the regional economy. Although fewer people are exposed to flood hazards in these areas, the impact of flooding on agriculture, ranching, and forestry can be severe. Floods can delay the planting season as they soak the fields and make them impassable for heavy equipment leading to reduced crop size, lower yields, and reduced profits. When floods occur as crops mature in the fields, they may destroy a whole season's work and investment. Floods at harvest time can make it impossible for farmers to harvest mature crops and get them to market. Livestock may drown in floodwaters if there is no high ground for them to escape. Even if the animals are safe, damage may occur to barns and other structures, and cleanup of muck and debris can affect their feeding grounds. Forestry or orchard operations can lose trees to long periods of inundation, fast-moving waters, and erosion, wiping out years of growth in an instant.

To characterize the economic activity and character of Texas' rural spaces, this plan employs the term "working lands," used by the Texas A&M Natural Resources Institute to describe the rural economic activity. Working lands are privately owned farms or cropland, ranches, and forests and associated uses that make up most of the economic activity in Texas' rural areas.

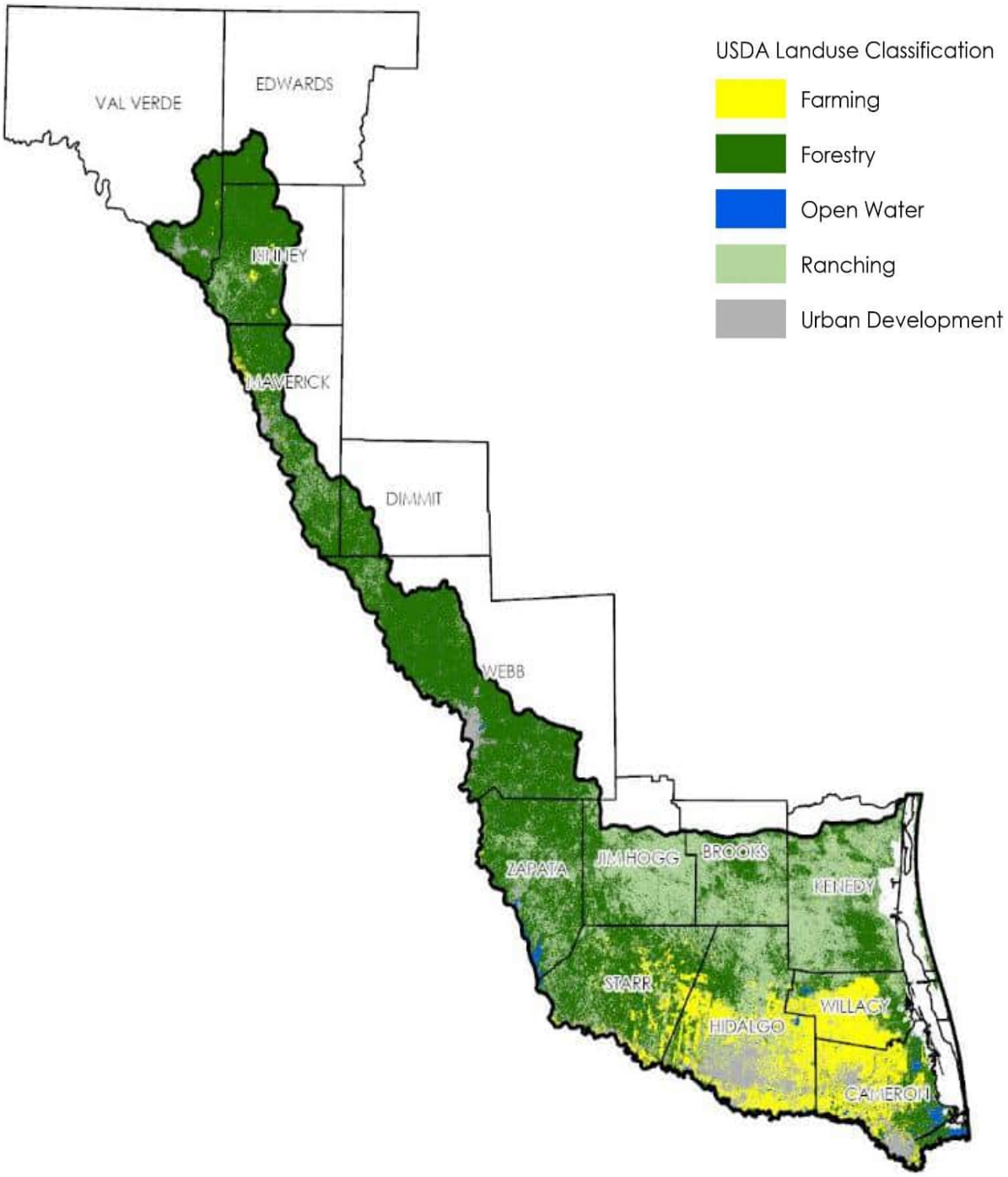
The distribution of these land uses across Texas is illustrated in **Figure 1.7**, which uses data from the United States Geological Survey (USGS) to help visualize how land is used across the basin. The area dedicated to each use identified in **Figure 1.7** is:

- **Ranching**: 1,642,000 acres
- **Forestry**: 4,577,000 acres
- **Farming**: 938,000 acres
- **Urban Development**: 437,000 acres

Across Texas, the average acreage of farm and ranch operations is decreasing, and a smaller parcel size may reduce the profitability of these enterprises. Combined with flooding losses, this could increase the likelihood of economic failure of a farming, ranching, or forestry operation.

Ranching and rangeland are predominately used in the northern parts of the region and Zapata, Starr, Jim Hogg, Brooks, Kenedy, and the northern portion of Hidalgo counties. While these areas constitute relatively large landholdings, the economic benefit is not reflected in the socioeconomic data, as the census tracts in these areas experience some of the lower median incomes. Additional areas where ranching is featured are in Kinney and Maverick counties.

Figure 1.7 Texas Working Lands by Land Cover



Cropland, symbolized in yellow, is the predominant use of working lands in Hidalgo, Willacy, and Cameron counties. These counties are home to some of the most fertile farmlands in the region. According to the United States Department of Agriculture (USDA), major crops between 2015 and 2019 included sorghum, cotton, corn, sugarcane, and other herbs (*USDA, 2021*).

Economic Status of Population

Median Household Incomes (MHI) can affect many factors, including education levels, employment opportunities, and location. It is important to note that within any given area, residents are outliers in both directions of the data. The MHI measure divides the data into two equal halves and provides a good comparison of income levels across the basin. The 2021 ESRI Census Tract data levels across the basin were used to define the MHI for this analysis and **Figure 1.8.** The state MHI, according to this measure, is $63,500.

Figure 1.8 Median Household Income per Census Tract in Lower Rio Grande Planning Region

The Lower Rio Grande Basin exhibits a similar trend observed across the state. Urban areas near the Texas-Mexico border show census tracts in the highest MHI categories, while the rural counties and areas with lower populations typically display tracts in more moderate-income categories. The MHI for all census tracts in Brooks, Edwards, Jim Hogg, Kenedy, Kinney, Willacy, and Zapata counties are much lower than the state average, falling between $0 to $54,000 per household. Major parts of Cameron, Hidalgo, Maverick, Starr, and Val Verde counties are also within this category. Almost 84 percent of the tracts within the basin lie within these two categories. Since these categories hold most of the data points, the MHI for the basin is $37,595. This median is significantly lower than the state's MHI of $63,500; however, as the cost of living is lower than in many of the more urbanized basins, it is important to state the relativity of median incomes with relation to the region.

The $54,000 to $75,000 category has significantly fewer census tracts and is generally located within Cameron, Hidalgo, and a large portion of Webb County. The last three categories encompass census tracts whose MHI is above $75,000. Only about 5 percent of the tracts in the basin represent these categories. These areas, displayed by the blues, lie in the most urban areas within Hidalgo County, Brownsville, Del Rio, and Laredo. Laredo contains the top four census tracts by MHI in the basin.

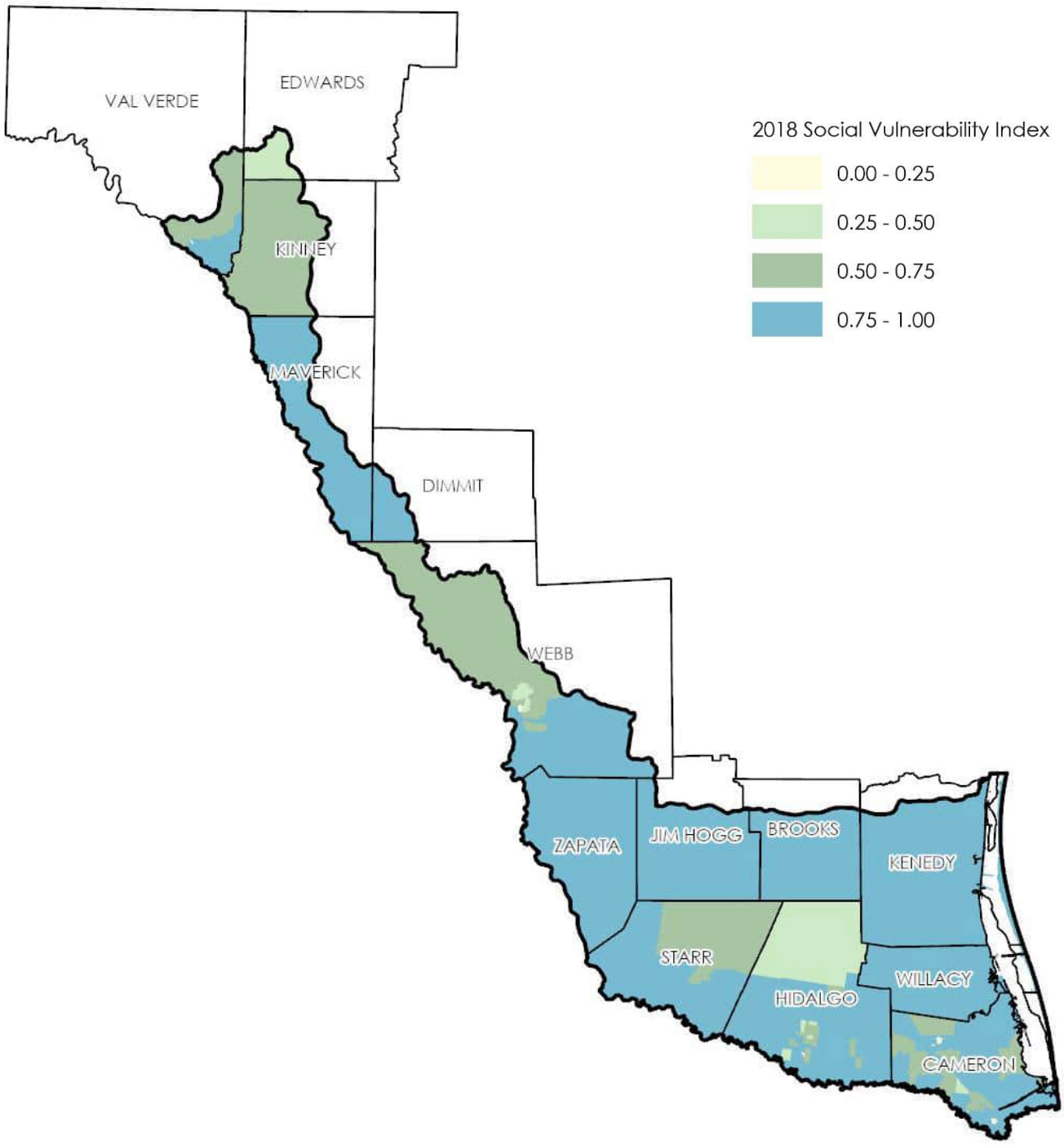
Social Vulnerability Analysis

When anticipating the likely extent of damages to a community from catastrophic floods, this assessment first considers "exposure" based on the geographic location of people and property. Another important dimension to increasing the resilience of the communities in the Lower Rio Grande Region is their relative "vulnerability" to floods when they do occur. Disasters affect different people or groups in different ways, ranging from their ability to evacuate an area in harm's way, the likelihood of damage to their homes and properties, capacity to find the financial resources needed to recover and rebuild after a storm. These factors are known as Social Vulnerability, or a person's or group's “capacity to anticipate, cope with, resist and recover from the impacts of a natural hazard,” based on their relative vulnerability.

Figure 1.9 is based upon an analysis of this region using the Social Vulnerability Index (SVI) – from the United States Department of Health and Human Services (HHS) Centers for Disease Control and Prevention (CDC). The SVI method is measured on a scale of zero to one, with one being the highest level of vulnerability, and is used here to map social vulnerability in the region at multiple scales. The index focuses on a series of 15 demographic indicators:

- below poverty
- unemployed
- low income
- no vehicle
- no high school diploma
- aged 65 or older
- aged 17 or younger
- civilian with a disability
- single-parent households
- minority status
- multi-unit structures
- mobile homes
- crowding
- group quarters
- language barriers

Figure 1.9 Social Vulnerability by Census Tract



The presence of several of these factors in a population, or even an individual household, has proven to be a reliable indicator of the long-term impact of a disaster. This plan will consider the location of highly socially vulnerable populations regarding the need to protect critical facilities and invest in 63 flood mitigation projects.

The social vulnerability may vary widely, even within a single county. In the Lower Rio Grande Regional Flood Planning Area, about half of the census tracts are within the 0.5 to 1 range, indicating a rather high level of social vulnerability across the basin. The lower half of the basin contains most of the census tracts in the 0.75 to 1 range in the rural portions of the counties. The urban areas in and around the larger cities display the lowest levels of social vulnerability and typically are those with the highest incomes.

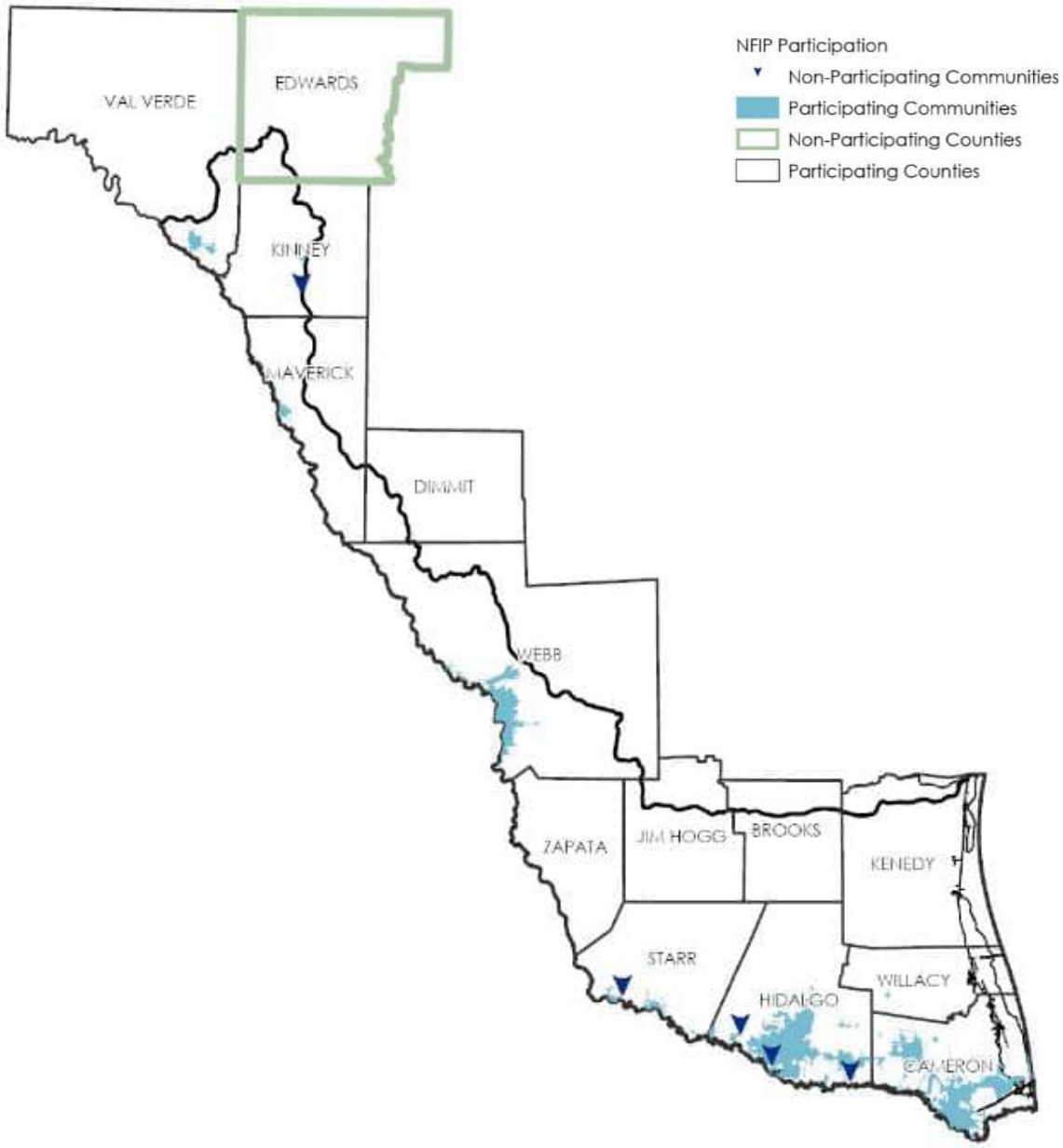
1.2. Major Flood Risks to Life and Property

A critical step in reducing the vulnerability of the Lower Rio Grande Region to future flooding is establishing flood risk. This section establishes what is currently known concerning the area's exposure to flood hazards and the vulnerability of the communities within the Lower Rio Grande Basin.

Today, a patchwork quilt of plans, regulations, and infrastructure provides Texans limited protection from flooding. Flood planning largely takes place at a local level, with an inconsistent set of standards from community to community that makes it very difficult to quantify risk across the region. Fortunately, most of the communities in the Lower Rio Grande Region (91 percent) participate in the NFIP. This is good news, as it improves their prospects for economic recovery in the event of a major flood and provides a system to reduce flood risk to new development. **Figure 1.10** shows which communities participate in the NFIP and which have not yet joined at the time of this report.

Many communities are using maps that are decades old and may only tell part of the story. These maps may not reflect changing development patterns and often fail to identify flood risks associated with changes in the topography and environment. Additionally, Flood Insurance Rate Maps are intended to identify and communicate risks in the watershed of less than 1 square mile. However, they do not always include all watersheds and may be greater than 1 square mile in many communities.

Figure 1.10 Participation in the National Flood Insurance Program (NFIP)

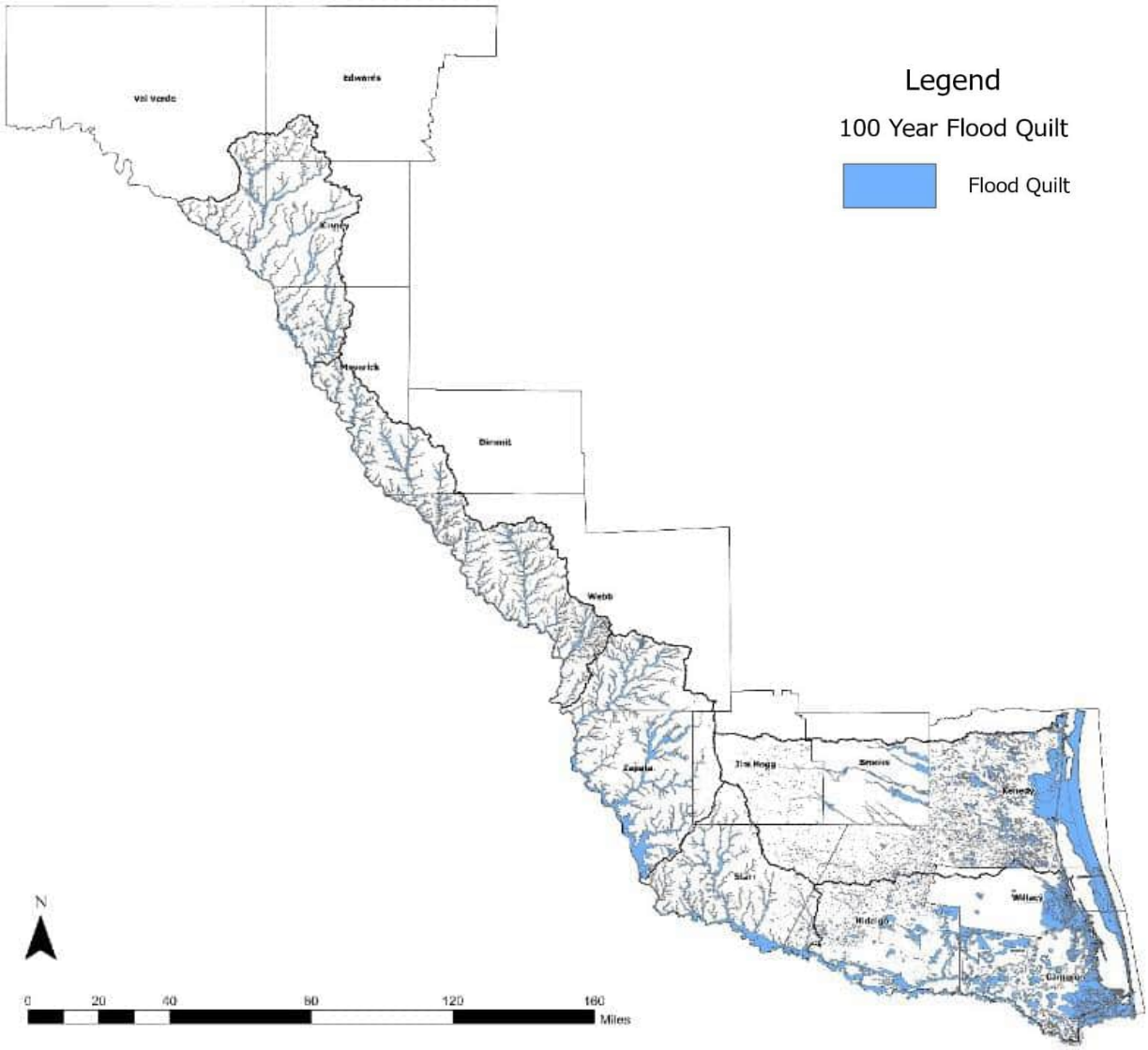


Identification of Flood-Prone Areas

According to current FEMA mapping, over 15 percent of the total area in the region is within the 1 percent annual chance event (ACE). In the Lower Rio Grande Region, more than 41 communities have over 20 percent of their land in the floodplain. This only tells part of the story because not all the floodplains within the Lower Rio Grande Region have been mapped and modeled. While developing a comprehensive flood risk model of the region is beyond the scope of this planning effort, the TWDB provided an initial floodplain quilt that patched together the best available flood risk mapping for this region for use in this plan. The floodplain quilt combines various data sources, providing comprehensive coverage of all known existing statewide flood hazard information.

Figure 1.11 shows the initial floodplain quilt information provided by the TWDB, which serves as the Lower Rio Grande Region's starting point, providing an approximation of region-wide flood risk using currently available data. In Chapter 2 – Flood Risk Analyses, this "quilt" will be confirmed, updated, and otherwise enhanced as appropriate to prepare a larger flood risk assessment (*TWDB, 2021*). When complete, this regional floodplain quilt will identify information gaps and more accurately approximate the distribution of flood risk across the region.

Figure 1.11 Initial Floodplain Quilt Map provided by TWDB for Regional Flood Planning



Types of major flood risks to life and property

The TWDB has defined the following flooding hazards in their Technical Guidelines for Regional Flood Planning, dated April 2021.

> ***Riverine flooding:*** *Riverine flooding is caused by bank overtopping when the flow capacity of rivers is exceeded locally. The rising water levels generally originate from high-intensity rainfall creating soil saturation and large volumes of runoff either locally and/or in upstream watershed areas.*
>
> ***Pluvial flooding, including Urban flooding****: Urban flooding is caused when the inflow of stormwater in urban areas exceeds the capacity of drainage systems to infiltrate stormwater into the soil or to carry it away. The inflow of stormwater results from (a) heavy rainfall, which can collect on the landscape (pluvial flooding) or cause rivers and streams to overflow their banks and inundate surrounding areas; or (b) storm surges or high tides, which push water onto coastal cities. Floodwater inundation and movement are influenced by (a) land development, which disturbs natural drainage patterns and creates hardened, impervious surfaces that inhibit infiltration of stormwater; and (b) stormwater systems that are undersized for current needs and thus increase exposure to drainage hazards. (National Academies of Sciences, Engineering, and Medicine, 2019).*
>
> ***Coastal flooding****: Coastal flooding occurs when normally dry, low-lying land is flooded by seawater.*

The Lower Rio Grande Region contains all three types of flooding hazards. The most prevalent type of flooding that poses a hazard to life and property is a combination of riverine and urban flooding.

1.3. Key Historical Flood Events

Although flood events have occurred from severe rainfall events, a good majority of the damaging floods that occur in the region are the result of tropical storms that move inland along the Rio Grande or through northern Mexico. In 1954, Hurricane Alice poured over 27 inches in 48 hours over the northern reaches of the region, causing flooding in the counties north of Webb County. In the southern extent of the region, Hurricane Beulah, which made landfall in September 1967, has caused the most damage of any recorded storms in the lower counties of Hidalgo and Cameron.

In the northern counties, flooding tends to occur along the major stream, while in the lower counties, the relatively flat terrain, low permeable soils, relatively high water table, and often inadequate channel capacities cause local flooding to occur, especially where manmade structures, such as roadways, irrigation canals, and railroad embankments often cause barriers to the drainage outfall channels. The three counties located along the coast also experience coastal flooding. Due to the coastline of Kenedy and Willacy counties not being as developed as Cameron County, the structural damages caused by coastal flooding in Cameron are much higher.

To protect the region from flooding from the Rio Grande, the federal government built the Amistad Dam and reservoir in Val Verde County, the Falcon Dam and reservoir in Starr County, and the Lower Rio Grande Flood Control Project (North Floodway, Arroyo Colorado Floodway, Anzalduas Dam, and Retamal Dam) in Hidalgo, Cameron, and Willacy counties. These facilities are owned and operated by the International Boundary and Water Commission, a bi-national organization. Although the Lower Rio Grande Flood Control Project mitigates flooding from the Rio Grande River, its levees and gate structures have caused stormwaters to pond outside the levee walls from severe events with large amounts of rainfall over areas in Hidalgo and Cameron counties that rely on the floodways as their outfall system.

Emergency Declarations and Major Declared Disasters

A Presidential Major Disaster Declaration (DR) puts into motion long-term federal recovery programs, some of which are matched by state programs, and designed to help disaster victims, businesses, and public entities. An Emergency Declaration (EM) is more limited in scope and without the long-term federal recovery programs of a Major Disaster Declaration.

Generally, federal assistance and funding are provided to meet a specific emergency need or help prevent a major disaster. Public Assistance (PA) is FEMA's largest grant program providing funds to assist communities responding to and recovering from major disasters or emergencies declared by the President. The program provides funding for emergency assistance to save lives and protect property and assists with funding for permanently restoring community infrastructure affected by a federally declared incident. Supplementally, PAs can be categorized for emergency work, such as PA-A for debris removal and PA-B for emergency protective measures. Individual Assistance (IA) programs are made available under EMs and are limited to supplemental emergency assistance to the affected state, territory, or tribal government to provide immediate and short-term assistance essential to save lives, protect public property, health, and safety, or to lessen or avert the threat of a catastrophe. All IA programs may be authorized once the President has declared a major disaster. The approval of IA under a major disaster declaration may also activate assistance programs provided by other federal agencies based on specific disaster needs.

Since 2000, there have been 14 Emergency Declarations and 34 Major Declared Disasters across Texas. One or more of the 14 counties that make up the Lower Rio Grande Region were included in 7 of the 14 Emergency Declarations and 12 of the 34 Major Declared Disasters. **Table 1.7** shows that most of those Emergency Declarations and Major Declared Disasters impacted the lower counties of Cameron, Hidalgo, Starr, and Willacy.

A description of some of the larger or more catastrophic storms is included in this section. The information from these storms is summarized from information gathered from the FEMA Declared Disasters website (Declared Disasters | FEMA.gov) as well as information from the National Oceanic and Atmospheric Administration's (NOAA)'s Storm Events Database on the National Centers for Environmental Information website (Storm Events Database | National Centers for Environmental Information (noaa.gov)

Table 1.7 Emergency Declarations and Major Declared Disasters for flooding within the Region since 2000

County	Hurricane Hanna (EM-3530-TX)	Tropical Storms Marco & Laura (EM-3540-TX)	Tropical Storm Alex (EM-3313-TX)	Hurricane Ike (EM-3294-TX)	Hurricane Gustav (EM-3290-TX)	Hurricane Dean (EM-3277-TX)	Hurricane Rita (EM-3261-TX)	Severe Storms and Flooding (DR-4454-TX)	Severe Storms and Flooding (DR-4377-TX)	Severe Storms and Flooding (DR-4272-TX)	Severe Storms and Flooding + (DR-4245-TX)	Severe Storms and Flooding + (DR-4223-TX)	Hurricane Alex (DR-1931-TX)	Hurricane Dolly (DR-1780-TX)	Severe Storms and Flooding + (DR-1709-TX)	Severe Storms and Tornadoes (DR-1697-TX)	Severe Storms and Flooding + (DR-1439-TX)	Tropical Storm Fay (DR-1434-TX)	Severe Storms and Flooding (DR-1425-TX)	Total
Brooks*	B		B	B	B	B	B							P						**7**
Cameron	B	B	B	B	B	B	B	I	I		I		A	A			I			**13**
Dimmit*	B						B												A	**3**
Edwards*							B													**1**
Hidalgo	B		B	B	B	B	B	I	I	X	A	A	A	A			I			**14**
Jim Hogg*	B		B	B	B		B						A	P	P					**8**
Kenedy*	B	B	B	B	B	B	B							P						**8**
Kinney*							B													**1**
Maverick*							B						A			B				**3**
Starr	B		B	B	B		B					P	A	P	A					**9**
Val Verde							B						I							**2**
Webb*	B		B	B	B		B						A		A			I		**8**
Willacy	B	B	B	B	B	B	B	I			A		P	A						**11**
Zapata	B		B				B						A							**4**

P = Public Assistance (Including Categories A-G) X = Individual and Public Assistance (Category B)
B = Public Assistance (Category B) A = Individual and Public Assistance (Including Categories A-G)
I = Individual Assistance

July 2020: EM-3530-TX

Hurricane Hanna made landfall as a Category 1 Hurricane on July 25, 2020, in Kenedy County, tracking from Kenedy County into Northern Hidalgo and then into Starr County as a Tropical Storm. Reported rainfall ranged from 8 to 15 inches in various parts of the region, particularly in Western Cameron and Eastern Hidalgo County near I-2. In addition to property damage, the heavy rains and associated flooding caused the region to lose approximately 95 percent of the annual cotton crop, resulting in a loss of $366 million in crop damage.

June 2019: DR-4454-TX

This sudden rainfall event started on the evening of June 24, 2019, and continued into the morning, producing 8 to 15 inches of rain in Western Willacy, Northwestern Cameron, and Eastern Hidalgo counties. A federal disaster declaration was made on July 17. Between the three counties, approximately 1,300 residences were impacted, with 1,100 classified as destroyed or with major damage; no deaths or injuries were recorded as a result of this flash flood event. At least 45,000 private and public utility power customers were without power at the peak of the storm. The rainfall impacted 30 Texas-managed highways, including I-2 and 1-69E frontage roads. Property Damage for Cameron County alone was estimated to be $30 million.

June 2018: DR-4377-TX

A tropical system from the Caribbean Sea arrived in South Texas on June 18, 2018, resulting in widespread heavy rains affecting much of the southeast portion of the region, including Hidalgo, Willacy, Cameron, Brooks, and Kenedy counties. A federal disaster declaration was made on July 6, 2018, for Hidalgo and Willacy counties. The resulting rainfall ranged from 12 to 18 inches in some parts of Hidalgo and Willacy counties and caused flood depths up to 3 feet in some homes and businesses. Official statistics for this event state that approximately 20,000 residences and businesses were affected by the floods, and more than 7,400 were defined as minor to destructive by FEMA Standards. Public infrastructure damage was estimated to be $50 million in Hidalgo and Willacy counties, and property damage for Cameron County alone is estimated to be $60 million.

October 2015: No Disaster Declaration

Thunderstorms produced heavy rain resulting in a flash flood that affected Maverick, Kinney, and Webb counties on the evening of October 8, 2015. The damage from the flooding resulted in $1 million of property damage in Eagle Pass and the direct loss of two lives. The storm event did not receive a Disaster Declaration from FEMA. However, it is the only recorded event from 2000 to 2021 in the region that resulted in more than one life being lost.

June 2010: DR-1931-TX

Hurricane Alex (2010) made landfall as a Category 2 Hurricane in Northern Mexico; due to the favorable conditions in the Caribbean and Gulf of Mexico, Alex became a large storm that affected south and southwest Texas from late June until its remnants dissipated on July 6. Torrential rains over the storm period contributed to widespread drawn-out urban flooding in Val Verde, Maverick, Webb, Zapata, Jim

Hogg, Starr, Hidalgo, and Cameron counties, resulting in an emergency declaration on August 3 for the period from June 30 to August 14. Of the 848 residences impacted by the flooding, 199 were destroyed, and 163 suffered from major damage caused by the flooding.

July 2008: DR-1780-TX

Hurricane Dolly (2008) caused significant rainfall in the region. The initial surge of rains became a more widespread area of moderate to heavy rainfall later in the evening and overnight within the Lower Rio Grande Valley. The heaviest rains were associated with the western and southern portions of Dolly's circulation, which edged into eastern Hidalgo County, then eased northwest overnight, reaching the four corners of Jim Hogg, Brooks, Hidalgo, and Starr county. The widespread flooding did not result in injury or loss of life. Still, it did result in approximately $181 thousand in property damage and the loss of approximately $335 million in damage to crops.

October 2003: No Disaster Declaration

Tropical moisture in combination with a weather disturbance over south Texas resulted in heavy rainfall across Brooks, Jim Hogg, Starr, Hidalgo, Willacy, and Cameron counties reaching up to 13 inches in La Joya in western Hidalgo County. Damage in Cameron County alone exceeded $4.5 million, with approximately 550 residences across the affected counties suffering from minor to moderate damage. Flooding in Brooks County resulted in the closure of US-281 for several days.

Past Casualties and Property damage

The overarching goal of this Regional Flood Plan is “to protect against the loss of life and property,” as outlined in the Guidance Principles in 31 TAC §362.3. The worst loss associated with any hazard is the loss of life. In the Lower Rio Grande Region, there have been four deaths as a direct result of storm events since the beginning of 2000. The deadliest storm event happened in Eagle Pass (Maverick County) on October 8, 2015. Heavy thunderstorms dropped more than 10 inches of rain in a matter of hours, causing a flash flood that resulted in several evacuations and 90 water rescues, leaving more than 60 people homeless. This single event resulted in the death of two men and a million dollars in damages (Storm Events Database - Event Details | National Centers for Environmental Information (noaa.gov)).

The Lower Rio Grande Region is fortunate to have no injuries directly from any historical flood events but unfortunate to have four deaths. Additionally, there were no injuries or deaths indirectly associated with any flood or flash flood event in this region. **Table 1.8** shows the total number of Casualties and Property Damages reported to the National Oceanic and Atmospheric Administration (NOAA) from January 1, 2000, to December 31, 2021, for the Lower Rio Grande Region. The totals included for the counties of Brooks, Dimmit, Edwards, Jim Hogg, Kenedy, Kinney, Maverick, and Webb in **Table 1.8** reflect only those events that impacted the portion of the counties that lie within the Lower Rio Grande Region, based on the event description provided on the NOAA Storm Events Database.

From 2000 to the present, property damage losses throughout the region amounted to $408,399,000 in 2021 dollars, with the largest losses found in densely populated metropolitan areas prone to flash flooding and in areas subject to tropical storms and hurricanes.

Table 1.8 Total number of Casualties and Property Damages reported to the National Oceanic and Atmospheric Administration (NOAA) from January 1, 2000, to December 31, 2021, for the Lower Rio Grande Region

County	Total Recorded Events	Total Recorded Injuries	Total Recorded Deaths	Property Damage Value, $
Brooks	7	0	0	1,460,000
Cameron	62	0	0	107,350,000
Dimmit	3	0	0	0
Edwards	6	0	0	150,000
Hidalgo	61	0	1	201,492,500
Jim Hogg	2	0	0	150,000
Kenedy	0	0	0	0
Kinney	39	0	0	226,000
Maverick	35	0	2	4,168,000
Starr	35	0	0	56,383,000
Val Verde	51	0	0	1,425,000
Webb	59	0	1	10,060,000
Willacy	31	0	0	24,264,500
Zapata	29	0	0	1,270,000
Region 15	**269**	**0**	**4**	**408,399,000**

Past losses for farming and ranching

According to the NOAA National Centers for Environmental Information, the cumulative reported losses to crops due to flooding in the Lower Rio Grande Region since 2000 amounted to $459,945,000. Due to every county not reporting an amount of crop damage, it is likely that amount of reported crop damage is greatly underestimated. Furthermore, we could not find a source that reports the amount of damage that historical storm events have had on livestock and other ranching activities. **Table 1.9** summarizes the crop damages by county within the Lower Rio Grande Region from 2000 through 2021.

Table 1.9 Total amount of Crop Damages reported to the National Oceanic and Atmospheric Administration (NOAA) from January 1, 2000, to December 31, 2021, for the Lower Rio Grande Region

County	Crop Damage Events	Crop Damage Value, $
Brooks	7	0
Cameron	62	107,210,000
Dimmit	3	0
Edwards	6	0
Hidalgo	61	163,000,000
Jim Hogg	2	0
Kenedy	0	0
Kinney	39	0
Maverick	35	2,000,000
Starr	35	50,500,000
Val Verde	51	0
Webb	59	0
Willacy	31	137,210,000
Zapata	29	25,000
Region 15	**269**	**459,945,000**

Figure 1.12 Photo of the flooded neighborhood and adjacent agricultural field in Los Fresnos during June 2018 rain event.

Source: NOAA Brownsville/Rio Grande Valley, TX Weather Forecast Office Storm Summary (The Great June Flood of 2018 in the RGV (weather.gov))

1.4. Political Subdivisions with Flood-related Authority

State guidelines for "Flood Protection Planning for Watersheds" define political subdivisions with flood-related authority as cities, counties, districts, or authorities created under Article III, Section 52, or Article XVI, Section 59 of the Texas Constitution, any other political subdivision of the state, any interstate compact commission to which the state is a party, and any nonprofit water supply corporation created and operating under Chapter 67. The TWDB provided an original list of over 140 separate political subdivisions within the Lower Rio Grande Region that were thought to potentially have some degree of flood-related authority. This list was refined through an initial data collection survey and outreach effort.

State law also provides for limited purpose Water Supply and Utility Districts. These are known as Municipal Utility Districts (MUDs), Municipal Water Districts (MWDs), Fresh Water Supply Districts (FWSDs), or Special Utility Districts (SUDs). These districts may be located in or adjacent to cities or counties and, in some cases, may be involved in the reclamation and drainage of overflowed land and other land needing drainage (Texas Legislature).

The following political subdivisions were identified as having flood-related authority:

Counties (14 total)

Brooks	Hidalgo	Maverick	Willacy
Cameron	Jim Hogg	Starr	Zapata
Dimmit	Kenedy	Val Verde	
Edwards	Kinney	Webb	

Municipalities, by County (54 total)

Cameron County (18 total)

Bayview	La Feria	Port Isabel	San Benito
Brownsville	Laguna Vista	Primera	Santa Rosa
Combes	Los Fresnos	Rancho Viejo	South Padre Island
Harlingen	Los Indios	Rangerville	
Indian Lake	Palm Valley	Rio Hondo	

Hidalgo County (22 total)

Alamo	Granjeno	Mission	Progreso Lakes
Alton	Hidalgo	Palmhurst	San Juan
Donna	La Joya	Palmview	Sullivan City
Edcouch	La Villa	Penitas	Weslaco
Edinburg	McAllen	Pharr	
Elsa	Mercedes	Progreso	

Kinney County (2 total)

Bracketville	Spofford

Maverick County (1 total)

Eagle Pass

Starr County (4 total)

Escobares	La Grulla	Rio Grande City	Roma

Val Verde County (1 total)

Del Rio

Webb County (3 total)

El Cenizo	Laredo	Rio Bravo

Willacy County (3 total)

Lyford	Raymondville	San Perlita

River Authorities (1 total)

International Boundary and Water Commission

Flood Districts (10 total)

Camero County Drainage District 1
Cameron County Drainage District 3
Cameron County Drainage District 4
Cameron Count Drainage District 5
Cameron County Drainage District 6
Hidalgo County Drainage District 1
Starr County Drainage District
Webb County Drainage District 1
Willacy County Drainage District 1
Willacy County Drainage District 2

Other with flood authority (7 total)

Irrigation Districts with Flood Control Authority (5 total)

Bayview Irrigation District 11
Donna Irrigation District Hidalgo County 1
Hidalgo and Cameron Counties Irrigation District 9
Harlingen Irrigation District
La Feria Irrigation District Cameron County 3

Municipal Utility Districts with Flood Control Authority (2 total)

Fort Clark Mud
Valley MUD 2

Other with no flood authority (28 total)

The following groups are included on the list of interest groups because of their close association with flood mitigation activities and possibly with the conveyance of stormwater. Some irrigation districts, for example, have entered into interlocal agreements with local flood districts or approved the use of their field runoff swales for drainage conveyance when farmlands are converted into subdivisions. Others

Irrigation Districts with no Flood Control Authority (15 total)

Brownsville Irrigation District
Cameron County Irrigation District 2
Cameron County Irrigation District 6
Cameron County Irrigation District 16
Delta Lake Irrigation District
Engelman Irrigation District
Hidalgo County Irrigation District 1
Hidalgo County Irrigation District 2
Hidalgo County Irrigation District 5
Hidalgo County Irrigation District 6
Hidalgo County Irrigation District 13
Hidalgo County Irrigation District 16
Santa Cruz Irrigation District 15
United Irrigation District
Valley Acres Irrigation District

Special conservation and reclamation district (1 total)

Rio Grande Regional Water Authority

Municipal Utility Districts with no Flood Control Authority (8 total)

Hidalgo County Mud 1
Los Fresnos MUD 1
Paseo De La Resaca MUD 2
Paseo De La Resaca MUD 3

Los Fresnos MUD 2
Paseo De La Resaca MUD 1
San Ygnacio MUD
Sebastian MUD

Council of Governments with flood control authority (4 total)

Coastal Bend Council of Governments
Lower Rio Grande Valley Development Council
Middle Rio Grande Development Council
South Texas Development Council

Entities removed from the original TDB list (15 total)

The following entities have been removed from the entities list as they have no flood control authority. Their primary purpose or mission relates to coastal areas or the conservation, delivery, and use of surface water for consumption and use.

Navigation Districts with no Flood Control Authority (3 total)

Brownsville Navigation District
Port Isabel San Benito Navigation District
Willacy County Navigation District

Water Districts with no Flood Control Authority (12 total)

Cameron County Water Improvement District 10
Cameron County Water Improvement District 16
Hidalgo County Water Improvement District 3
Hidalgo County WCID 18
Hidalgo County WCID 19
Laguna Madre Water District
Maverick County WCID 1
Port Mansfield Public Utility District
Rio Grande Palms Water District
Siesta Shores WCID
Southmost Regional Water Authority
Zapata County WCID-Hwy 16 East

Flood Planning, Floodplain Management, and Flood Mitigation activities

Flood Planning Activities

Flood planning activities are those activities that are undertaken before a flood event happens to better understand the mechanical workings of the watershed to develop strategies or other mitigation measures to lessen or eliminate the impacts of flood events. These types of activities can be undertaken by the local communities that manage the floodplains, but also states, flood districts, river authorities, and other special districts and entities that develop or partner with local entities for the common goal of developing resilient communities. Flood planning activities typically include activities like hydrologic and hydraulic studies of watersheds or subbasins, feasibility studies and design of flood mitigation projects, coordination and development of regional projects, assessment and development of proposed policy and regulatory protocols for floodplain management, and other activities to prepare communities in case there is a flood event.

Floodplain Management Activities

FEMA defines floodplain management as a community-based effort to prevent or reduce the risk of flooding, resulting in a more resilient community (Floodplain Management | FEMA.gov). Floodplain management activities are usually performed by local governments and include passing and enforcing

land use and development regulations. Floodplain management activities include zoning regulations, building codes, adoption of minimum standards for development and redevelopment of areas within the city or county, enforcement of these regulations, education, and other similar tasks. While FEMA has minimum floodplain management standards for communities participating in the National Flood Insurance Program (NFIP), adopting higher standards will lead to safer, stronger, and more resilient communities.

Flood Mitigation activities

Flood mitigation activities typically have an implementation cost and are protection measures that are effective in protecting life and property. These activities are typically performed by local communities, flood districts, and river authorities responsible for protecting a community from floods. Flood mitigation activities include constructing structural projects or implementing non-structural flood protection measures. Structural flood mitigation projects include flood control structures such as weirs, pump stations, and gates; drainage infrastructure such as channels, ditches, ponds, and storm sewer systems; infrastructure such as retention and detention ponds; and green structures such as bioswales, infiltration gardens, and green streets. Non-structural flood mitigation projects include property buyouts for highest-risk properties and restoration of riparian corridors, floodplains, coastal areas, wetlands, etc. Other flood mitigation measures could include warning systems, stream gages, educational campaigns, and crossing barriers.

A summary of the number of political subdivisions, or entities, identified for the Lower Rio Grande Region by entity type is included in **Table 1.10**. This table also lists the type of activities that entities typically undertake. Only those entities listed as having no flood authority are the ones that are not active with flood planning, floodplain management, or flood mitigation activities.

Table 1.10 Political Subdivisions with Flood-related Authority, by Entity Type, in the Lower Rio Grande Region

Entity Type	Number in Region	Type of Activities typically undertaken by Entity Type
Counties	14	Flood Planning, Floodplain Management, and Flood Mitigation activities
Municipalities	54	Flood Planning, Floodplain Management, and Flood Mitigation activities
River Authorities	1	Flood Planning, Floodplain Management, and Flood Mitigation activities
Flood Districts	10	Flood Planning, Floodplain Management, and Flood Mitigation activities
Other with flood authority	7	Flood Planning activities
Other with no flood authority	28	None

1.5. Extent of Flood Risk-related Regulations

In the Lower Rio Grande Region, 91 percent of eligible entities (49 of 54 municipalities and 13 of 14 counties) participate in the NFIP. The Texas Water Code §16.315 requires NFIP participants to adopt a floodplain management ordinance and designate a floodplain administrator responsible for understanding and interpreting local floodplain management regulations and reviewing them for compliance with NFIP standards. Some of the rights and responsibilities granted under this authority include:

- applying for grants and financing to support mitigation activities
- guiding the development of future construction away from locations threatened by flood hazards
- setting land use standards to constrict the development of land which is exposed to flood damage and minimize damage caused by flood losses
- collecting reasonable fees to cover the cost of administering floodplain management activities
- using regional or watershed approaches to improve floodplain management
- cooperating with the state to assess the adequacy of local structural and non-structural mitigation activities

Summary of Existing Flood Plans and Regulations

The following tables summarize the entities' responses to questions about their existing regulatory environment and any measures they may have in place to increase resilience. The information in these tables is strictly based on responses to the data collection survey.

A total of 31 entities responded to the data collection survey. Table 1.11 summarizes the type of regulations or development codes that the entities who responded to the survey indicated they had implemented to manage existing and future risk for developments. The responses are included as a percentage of survey participants. These plans and regulations were divided into four categories: Drainage Criteria Manual/Design Manual, Land Use Regulations, Ordinances (Floodplain, Drainage, Stormwater, etc.), and Unified Development Code (UDC) and/or Zoning Ordinance with map. Of the four types of regulations and plans, the largest number of respondents indicated that they had an active floodplain, drainage, and/or stormwater ordinance.

Table 1.11 Types of Measures to Promote Resilience in Flood-Prone Areas

Type of Regulation	Percent of Data Collection Respondents, %
Drainage Criteria Manual/Design Manual	36
Land use regulations	55
Ordinances (Floodplain, Drainage, Stormwater, etc.)	71
Unified Development Code (UDC) and/or Zoning Ordinance with map	36

Source: Lower Rio Grande Region Data Collection Tool and Interactive Webmap

In general, these regulations and ordinances cumulatively:

- restrict and prohibit land uses that are dangerous
- control alteration of floodplains, channels, and natural protective barriers
- describe permitting and variance procedures for land use regulation in relation to flood prevention
- define the duties of the floodplain administrator
- specify subdivision and construction standards
- prescribe penalties for non-compliance to standards
- define overall rules and regulations for flood control and flood hazard reduction

Beyond regulations, **Table 1.12** identifies additional measures entities undertake to comprehensively promote resilience in flood-prone areas to mitigate the effects of flooding. As defined by FEMA, resilience aims to build a culture of preparedness through insurance, mitigation, continuity, preparedness programs, and grants. According to the 31 respondents to the data collection survey, the most popular measures entities currently employed in the Lower Rio Grande Region include participation in the NFIP Program, implementation of land use regulations that limit future flood risk, and flood response planning. Roughly half of the respondents indicated that these three measures were currently being used. Flood readiness education and training and the use of a flood warning system was used by 39 percent and 23 percent of respondents, respectively. A respondent from one of the municipal utility districts indicated they take the same measures that the other local entities with overlapping jurisdictions take. See **Table 1.12** for a detailed breakdown of the measures currently employed to promote resilience in the region's flood-prone areas.

Table 1.12 Types of Measures to Promote Resilience in Flood-Prone Areas

Measures to Promote Flood Resilience	Percent of Data Collection Respondents, %
Acquisition of flood-prone properties	16
Flood readiness education and training	39
Flood response planning	45
Flood warning system	23
Higher Standards for floodplain management	19
Land use regulations that limit future flood risk	45
Participation in the Community Rating System (CRS)	3
Participation in the National Flood Insurance Program (NFIP)	55
Coordination with adjacent entities who share watershed	3

Source: Lower Rio Grande Region Data Collection Tool and Interactive Webmap

Using plans and policies to reduce the exposure of people and properties to flood risk is a form of non-structural flood control. By encouraging or requiring communities to avoid developing in flood-prone areas or to take precautions such as increasing building elevation, preserving overflow areas through buffering, and avoiding sensitive natural areas such as wetlands, communities can prevent new development from being in harm's way.

Floodplain Ordinances and Local and Regional Flood Plans

Floodplain ordinances dictate how development is to interact with or avoid a city's floodplain. FEMA provides communities with flood hazard information based on floodplain management regulations. Floodplain ordinances are subject to the National Flood Insurance Program and ensure that communities and entities consider flood hazards when making land use and land management decisions. Ordinances may include maps with base flood elevations (BFE), any freeboard requirements, as well as criteria for land management and use. This information will be discussed in greater detail in Chapter 3.

Comprehensive Plans and Future Land Use Plans

The comprehensive plan establishes policies and a program of action for a community's long-term growth and development. The future land use (FLU) plan provides a guide for future areas of growth and development, as well as areas that are to be conserved in their natural state. The comprehensive plan and its embodied FLU plan set the groundwork necessary to undertake quality decision-making for future growth and development. While many cities have FLUs, the content of these plans varies widely in specificity. Irrespective, the existence of a FLU plan may mean that the entity is likely taking a more detailed approach to the type and location of future development.

Comprehensive plans and their associated FLU plans also provide legal authority for zoning regulations in the State of Texas. They consider capital improvements necessary to support current and future populations and often consider social and environmental concerns the community wishes to address. To produce a comprehensive plan, communities undertake an extensive planning process that encourages discussion about topics such as risk from natural hazards and may include recommendations regarding the development location with respect to floodplains, the need for future drainage improvements, etc. As many development decisions are made during the first step in the development process, particularly during negotiated development proposals like planned unit developments (PUDs), it is critical for floodplains to be accounted for in these conversations.

Land Use Regulations and Policies: Zoning, Subdivision

Zoning ordinances regulate how property owners can use their property and what types of uses are allowed within a certain area. It is one of the most important tools that communities use to regulate the form and function of current and future development. Within the zoning ordinance, communities may incorporate a variety of tools, which may include, among others:

- stream buffers
- setbacks from wetlands and other natural areas
- conservation easements

Subdivision regulations get into a more focused direction on the design and form of the building blocks of a city. They regulate platting processes, standards for the design and layout of streets and other types of infrastructure, the design and configuration of parcel boundaries, and standards for protecting natural resources and open space. While both cities and counties have subdivision ordinances, counties do not have zoning authority in Texas. As identified by the survey results, 18 jurisdictions indicated that they have land use regulations to manage existing flood risk as part of development, while 15 indicated they had a future conditions land use plan or future zoning plan. Eleven jurisdictions indicated that they currently have unified development codes and/or zoning for construction.

Drainage Criteria

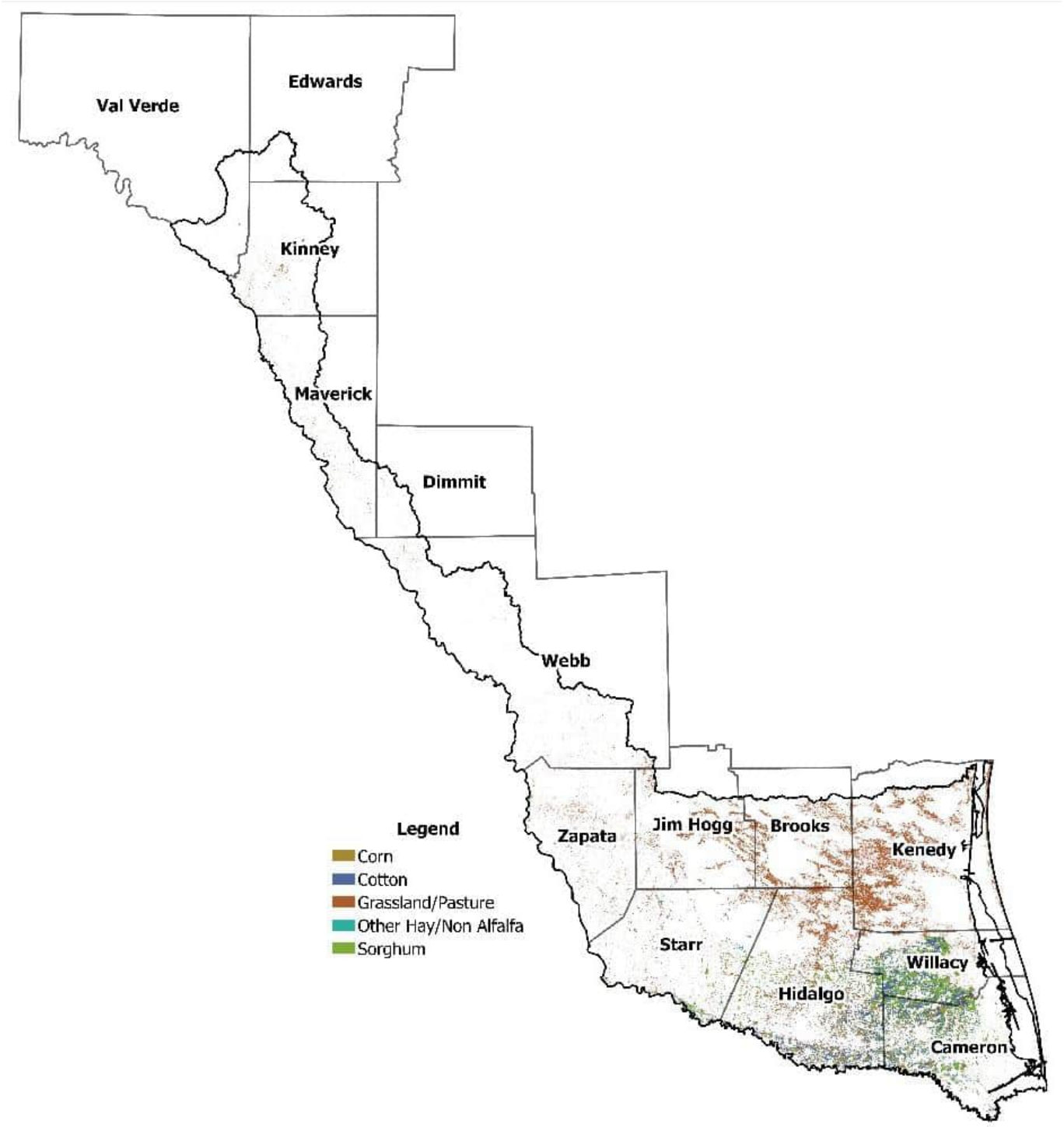
Drainage criteria are created to set the minimum standards for design engineers to follow when preparing plans for construction within the jurisdictions in which they serve. These could be for municipalities, counties, or districts with flood-related authority within the basin. The document covers standards pertaining to submissions, right of way/easements, hydrology, and hydraulics.

A storm drain system is a network of open channels, and underground pipes designed to capture and convey concentrated stormwater flows to a point beyond the developed property limits. Developers may sometimes oversee creating drainage infrastructure that will be continuous and synergistic with the existing storm drain system and will not prevent surrounding property owners from extracting economic benefits from their properties. As identified by the survey results, 11 jurisdictions have indicated that they currently have drainage criteria manuals/design manuals.

1.6. Agricultural and Natural Resources impacted by flooding

Figure 1.13 displays the locations where the top 5 crops in the region intersected with the floodplain. A large portion of these five major crops is located in the southern half of the Lower Rio Grande Basin. This means a large amount of the crops that are within the floodplain are within the northwest portions of Zapata County to the southeast portions of Cameron County. There are a few portions of the upper region of the basin that hold significant amounts of grasslands, with a mix of crops in Maverick & Kinney Counties. These will typically be the crops and regions that feel the effects of flooding the most. As discussed in section 1.3, NOAA estimates the amount lost in this region due to flooding to be $459,945,000 since 2000. However, we can see that not every county reports property/crop damage from disasters after every emergency, so this figure could be severely underestimated.

Figure 1.13 Top 5 crops in the Floodplain



1.7. Existing Flood Mitigation Planning Efforts

Most of the planning efforts within the Lower Rio Grande Region appear to be conducted at the local government level. Of the 14 counties located within the Lower Rio Grande Region, only 57 percent of them have current Hazard Mitigation Plans (HMP) that are approved by FEMA according to TDEM County Hazard Mitigation Plans Status Webmap as of 11/1/2020 (County Hazard Mitigation Plans Status (arcgis.com)). Of those, four counties have HMPs that expire by the end of 2021. In addition to the counties, 34 of the 54 municipalities and 2 of the 17 special districts have done additional Hazard Mitigation planning to address needs specific to their unique circumstances. It is important to note that only 5 HMPs were available for the Lower Rio Grande RFPG's review, and four of these HMPs were a collaboration between a county entity with one or more of the municipal entities located within its jurisdiction. Most of the identified Flood Management Strategies, Flood Management Evaluations, and Flood Mitigation Projects identified in this Regional Flood Plan (See Chapter 5) were listed in these HMPs because of the various planning efforts conducted across the region.

Currently, the Texas GLO is conducting a hydrologic and hydraulic study of the lower four counties of Cameron, Hidalgo, Starr, and Willacy County. This is the largest regional study being performed in the region. The Lower Rio Grande Valley Development Council is also performing a study of Cameron, Hidalgo, and Willacy County. Part of this second project will include the installation of flood stage gauges along the major outfall streams and drainage channels within the study area. These two projects and several other ongoing within the region are included in **Table 2** of **Appendix B**.

1.8 Inventory and Assessment of Existing Flood Infrastructure

This section provides an overview of natural and structural flood infrastructure in the Lower Rio Grande Flood Planning Region that contributes to lowering flood risk. The Lower Rio Grande Region's flood infrastructure serves not only the communities from Del Rio to South Padre Island, but in contrast to other flood planning regions in Texas, flood control infrastructure in this region depends on binational coordination through the International Boundary and Water Commission (IBWC). A map of the known existing flood infrastructure, natural and constructed, is included in **Appendix A** as **Map 1**- Existing Flood Infrastructure.

When assessing flood risk management infrastructure, this plan considers both the natural and manmade features that contribute to risk reduction, which may include, but are not limited to:

Natural Features: rivers, tributaries, and functioning floodplains;

- wetlands;
- Parks, preserves, natural areas;
- playa lakes;
- sinkholes;
- alluvial fans;
- vegetated dunes;

Structural Features:

- levees;
- sea barriers, walls, and revetments;
- tidal barriers and gates;
- stormwater tunnels;
- stormwater canals;
- dams that provide flood protection;
- detention and retention ponds;
- weirs;
- storm drain systems

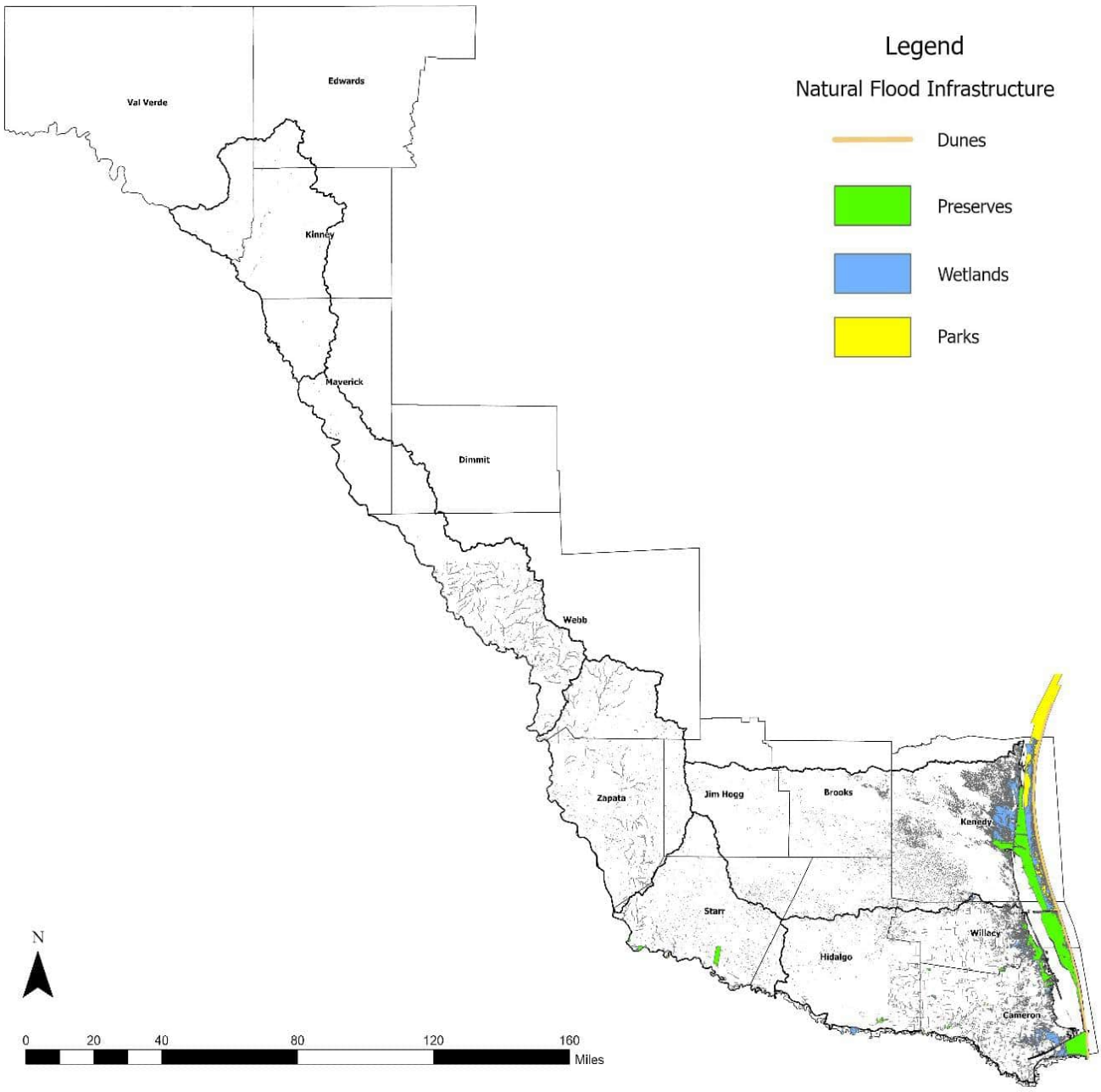
Both natural areas and built features make up the flood infrastructure in the region, including dams, levees, regional detention ponds, etc. The Texas Water Development Board provided several data sources to assist with the identification of flood management infrastructure in the Flood Data Hub. These features may be owned and managed by stakeholders ranging from the US Army Corps of Engineers to the National Parks Service to individual landowners. There were several questions posed in the data collection survey that was used to complement the information provided by existing data sources to create a more complete picture of how communities in the region protect themselves from flood risk.

Information related to the Inventory of Existing Flood Infrastructure that is summarized in this section is included in TWDB **Table 1**: Existing Flood Infrastructure Summary Table, included in **Appendix B** of this plan and serves as the basis for several of the tables and charts in this section.

1.8.a Natural Features

As the population growth and infrastructure trends along the U.S./ Mexico border continue, the basin will need to take a more deliberate approach to manage its natural infrastructure to continue to receive the benefits of open spaces, something which the U.S. Army Corps of Engineers addresses in its Engineering with Nature Initiatives. The State and Federal government are already actively managing Local, State, and National Parks and Wildlife Management Areas that form part of the region's natural infrastructure, all of which are illustrated in **Figure 1.14**. Recent changes to border security infrastructures and the built environment have begun to disrupt preserves and natural areas, as well as the natural hydrology.

Figure 1.14 Natural Flood Infrastructure



When left in their natural state, many soils can be efficient at handling rainfall. As drops fall from the sky, they are intercepted by trees, shrubs, or grasses, which allow rain time to soak into the soil and slow the passage of runoff to the region's waterways. Wetlands and woodlands are most efficient at recycling rainfall. The branches and undergrowth intercept water before reaching the ground, thus minimizing overland flow to tributaries and the river. Pastureland performs this function effectively as well, whereas croplands may shed a greater degree of water so as not to inundate the fields.

Similarly, parklands in urban areas that are designed for dual functions can achieve nearly the same rate of capture of stormwater as lands in undeveloped areas (Marsh, 2010). For natural features to achieve maximum effectiveness at flood mitigation, they should form part of an interconnected network of open space consisting of natural areas and other green features that also protect ecosystem functions and contribute to clean air. This is sometimes known as green infrastructure, the practice of replicating natural processes to capture stormwater runoff (Low Impact Development Center). Even small changes in developed areas can have a significant impact on downstream flooding.

Natural areas can be managed to be even more efficient at these functions in a variety of settings, including:

- **Watershed or Landscape Scale**: Where natural areas are interconnected to provide opportunities for water to slow down and soak in and overtop the banks of creeks and channels when needed. These solutions often include multiple jurisdictions and restoration of natural habitats to achieve maximum effectiveness.
- **Neighborhood Scale**: Solutions built into corridors or neighborhoods that better manage rain where it falls. Communities establish regulatory standards for development that guide the use of neighborhood-scale strategies.
- **Coastal Solutions:** To protect against erosion and mitigate storm surge and tidally influenced flooding, nature-based solutions can be used to stabilize shorelines and restore wetlands. (FEMA, 2021)

As forests and fields give way to urban development, soil permeability decreases. This makes land less efficient at the tasks of maintaining natural runoff velocities and allowing rainfall to soak into the ground and recharge the groundwater. In the twenty years between 1997 and 2017, the Texas Land Trends project found that the Lower Rio Grande River Basin lost about 200,000 acres of working land (crops, grazing lands, timber, and wildlife management) to urban and suburban development. While the population increased by more than 15% during that time, only about 1 percent of the total acreage of natural areas was replaced with structures, roads, and parking lots. These types of hard surfaces can increase the potential for increased runoff unless flood mitigation is incorporated into the development. The acreage that remained as open space grew increasingly fragmented.

As the trend toward urbanization and fragmentation continues, the region should consider taking a more deliberate approach to managing its natural infrastructure to continue to receive the benefits of open spaces, something which the U.S. Army Corps of Engineers addresses in its Engineering with Nature initiatives, which align natural and engineering processes to deliver economic, environmental,

and social benefits efficiently and sustainably through collaborative projects. The TWDB also identified Local, State, and National Parks and Wildlife Management Areas that form part of the region's natural infrastructure, all of which are illustrated in **Figure 1.14** above.

Rivers, Tributaries & Functioning Floodplains

The natural flood storage capacity of all streams and rivers and the adjacent floodplains contribute greatly to overall flood control and management. The floodplain is a generally flat area of land next to a river or stream that stretches from the banks of the river to the outer edges of the valley. The first part of the floodplain is the main channel of the river itself, called the floodway, which may be dry for part of the year. Surface water, floodplains, wetlands, and other features of the landscape function as a single integrated natural system. Disrupting one of these elements can lead to effects throughout the watershed, which increase the risk of flooding to adjacent communities and working lands. Maintaining the floodplain in an undeveloped state provides rivers and streams with room to spread out and store floodwaters to reduce flood peaks and velocities. Even in urban areas, preservation of this integrated system of waterways and floodplains serves a valuable function, as even small floods resulting from a 5- or 10-year storm can cause severe flood damage. Depending on soil type and permeability, a single acre of floodplain land can significantly reduce the risk to properties downstream. With over 33 percent of its land area located in the floodplain and the Rio Grande River and its tributaries crossing through both rural and highly urbanized areas of Texas, the river and its many tributaries and floodplains contribute to flood risk reduction as they meander southeast on their way east to the Gulf of Mexico. (FEMA, 2021)

Similar to the floodplain quilt, the region's streams were populated with available information from FEMA, USGS, TWDB, and local entities. It should be noted that the streams are compiled from the best available datasets; however, they generally do not align with the current topography. Along with statewide mapping, the TWDB is developing updated stream layers that can be integrated into the next planning cycle. As displayed in **Table 1.13** Streams by HUC-8 Watershed, there are over 29,878,173.74 stream miles in the Lower Rio Grande Region.

Table 1.13 Streams in Lower Rio Grande Region by HUC-8

Stream Name	HUC-8	COUNTY	Area (Acres)	Stream Miles
Elm-Sycamore	13080001	Val Verde	2626958	4791121
Central Laguna Madre	12110207	Kenedy	2392011	3086686
South Laguna Madre	12110208	Willacy	1910401	8809707
San Ambrosia-Santa Isabel	13080002	Webb	3691642	7324160
International Falcon Reservoir	13080003	Webb	1802008	4729751
Los Olmos	13090001	Starr	2012880	1136748

Wetlands

Wetlands are some of the most effective natural features for recycling water by minimizing the overland flow and reducing the need for other types of flooding infrastructure. The USGS defines wetlands as transitional areas sandwiched between permanently flooded deep water environments and well-drained uplands, where the water table is usually at or near the land's surface and is covered by shallow water. They can include mangroves, marshes, swamps, forested wetlands, and coastal prairies, among other habitats, and their soil or substrate is at least periodically saturated by fresh or salt water. There is a robust concentration of wetlands directly surrounding the Rio Grande River, and as the river heads eastward towards the coast, the concentration of wetlands increases. When left undisturbed by development, wetlands can not only mitigate flooding from upstream but also blunt the force of storm surges from the coast in the form of hurricanes and other tropical storms. According to the USGS National Wetlands Inventory, wetlands comprise 414,900 acres within the basin. This accounts for one of the largest types of natural infrastructure for the basin.

Parks, Preserves & Other Natural areas

Parks and preserves serve as essential components of the ecosystem as they house a wide variety of local flora and fauna, as well as physical features necessary for the region's continued ecological health. Parks include any municipal, county, state, and national parks within the region, while preserves include the Texas Parks & Wildlife Department’s State Wildlife Management Areas. These areas provide a sanctuary for all these aspects, which are impacted by human activity. Additionally, these are essential components for water retention in the event of flooding and severe rainfall.

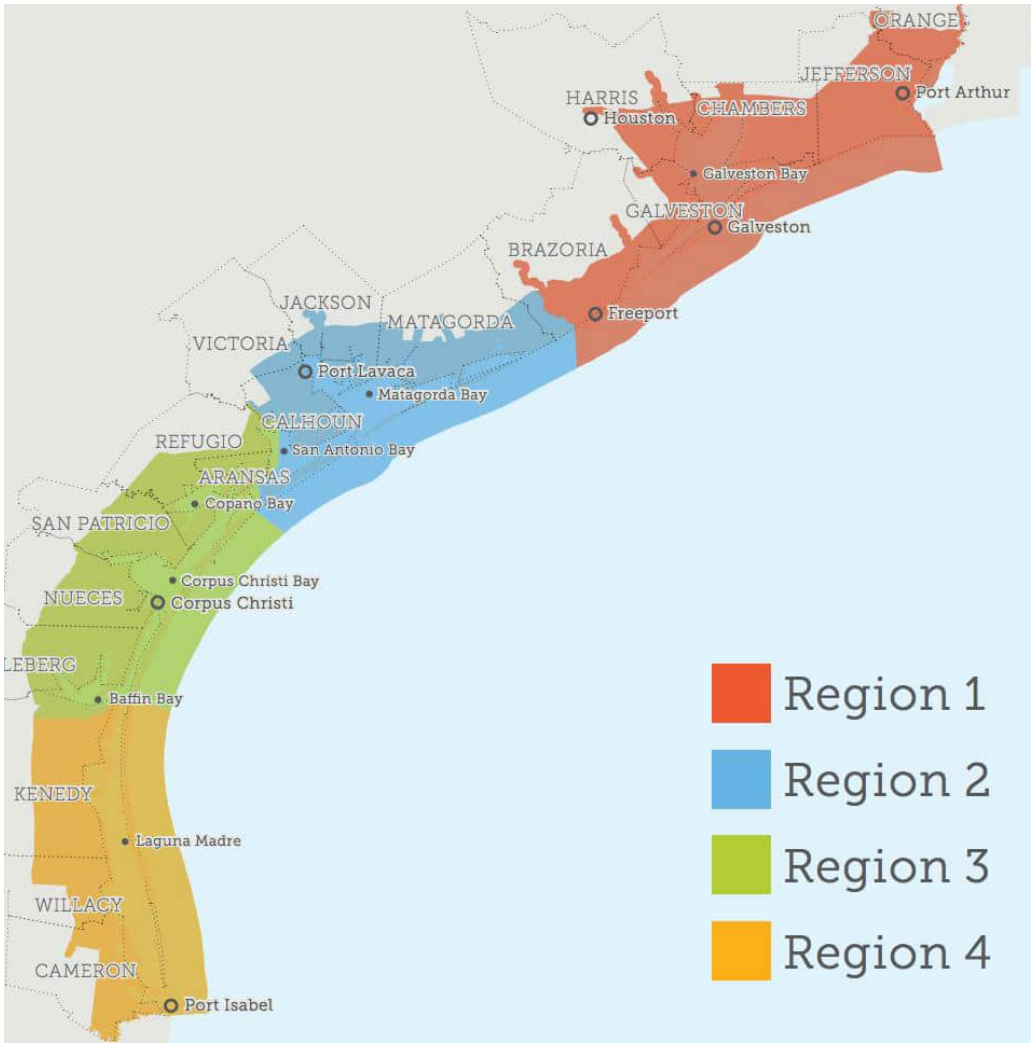
- Parks account for 165,200 acres
- Preserves make up 191,400 acres within the basin.

This acreage includes state and local parks, wetlands identified on the National Wetlands Inventory, as well as USACE properties. These types of natural flood infrastructure are generally located in or close to floodplain areas throughout the basin, with higher concentrations of them being located along or close to the major rivers.

Coastal areas

The National Coastal Zone Management Program is a voluntary partnership between NOAA and coastal states that was formed between states and the federal government following the passage of the Coastal Zone Management Act of 1972.

Figure 1.15 The 4 Regions of Texas' Coastal Zone, as defined by the Texas General Land Office (GLO) in their 2019 Coastal Resiliency Master Plan (CMRP)



Source: 2019 Texas Coastal Resiliency Master Plan

In Texas, this program is managed by the Texas General Land Office (GLO) and implemented through the 2019 Coastal Resiliency Master Plan (CRMP). The geographic extent of the State's Coastal Zone is illustrated in **Figure 1.15**. The State divides the Texas Coast into four regions for planning purposes based on approximate size, population centers, habitats, and environmental conditions. In the Lower Rio Grande Region, only the eastern areas of Cameron, Willacy, and Kenedy Counties touch the Laguna Madre area in the Texas Coastal Zone, located in Region 4. The dynamics of flooding in coastal areas differ from riverine flooding in that they are influenced by issues such as sea level rise, land subsidence, tidal flooding, storm surge, as well as rainfall events. Mitigating coastal flooding is one of the primary objectives of the CRMP, and proposed solutions include

- elevating structures
- incorporating green infrastructure into development
- creating flood resilient parks and recreational spaces
- retaining and restoring open space
- maintaining/creating freshwater wetlands and coastal prairies

The State is in the process of updating the 2019 CRMP and anticipates the release of a new plan in 2023 that will include a list of Tier 1 projects in each region that will be priority projects for funding in the future years. (Texas General Land Office, 2019)

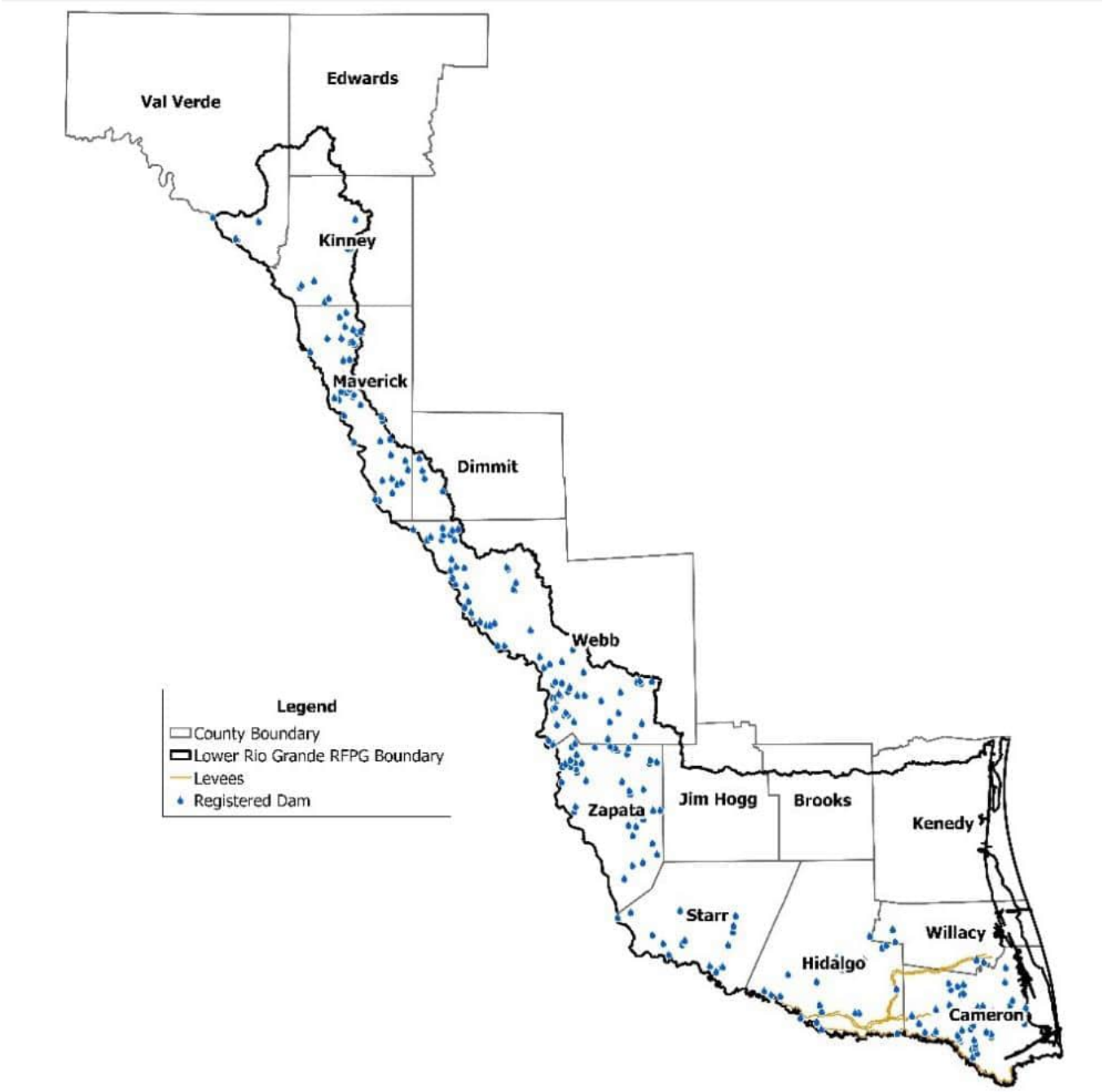
1.8.b Constructed Flood Infrastructure/ Structural Protections

A wide variety of structural measures are used by state and federal agencies, communities, and private landowners to protect development and agricultural areas from flooding. These may include flood control reservoirs, dams, levees, and local drainage infrastructure such as channels and detention areas. Dams and levees are some of the most frequently used defenses to achieve structural mitigation of future flood risk in this region and serve an established role of protecting people and property from flood impacts and will therefore be a primary focus of this section. **Figure 1.16** below identifies the location of all known dams and levees in the Lower Rio Grande Region.

Dams in Texas serve many purposes including recreation, flood risk mitigation, irrigation, water supply and fire protection, among others. About 1 in 3 of the state's dams are for flood risk mitigation and one in seven dams are for irrigation or water supply.

Levees are man-made structures that provide hurricane, storm, and flood protection. More than one million Texans and $127 billion dollars' worth of property are protected by levees. The Texas 2018 Levee Inventory Report lists 51 U.S. Army Corps of Engineers (USACE) levee systems (2021 Texas Infrastructure Report Card, 2021)

Figure 1.16 Known Dams and Levees



Dams, Levees & Reservoirs

The *Lower Rio Grande Flood Control System* contains 270 miles of U.S. flood control levee along the Rio Grande, interior floodways, and the Arroyo Colorado in Texas. Flood control works along the Rio Grande include 102 miles of levees and floodplain from Peñitas, Texas to beyond Brownsville, Texas. The interior floodway, which starts 13 levee-miles downstream from Peñitas at Anzalduas Dam, is about 70

miles long and is bounded by 143 miles of levees: 68 miles on the right side and 75 miles on the left side. The Arroyo Colorado, a 53-mile natural channel that breaks-off the interior floodway, is confined by high ground and 25 miles of levee; 10.5 miles on the left side and 14.6 miles on the right side. The Lower Rio Grande Flood Control System provides protection to the following metropolitan statistical areas: Brownsville-Harlingen, Texas and McAllen-Edinburg-Mission, Texas. Approximately one million U.S. residents live in the Lower Rio Grande Valley. Due to its proximity to the Gulf of Mexico and related tropical weather systems, the Lower Rio Grande Valley is prone to hurricanes and annual flood events.

1.8.d Condition and Functionality of Infrastructure and Other Flood Mitigation Features (TABLE 1)

TWDB require **Table 1**: Existing Flood Infrastructure Summary Table is included in **Appendix B** and includes the location and summary of existing flood infrastructure and natural features within the Lower Rio Grande Flood Planning Region whose information was readily available. Although there have been efforts to collect flood control and conveyance information from the entities with the Lower Rio Grande, no digital information has been able to be collected thus far. It is expected that this database will be enhanced with more local information as future data collection efforts are undertaken. Thus, no information has been acquired or received regarding functionality of constructed flood infrastructure.

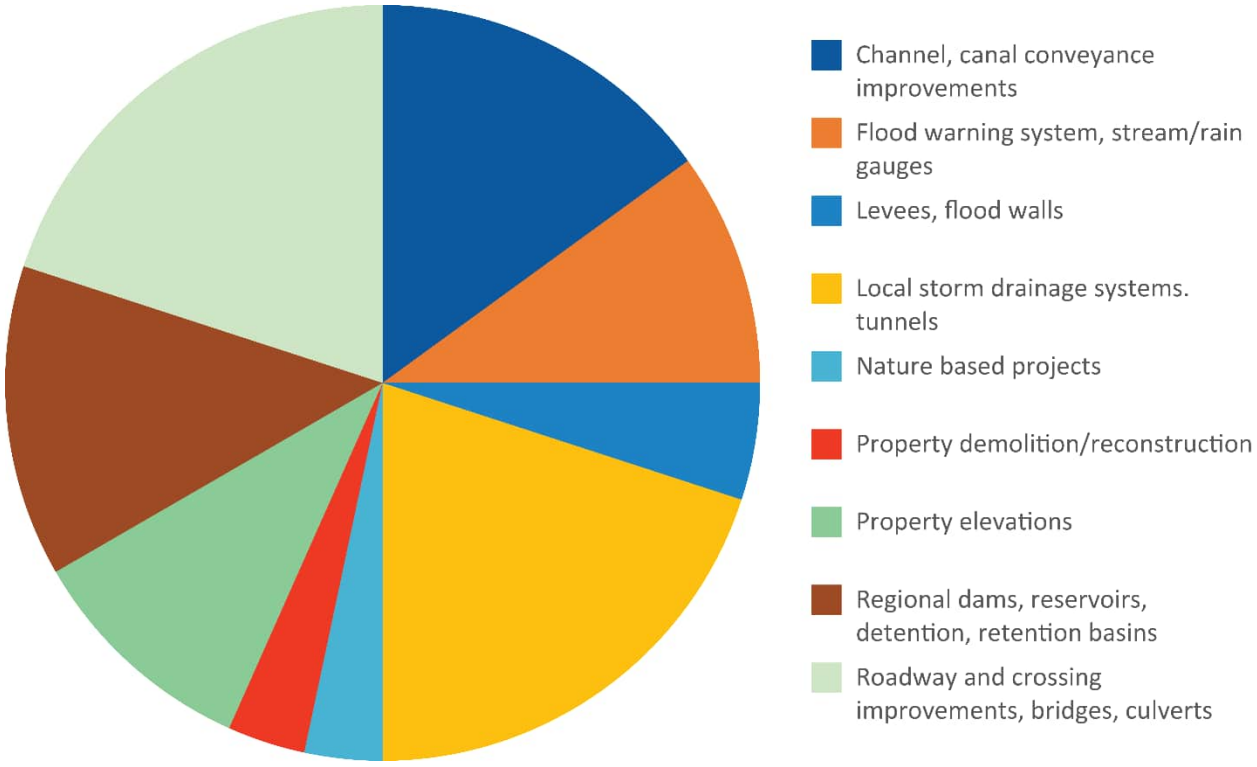
1.9 Proposed or Ongoing Flood Mitigation Projects (Planned Flood Infrastructure Improvements (Table 2)

The data for this section is derived from two primary sources. The first source of this data is the region's data collection survey, which was supplemented by direct outreach and interviews with stakeholders. More detailed results are available in TWDB required **Table 2:** Summary of Proposed or Ongoing Flood Mitigation Projects is included in **Appendix B**. The second source was a summary of TWDB sponsored flood mitigation projects that were provided during the planning process.

About 25 communities indicated in the survey that they planned to undertake flood mitigation projects in the coming years. However, there are several gaps in this data set as little data was provided on individual projects. Only two respondents spoke about specific projects. Others indicated that they anticipated pursuing a variety of Flood Mitigation Projects (FMPs) in the coming years. Respondents were allowed to select multiple alternatives.

Most respondents to this question indicated they intended to pursue more than one type of flood mitigation project. **Figure 1.17** represents all potential types of projects identified in the survey. Local storm drainage systems, tunnels, and Roadway and crossing improvements, bridges, culverts are among the most frequently cited FMPs for all responding jurisdictions. The topic of Flood Mitigation Projects (FMPs) will be covered in greater detail in Chapter 4 of this plan.

Figure 1.17 Flood Mitigation Project Types Survey Result



To accompany this chart**, Table 1.14** details the frequency with which communities plan on implementing a particular type of flood mitigation project. While several project types, like local storm drainage systems and roadway improvements may be local in nature, many other solutions are more regional in nature, such as regional dams and retention and even highway improvements that may involve State agencies.

Table 1.14 Flood Mitigation Projects (Survey)

Types of Flood Mitigation Projects	Count
Channel, canal conveyance improvements	9
Flood warning system, stream/rain gauges	6
Levees, flood walls	3
Local storm drainage systems. tunnels	12
Nature based projects	2
Property demolition/reconstruction	2
Property elevations	6
Regional dams, reservoirs, detention, retention basins	8
Roadway and crossing improvements, bridges, culverts	12

Structural Projects under Construction

Of the 85 total ongoing Flood Mitigation Projects throughout the Lower Rio Grande Region, 77 of them are structural projects. The concentration of these is within Hidalgo, Cameron, & Willacy Counties. These projects include detention ponds (regional/local), ditch improvements, drainage improvements, channel/canal improvements, among other improvements.

Nonstructural Flood Mitigation Projects being implemented

Of the 85 total ongoing Flood Mitigation Projects throughout the Lower Rio Grande Region, 8 of them are nonstructural projects. These are also within the Counties of Hidalgo, Willacy, & Cameron. These projects include flood studies, gauging/monitoring mechanisms, other expansion of a drainage district's machinery for the construction and maintenance of flood mitigation infrastructure.

Structural & Non-Structural Flood Mitigation Projects with Dedicated Funding & Year Complete Funding sources

There are currently 76 ongoing projects which do have a dedicated source of funding for construction. Of these projects, a large majority of them are funded through the FIF or a Drainage Bond Program. Of the funded projects, 45 of them are in Hidalgo County, 14 are in Cameron County, 12 are in Willacy County, 5 are in Webb County and 1 is in Val Verde County.

Chapter 2

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Chapter 2: Flood Risk Analyses

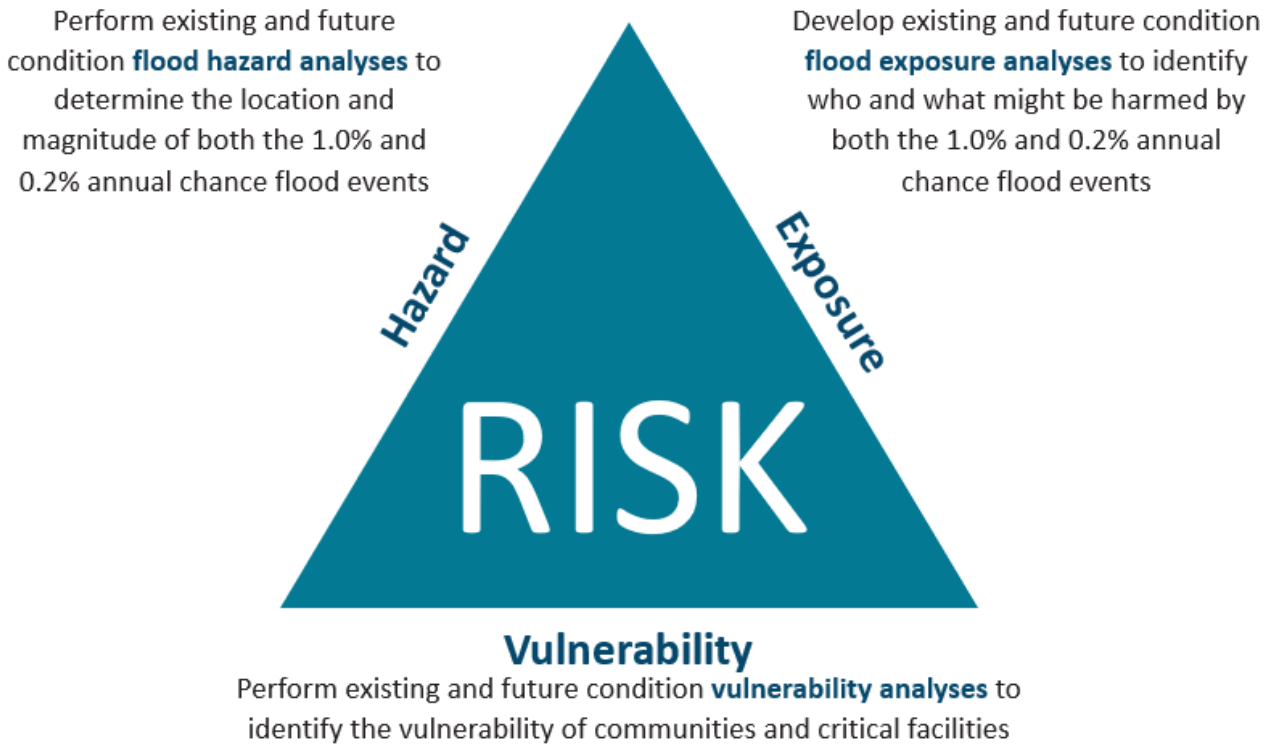
An important aspect of developing a Regional Flood Plan involves accurately assessing the flood risk. This includes a description of flooding, identifying what is at risk, and estimating the associated impacts. In terms of understanding the environment, the Lower Rio Grande Regional Flood Plan assessed flood risk for existing and future conditions.

In this Lower Rio Grande Regional Flood Plan, the existing and future conditions flood risk assessment focused on the following three main components:

1. Flood hazard analyses to determine the location, magnitude, and frequency of flooding
2. Flood exposure analyses to identify who and what might be harmed within the Lower Rio Grande Basin; and
3. Vulnerability analyses to identify the degree to which communities and critical facilities may be affected by flooding

Figure 2.1 shows the Risk Triangle framework applied to the Lower Rio Grande Regional Flood Plan Flood Risk Analyses.

Figure 2.1 Flood Risk Analyses Triangle Framework



Source: Texas Water Development Board (TWDB)

Task 2A – Existing Condition Flood Risk Analyses

2A.1 Existing Condition Flood Hazard Analysis

2A.1.A Sufficiency of Existing Conditions for Planning Purposes

In terms of potential flood hazard analysis, existing conditions refer to the hydrologic and hydraulic conditions present when the analysis was performed. These conditions include current land use, estimated precipitation data, and constructed drainage-related infrastructure. Existing conditions in relation to the Lower Rio Grande Planning Region do not consider projected changes in rainfall patterns, future land use/population growth, or planned new/improved infrastructure. Federal Emergency Management Agency (FEMA) Flood Insurance Rate Maps (FIRMS) Special Flood Hazard Areas (SFHA) are generally based on existing conditions. The FEMA regulatory SFHA boundaries from these maps form the foundation of the Lower Rio Grande Planning Region's existing conditions flood hazard analysis.

Land Use

Land use is an important factor in determining existing conditions flooding limits. It affects the hydrological processes such as evapotranspiration, interception, and infiltration. As urban development (impervious area) is added to a watershed, the hydrologic response is changed, and surface runoff often increases. As demonstrated in Chapter 1, most urban development occurs in the lower three counties of Cameron, Hidalgo, and Webb. These three counties are surrounded by heavy agricultural use. For unpopulated areas of the region, the existing land use is mostly agriculture and forested. Localized urban development is largely confined within city boundaries and the extraterritorial jurisdiction (ETJ). While not as prolific as urban development, cultivated agricultural and grazed land use still quickens the watershed's response time in comparison to natural forested ground cover, increasing existing flood risk. The development rate and land use changes since the initial determination of the flooding limits affect the validity of the analysis for planning purposes. For example, FEMA's SFHA within the Lower Rio Grande River basin is based on hydrologic and hydraulic analyses performed between the mid-1970s and today. While the 1970's studies are nearly 50 years old, some of the flood limits may still be valid due to little change in land use and basin size following the completion of the analysis.

Precipitation

When planning for existing conditions flood risk, assessing potential anomalous floods causing precipitation is crucial. Precipitation, as it relates to flood risk, is commonly analyzed in terms of inches of rainfall that occur within a 24-hour duration. In 1973 the FEMA National Flood Insurance Program (NFIP) set the standard for flood hazard areas based on the 1 percent annual chance exceedance (100-year flood). For the purposes of the State Flood Plan, all risk assessments will be based on this recurrence interval in addition to the 0.2 percent annual chance exceedance (500-year flood). A majority of FEMA's SFHA boundaries within the Lower Rio Grande Flood Planning Region were developed using hypothetical rainfall data from the *Nation Weather Service (NWS) Technical Paper No. 40/NWS Hydro-35* (1961/1977) or *The United States Geological Survey Atlas of Depth-Duration Frequency of Precipitation Annual Maxima for Texas* (2004). Rainfall data was broken down in terms of duration and recurrence interval. In 2019, National Oceanic and Atmospheric Administration (NOAA) developed updated

hypothetical rainfall in Texas based on historical rainfall data in its Atlas 14 study. The NOAA Atlas 14 study anticipates significant differences between hypothetical rainfall in the upper portion of the Lower Rio Grande Planning Region watershed compared to the 1961/1977 and 2004 rainfall data. **Table 2.1** below shows the rainfall for each data source.

Table 2.1 Precipitation Data Comparison

Lower Rio Grande Flood Planning Region Watershed	TP40/Hydro 35 100-year, 24-hour Rainfall (inches)	USGS 2004 100-year, 24-hour Rainfall (inches)	NOAA Atlas 14 100-year, 24-hour Rainfall (inches)
Upper (Eagle Pass)	8.8	9.0	12.3
Middle (Laredo)	9.7	9.0	10.2
Lower (Brownsville)	12.0	10.0	12.7

Infrastructure

Drainage-related infrastructure is a key element in determining the existing conditions of flood risk. As described in *Task 1: Planning Area and Description*, drainage-related infrastructure includes natural and structural infrastructure such as dams, levees, detention and retention ponds, bridges, culverts, low water crossings, drainage stormwater tunnels, urban storm drain networks, breakwaters, bulkheads, and revetments.

Structural infrastructure is intended to mitigate or reduce flood risk. However, outdated, undersized, or unmaintained drainage infrastructure may increase flood risk. Bridges, culverts, and storm drain systems designed and constructed before major land use changes, rainfall changes, and/or higher floodplain management standards may no longer serve their intended purpose during significant storm events. The result is increased flood risk to both property and life. Structural flood infrastructure must be inspected and maintained regularly to perform as designed in the event of a flood.

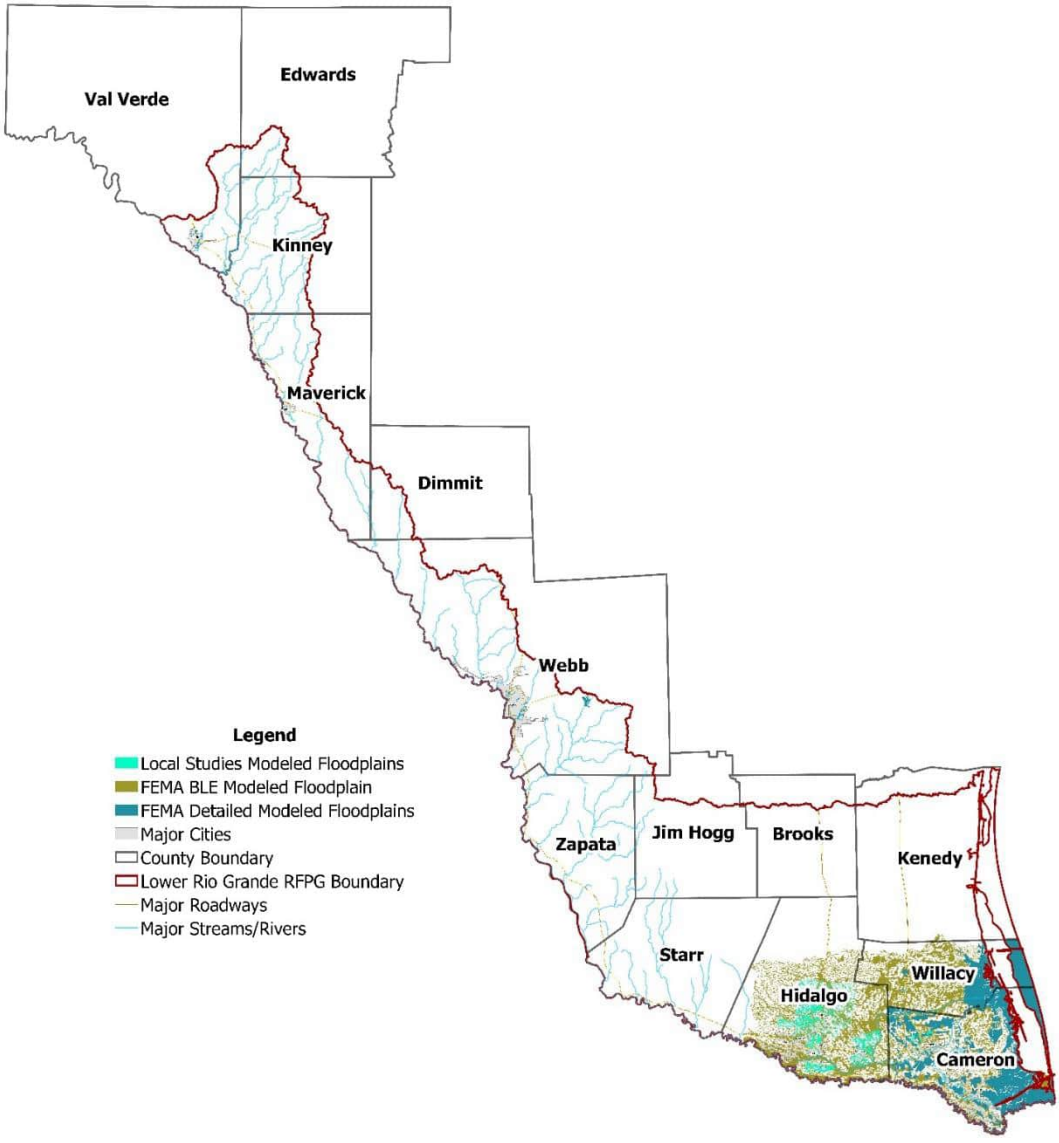
2A.1.B Existing Hydrologic & Hydraulic Model Availability

Hydrology and hydraulic (H&H) modeling is a necessary component in determining how water flows over land. It is a crucial element in developing effective flood planning strategies. Hydrology is the scientific study of the earth's natural water movement with a focus on how rainfall and evaporation affect the amount of flow of water in streams and storm drains. Hydraulics represents the engineering analysis of the flow of water in streams and infrastructure, such as channels, pipes, and other man-made structures.

Applied since the 1970s, H&H uses computer software applications that simulate the flow of rainfall-runoff over the land to predict the rise of creek and river water levels and potential flooding, as well as test ways to reduce flooding without constructing projects. H&H modeling simulates the flow, frequency, depth, and extent of flooding over land. These models inform decisions about selecting and implementing flood reduction and restoration projects. H&H Modeling also satisfies regulatory requirements and ensures that natural, agricultural, and social resources are not damaged by flooding induced by modifications to creeks, rivers, and channels.

Within the Lower Rio Grande Flood Planning Region's seven 8-digit Hydrologic Unit Code (HUC-8) watersheds, there are hundreds of H&H models that are each calibrated for the specific region and spanning from the late 1970s to the present. All the data output from the various modeling efforts is ultimately incorporated through geographic information system (GIS) mapping into the Lower Rio Grande Flood Planning Region floodplain quilt as described in Section 2A.1.c. **Figure 2.2** shows the stream model location in the Lower Rio Grande Region.

Figure 2.2 Existing Conditions Model Availability

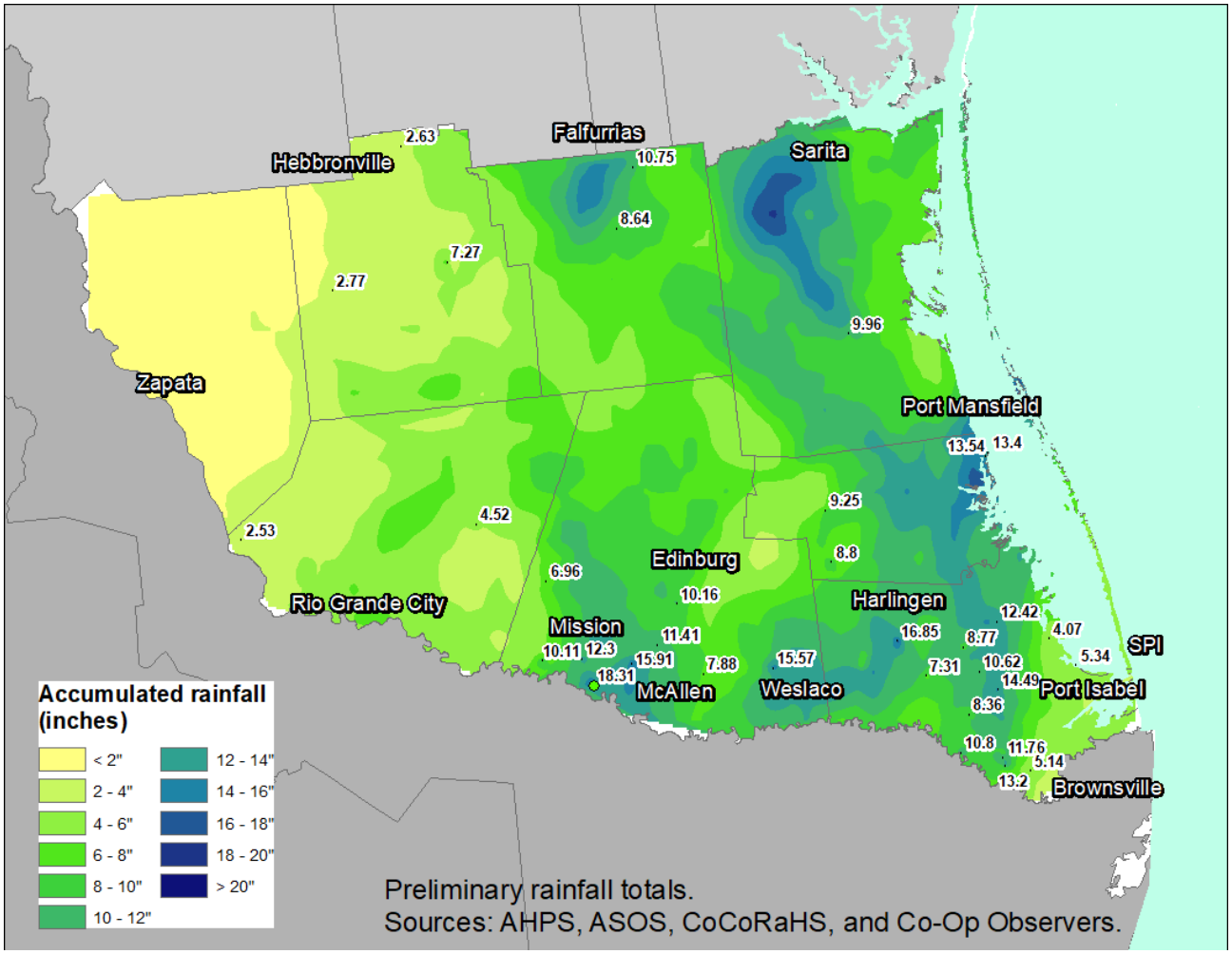


2A.1.C Best Available Existing Flood Hazard Data

Flooding within the lower extent of the Lower Rio Grande Region is mostly riverine with some coastal influence in Cameron, Hidalgo, Willacy, Kenedy, and Brooks counties, where they are directly hit by Hurricane storms from the Gulf of Mexico. Hurricanes typically fade and downgrade to tropical storms or tropical depressions as they move away from the coast. Riverine flooding is mostly from general rain floods and thunderstorm floods. Flash floods are common from these rainfall events, which can occur within a few minutes or after hours of excessive rainfall, exposing millions of dollars in valuable public and private property to flood risk. **Figure 2.3** shows a documented major flood event that occurred in the Lower Rio Grande Valley in June of 2018.

Even though riverine and coastal-based flooding is dominant in the Lower Rio Grande Region, urban flooding data were evaluated for inclusion in the existing floodplain quilt where available. Urban flooding (off-floodplain, pluvial, or surface flooding) is caused by intense local precipitation running-off impermeable surfaces such as paved streets and sidewalks that overwhelms local drainage systems and overflows small waterways. Consequently, the water enters buildings and other properties. This flooding often occurs in locations such as historic downtown areas and residential neighborhoods, which either predate higher design standards or were constructed before urban sprawl.

Figure 2.3 June 18-22, 2018 Rainfall in Lower Rio Grande Valley



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

The most current existing flood hazard mapping data from multiple sources were compiled by the TWDB to create a comprehensive, single, coherent, continuous set of best available existing floodplain quilt for the Lower Rio Grande Planning Region. Mapping data compiled was mainly the 1 percent and 0.2 percent ACE data. The existing floodplain quilt data was then updated with data obtained from FEMA, United States Army Corps of Engineers (USACE), United States Geological Survey (USGS), and local communities where available. The main data sources comprising the existing floodplain data for the Lower Rio Grande Region are described below:

Regulatory FEMA Floodplain Data

The regulatory FEMA floodplain data included digital FEMA floodplain datasets from areas that were already effective and have become available for NFIP regulatory use. Nearly 90 percent of the regulatory floodplains are Zone A, undetailed studies.

1 Percent-Annual-Chance Floodplain

On FIRMs, FEMA maps both the 1 percent and 0.2 percent annual chance flood events. Floodplain data developed for the Lower Rio Grande Planning Region included only the 1 percent and 0.2 percent ACE events to describe the flood hazards and perform the exposure and vulnerability analyses.

The 1 percent annual chance has a 1 in 100 chance of being equaled or exceeded in any given year and an average recurrence interval of 100 years. Also referred to as the SFHA or 100-year flood, this boundary is mapped as a high-risk flood area subject to one percent or greater annual chance of shallow flooding in any given year, where shallow flooding is usually in the form of ponding or sheet flow with average depths between one and three feet. Along the coast, these high-risk areas are associated with velocity wave action. In the Lower Rio Grande Planning Region, coastal wave action only affects Cameron, Willacy, and Kenedy counties. The 1 percent annual chance flood areas may also be susceptible to erosion, deposition, and mudflow. It is sometimes referred to as the "Base Flood." The Base Flood is the national standard used by the NFIP and other federal agencies for the purposes of regulating development and requiring the purchase of flood insurance.

0.2 Percent Annual Chance Floodplain

The 0.2 percent annual chance flood has a 0.2 percent chance (or 1 in 500 chance) of occurring in any given year and is also referred to as the 500-year flood. The 0.2 percent annual chance flood refers to areas of moderate flood risk that are not considered in immediate danger from flooding caused by overflowing rivers; areas in the 100-year flood with average depths less than one foot or with drainages areas less than 1 square mile. It also refers to areas protected by levees from the 100-year flood. The 0.2 percent annual chance areas are called Non-Special Flood Hazard Areas (NSFHA).

Other Floodplain Data – FAFDS, BLE, and Fathom Data

Where only paper-based FEMA data was available, digitally converted FIRMs from First American Flood Data Services (FAFDS) were utilized. FEMA and the TWDB's Base Level Engineering study data that produces model-backed approximate studies on a HUC-8 wide level was leveraged to revise the existing floodplain quilt.

The TWDB provided modeled flood data from the 2021 Fathom data set to be used where applicable. Fathom is developed by a research group at the University of Bristol, England, and the Fathom model has been peer reviewed and compares reasonably well to FEMA flood data. The Fathom model is a two-dimensional (2D) hydraulic framework developed at a national scale on 30-M Digital Elevation Models (DEMs). The results have been mapped on 10 feet Light Detection and Ranging (Lidar) for Texas to create statewide flood depth rasters for fluvial, pluvial, and coastal mapping for the 1 percent and 0.2 percent ACE events and other frequencies. The fluvial, pluvial, and coastal flood depth rasters from the Fathom data for the Lower Rio Grande basin were mosaicked together with the greatest depth where the datasets overlap. The combined rasters were processed into flood polygon boundaries using guidance provided by the TWDB. The Fathom data served as a supplemental dataset for inclusion in the existing flood boundaries where data was not available, or the approximate study extents were abruptly truncated as a limit of study.

Regional Data Collection and Possible Flood-Prone Areas

A regional online data collection website was created as an outreach tool to work closely with regional entities (counties, municipalities, state and federal agencies, or political subdivisions with flood-related authorities) to gather local flood-risk information. A web mapping application on the data collection tool enabled entities to document other possible flood-prone areas not previously identified as mapped flood hazard areas. These included areas of historical flooding events, roads that frequently overtopped, and past flood claims hot spots.

The Lower Rio Grande Planning Region Consultant Team also collected data related to areas subject to inundation from reservoirs and levee inundation areas. Dam breach inundation areas are included where data is publicly available. Data submitted to the Regional Flood Planning Group (RFPG) through the online GIS-based data collection tool was also added. Cities, counties, entities with flood control responsibilities and the general public had the opportunity to submit data to the RFPG.

The RFPG Consultant Team weaved the existing conditions floodplain quilt together. The existing conditions floodplain quilt was presented at the Lower Rio Grande RFPG meeting on March 9, 2022. The various data sources received were compiled according to the TWDB's ranking hierarchy, as shown in **Table 2.2**. The data ranking was based on quality and coverage extent relative to other datasets.

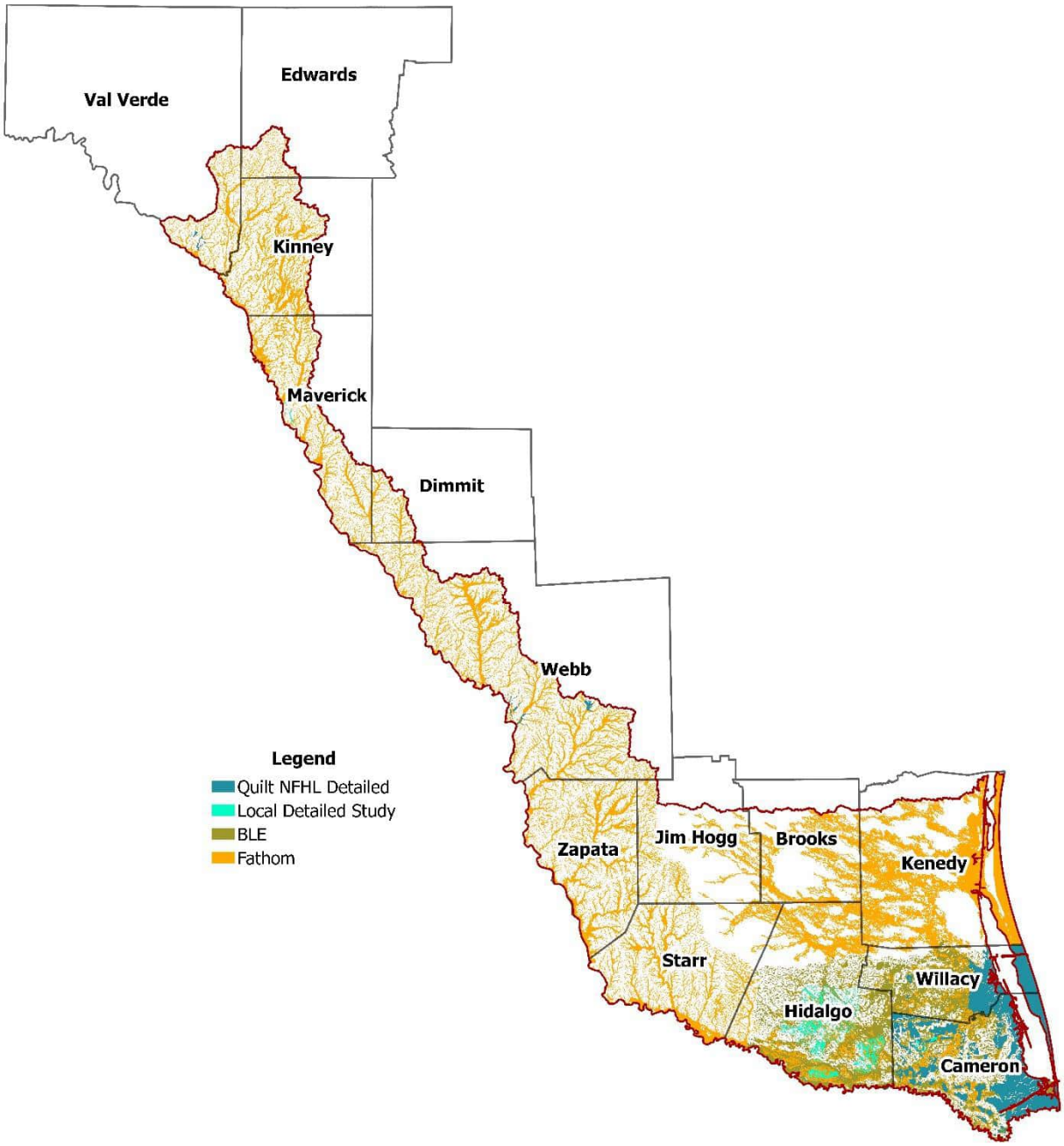
Table 2.2 Floodplain Quilt Data Hierarchy and Sources

Ranking	Data Category	Source
1	NFHL Pending (Detailed and Approximate Studies)	FEMA
2	NFHL Preliminary (Detailed and Approximate Studies)	FEMA
3	NFHL Effective (Detailed Study Only)	FEMA
4	BLE	FEMA
4.5	FATHOM	FEMA
5	NFHL Effective (Approximate Study Only)	FEMA
6	Digitized Effective FIRMs	CoreLogic FAFDS
	Other Potential Data Sources	USACE or Other Federal Data (0.5 to 4.5 Ranking) Regional or Local Community Data (0.5 to 6.5 Ranking)

Source: TWDB Technical Guidelines for the Regional Flood Planning

Figure 2.4 shows the floodplain data sources by location developed for the Lower Rio Grande Planning Region.

Figure 2.4 Floodplain Quilt Data Sources



The compiled existing floodplain quilt data for the Lower Rio Grande Planning Region is included in the submittal GIS database layer named "ExFldHazard." **Figure 2.5** shows a GIS coverage map of the comprehensive existing floodplain data compiled for the Lower Rio Grande Planning Region, showing the 1 and 0.2 percent annual chance floodplains. Larger detailed maps are included in **Appendix A**.

The total floodplain area for each county and associated percentage distribution within the Lower Rio Grande Planning Region are also shown in **Figure 2.6** and **Table 2.3**.

Within the Lower Rio Grande Planning Region, when this compiled existing floodplain quilt was shown to the public either through an online webmap or in-person meeting, the disclaimer note below was used:

"The floodplain quilt is a compilation of data from multiple sources and is intended to approximate the extent of existing flood risk in the Lower Rio Grande Region. This data layer is for planning purposes only and is not to be used for any regulatory activities. For regulatory floodplain maps, contact your local floodplain administrator or visit the FEMA Map Service Center."

Figure 2.5 Existing Conditions Floodplain Quilt

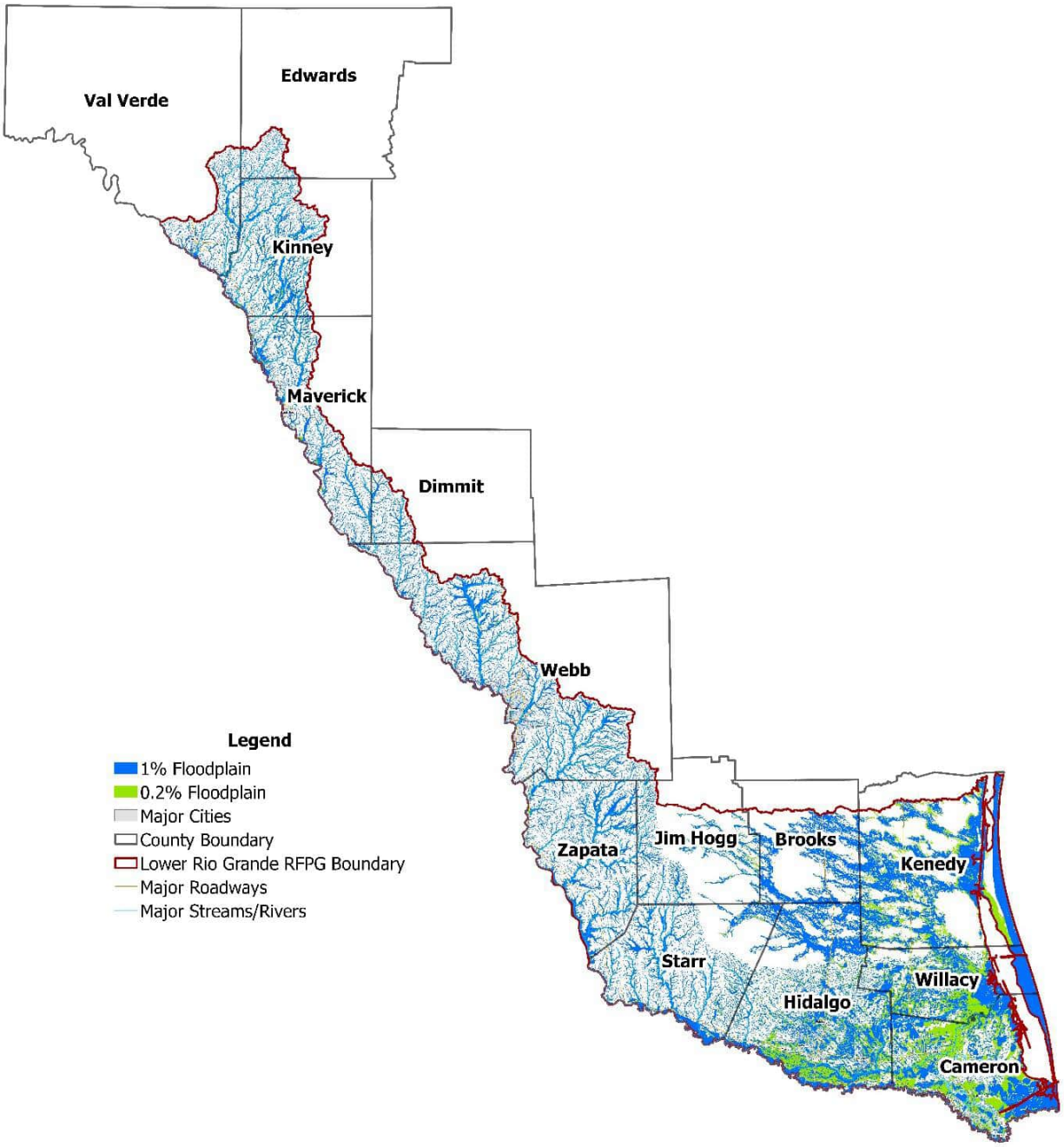


Figure 2.6 Existing Conditions Flood Hazard Areas (in Square Miles) by County

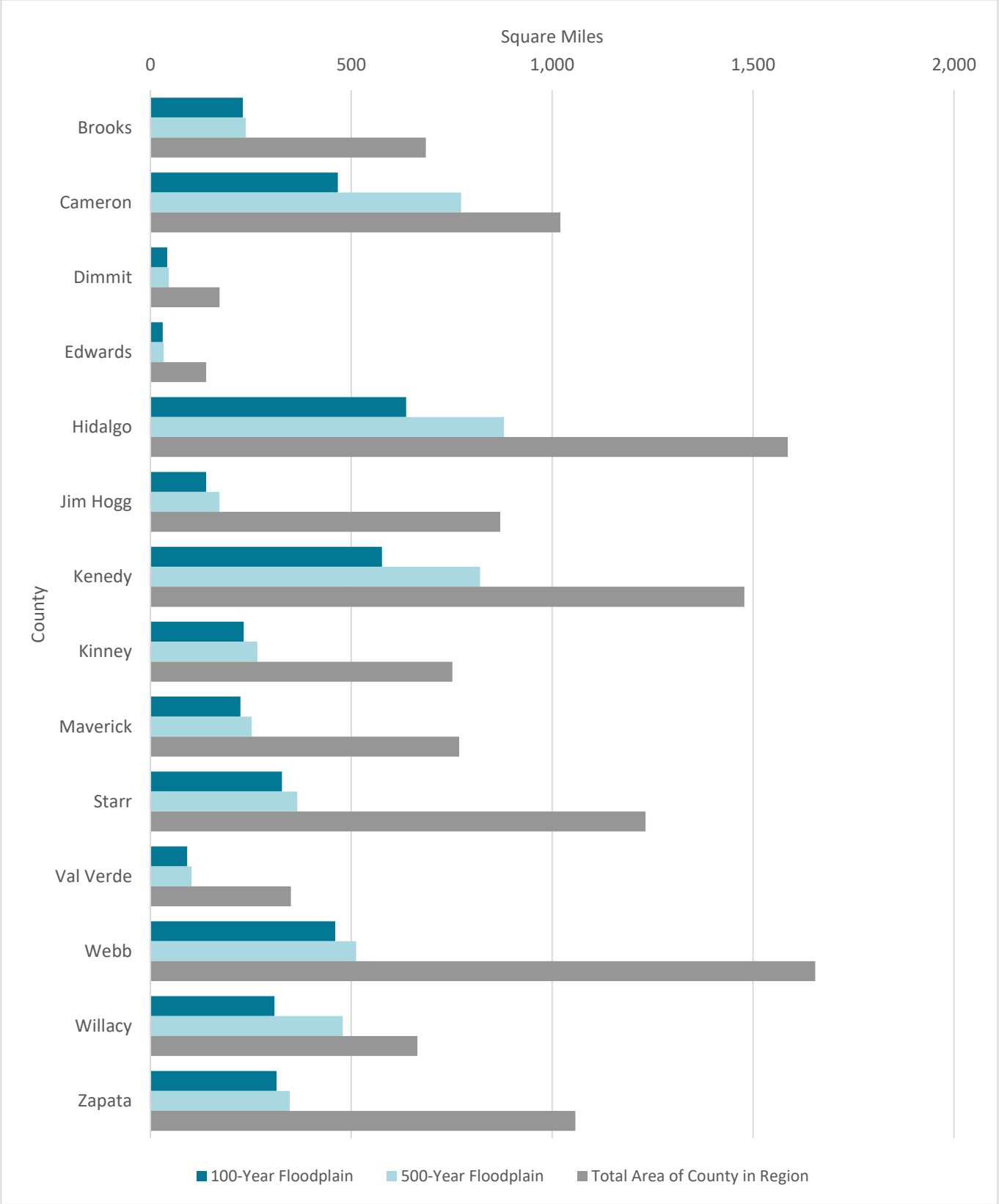


Table 2.3 Percentage of Land Area in Existing Floodplain Quilt by County

County	1% Flood Hazard	0.2% Flood Hazard*	Combined Flood Hazard
Brooks	34%	1%	35%
Cameron	46%	30%	76%
Dimmit	24%	2.5%	27%
Edwards	22%	2%	24%
Hidalgo	40%	15.4%	55%
Jim Hogg	16%	4%	20%
Kenedy	39%	16.5%	56%
Kinney	31%	4%	35%
Maverick	29%	3.7%	33%
Starr	27%	3%	30%
Val Verde	26%	3.2%	29%
Webb	28%	3%	31%
Willacy	46%	25.6%	72%
Zapata	30%	3%	33%

**The 0.2 percent Flood Hazard does not incorporate the 1 percent Flood Hazard to avoid overlapping polygons*

Overall, the Lower Rio Grande Planning Region covers a total land area of approximately 12,430 square miles, with about 33 percent (4,100 square miles) in the existing conditions floodplain. It must be noted that Cameron County has a high percentage of the land areas in the Lower Rio Grande Planning Region within the floodplain. This is because Cameron County is on the Gulf Coast with relatively flat terrain and inundated coastal flooding coupled with riverine flooding from the Rio Grande River. Jim Hogg County has the lowest percentage of land area in the floodplain at 20 percent.

2A.1.D Flood Data Gaps

Once the best available comprehensive existing flood data was complied, data gaps were assessed to identify any remaining areas where flood inundation boundary mapping was missing, lacked modeling and/or mapping, or used outdated modeling and/or mapping. Other contributing engineering factors used to identify data gaps included modeling technology, significant topographic change, significant land use and/or impervious area change, change in flood control structures, channel configuration (including erosion and sedimentation) changes, and rainfall pattern changes altering peaks discharges.

Following the compilation of the floodplain quilt, a flood hazard gap analysis was performed to identify known or “apparent” flood-prone areas that lack models and maps or have existing models and maps that are outdated or otherwise not considered reliable. The existing condition gap analysis identifies the following:

- absence of hydrologic and hydraulic models where the Fathom mapping is utilized
- outdated National Flood Hazard Layer data greater than 10 years old

- absence of 0.2 percent annual chance (500-year) flood risk data
- more than 50 percent absence of 0.2 percent annual chance (500-year) flood risk data
- absence of modeling and mapping utilizing NOAA Atlas 14 rainfall data

The compiled existing condition gap analysis for the Lower Rio Grande Planning Region is included in the geospatial submittal. **Figure 2.7** shows a map of the locations of identified existing condition flood data gaps. **Figure 2.8** shows a map of the locations where Base Level Flood mapping, Fathom Data, and reported flood prone areas were added to the quilt in an attempt to provide better flood risk information. .A larger, more detailed version of this figure is included as TWDB-required **Map 5** in **Appendix A.**

While areas were identified within the floodplain quilt as data gaps with outdated information, the complied existing floodplain quilt still comprised the best available floodplain datasets for the Lower Rio Grande Flood Planning Region and was used for the flood risk analysis in the Lower Rio Grande Regional Flood Plan. This plan aims to further evaluate these data gaps for inclusion as Flood Management Evaluations (FMEs) discussed in *Task 4A*.

Figure 2.7 Existing Conditions Floodplain Quilt Data Gaps

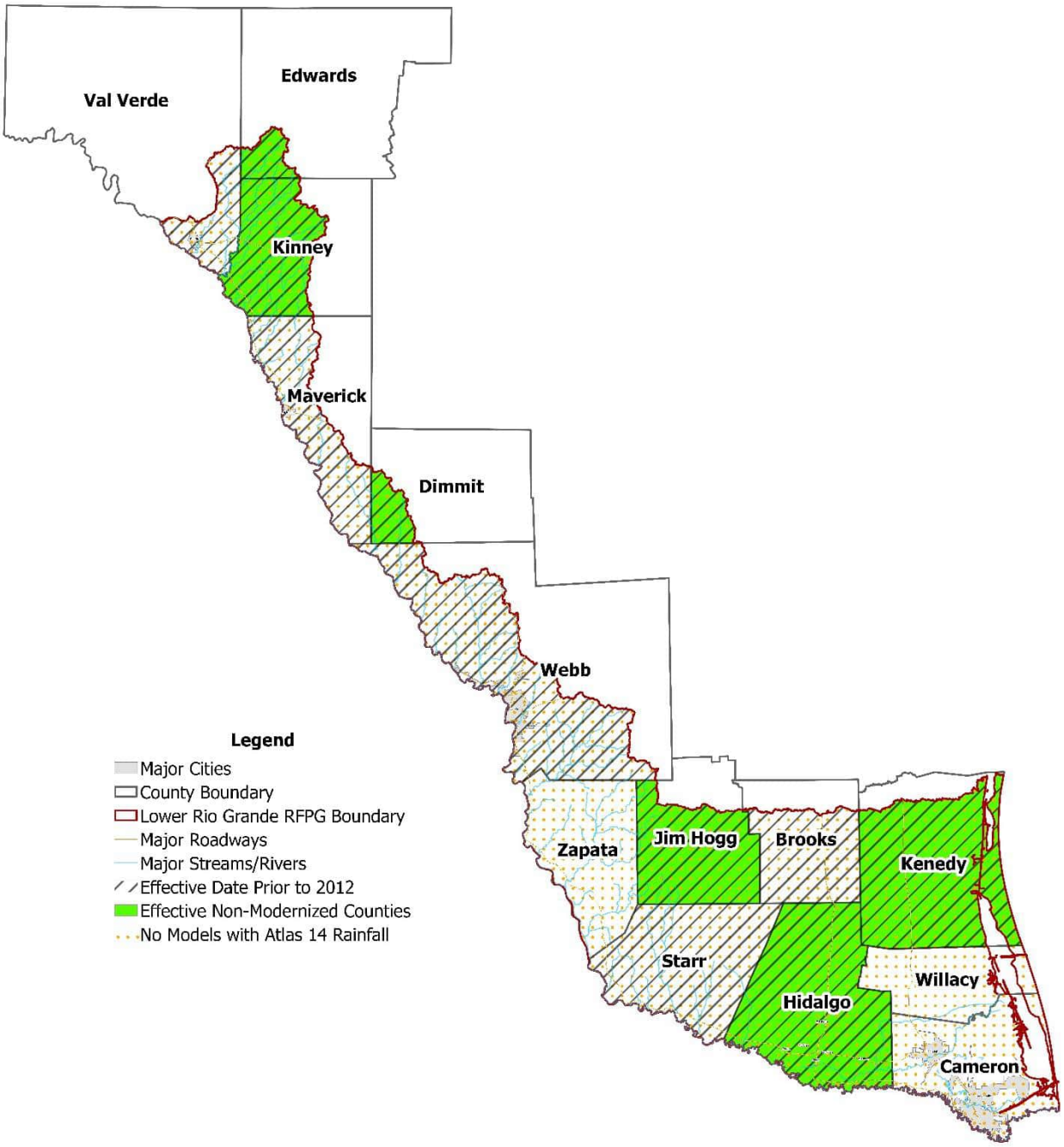
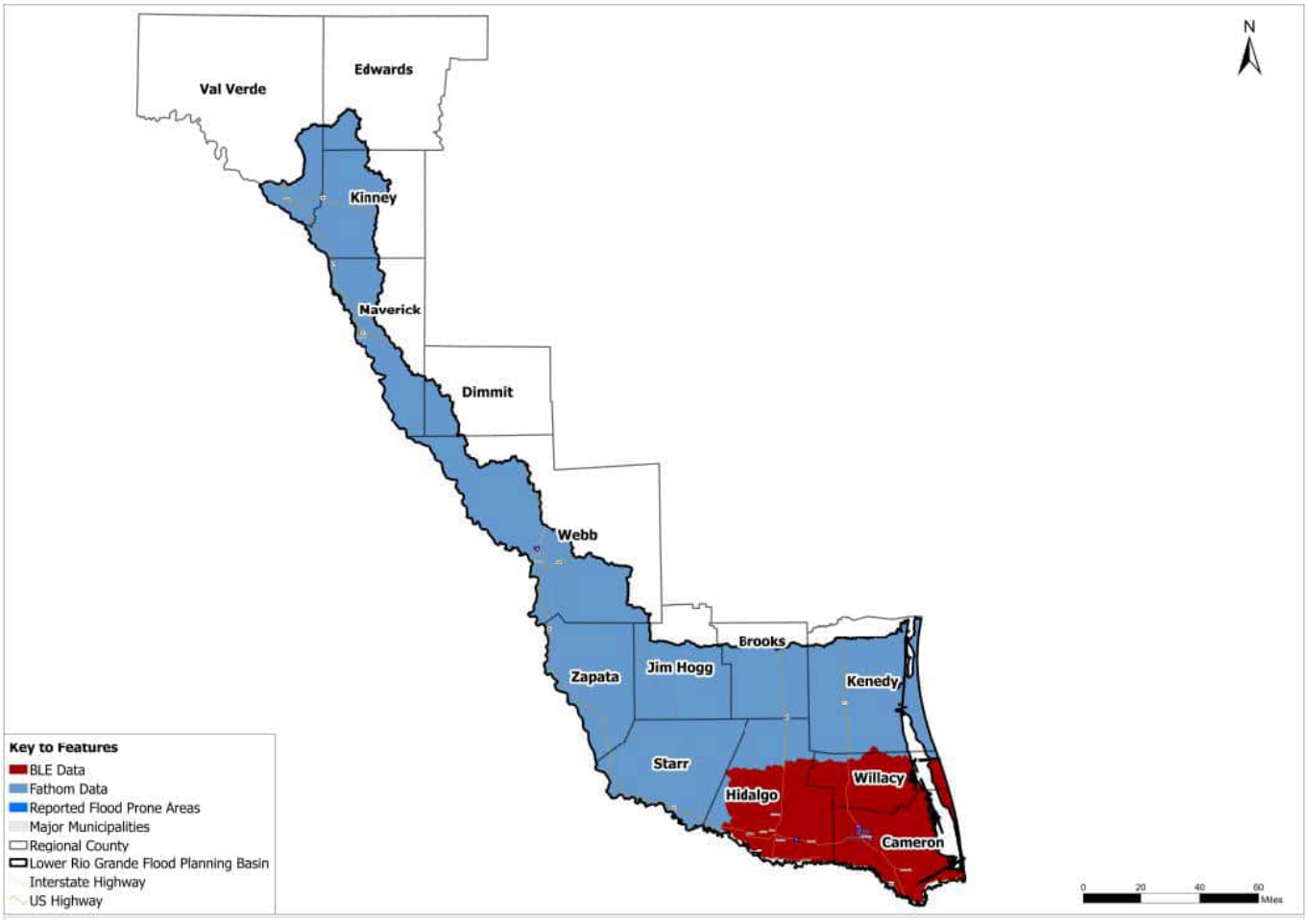


Figure 2.8 Existing Conditions Floodplain Quilt Data Gaps



2A.2 Existing Condition Flood Exposure Analysis

Flooding is common in the Lower Rio Grande Planning Region (See **Figure 2.3**). Flooding can become a significant hazard when it inundates the built environment and causes direct damage to buildings, critical facilities, crops, or significant injuries and sometimes death to people. Flooding frequency and intensity have been increasing in recent years, often necessitating state and federal relief, which has risen to record levels. The existing condition flood risk exposure analysis leveraged the compiled existing conditions 1 and 0.2 percent annual chance floodplains in the Lower Rio Grande Planning Region to determine existing flooding exposure to buildings, critical facilities, and agriculture. Results from the flood exposure analysis were utilized to estimate the impact on socially vulnerable populations or communities discussed in section 2A.3.

2A.2.A Existing Development within the Floodplain

A region-wide inventory of buildings, population, critical facilities, utilities, and agriculture was conducted to assess who and what is at risk during the Lower Rio Grande Regional Flood Planning Study. Existing development data leveraged for the Lower Rio Grande Regional Flood Plan came from several data sources. The Homeland Infrastructure Foundation Level Data (HIFLD) and data from the TWDB were the sources of critical facilities data. The Texas Department of Transportation (TxDOT) bridge inventory and roadway data were also used. The TWDB provided building data in August 2021 with (associated) population and Social Vulnerability Index (SVI) estimates, which were confirmed and updated where additional information was available.

The 2021 TWDB building dataset was built on available Lidar information (2010 to 2021), Microsoft Artificial Intelligence Version 2 data, and 2021 Open Street Map (OSM) buildings. The 2019 LandScan USA dataset from Oak Ridge National Laboratory (ORNL) was utilized to estimate the population per building for both day and night. The 2018 Centers for Disease Control and Prevention (CDC) SVI dataset was applied at the census tract level.

The 2020 Texas Cropland Data layer was developed by the United States Department of Agriculture (USDA) National Agricultural Statistics Service (NASS). The bridge and roadway asset inventory data came from the 2020 TxDOT dataset. Communities and stakeholders within the Lower Rio Grande Region also provided data via the online GIS-based data collection tool developed for the Lower Rio Grande Planning Region.

The results of the detailed analyses of exposure to development within the existing floodplain are presented in sections 2A.2.B – 2A.4.

2A.2.B Flood Exposure Due to Existing Levees or Dams

Flood exposure is the identification of what is at risk due to extreme flooding. This refers to the people, buildings, businesses, infrastructure systems, and associated functions that could be lost to a flood hazard [*FEMA, 2017*]. Exposure also refers to the economic value of assets subjected to the flood hazard. This section discusses flood exposure due to levees and dams in the Lower Rio Grande Planning Region.

Levees

In the most populated counties, Cameron, Hidalgo, and Willacy, there is an estimated 260 miles of levees. Levees can be breached during flood events due to overtopping, toe scour, seepage/piping, and foundation instability. The resulting torrent can quickly inundate a large area behind the failed levee with little or no warning, exposing them to extreme flooding effects and consequences.

Dams

In the Lower Rio Grande Planning Region, dams and their associated reservoirs are used for water supply, recreation, navigation, electric generation, irrigation, and flood control. According to the USACE National Inventory of Dams and the Texas Commission on Environmental Quality (TCEQ), there are over 376 dams in the Lower Rio Grande Planning Region. Most of these are used for flood control, water supply, recreation, or agriculture. Most dams are owned by local and private entities.

Dam-controlled reservoirs with flood storage capacities keep floodwaters impounded and either release floodwaters in controlled amounts downstream to the river below or store or divert water for other uses. As such, areas lying adjacent to or downstream of dams are exposed to severe flooding and its associated consequences when a dam breaks or fails.

Dams suffer the same failure modes as levees. A dam failure causes an uncontrolled release of impounded water to adjacent or downstream areas. The dams in the Lower Rio Grande Planning Region are, on average, 61 years old. The dams owned and operated by large entities are typically well-maintained. However, dams owned and operated by smaller entities or private landowners may need inspections and/or rehabilitation as funding for such activities is often more costly than the property owners can afford.

Table 2.4 Average age of Dams by County

County	Levee Miles	Dams within County Limits	Average age of Dams (years)
Brooks	N/A	2	61
Cameron	88.9	41	72
Dimmit	N/A	62	64
Edwards	N/A	1	62
Hidalgo	142.7	22	62

County	Levee Miles	Dams within County Limits	Average age of Dams (years)
Jim Hogg	N/A	0	N/A
Kenedy	N/A	0	N/A
Kinney	N/A	0	N/A
Maverick	N/A	61	59
Starr	N/A	17	56
Val Verde	N/A	7	50
Webb	N/A	114	59
Willacy	29.3	4	70
Zapata	N/A	45	56

2A.2.C Existing Conditions Flood Exposure

This section of the Lower Rio Grande Regional Flood Plan discusses and summarizes the results of the existing condition flood exposure to existing development. The existing conditions flood exposure analysis considered buildings, population, public infrastructure, critical facilities, roadway crossings, and agricultural areas exposed to the compiled existing conditions floodplain quilt. This section excludes flood exposure for levees and dams and only applies the existing conditions 1 and 0.2 percent annual-chance flood mapping extents in the Lower Rio Grande Planning Region floodplain quilt.

Buildings, Critical Facilities, Infrastructure, and Agriculture Exposure Totals by County

For this planning cycle, flood exposure analysis estimated the structure count of buildings, critical facilities, low water crossings, roadway segments, and agriculture areas potentially exposed to existing flooding by overlaying the existing conditions floodplain quilt developed for the Lower Rio Grande Planning Region. **Figure 2.9** shows the total number of buildings, critical facilities, low water crossings, and agriculture areas exposed to the existing floodplain quilt. The highest counts are in the populated areas of Hidalgo and Cameron counties, as well as Willacy and Webb counties showing significant counts. Most of the Lower Rio Grande Planning Region shows moderate exposure counts with a few overall county totals interspersed in-between.

Population Totals by County

Population data (day and night) attributed to the buildings and critical facilities data was used to summarize the countywide population exposed to the existing conditions floodplain quilt. The higher day or night population attributes were used for the exposure population estimates according to guidance from the TWDB. **Figure 2.10** shows the percent population exposure to the existing floodplain quilt by county. As shown in **Figure 2.10**, high population exposures occur in Hidalgo and Cameron counties. It must be noted that because the population count is higher than the day or night numbers,

this assumes the worst possible scenario where the maximum number of people present are exposed to the existing condition floodplain quilt.

Figure 2.9 Existing Conditions Flood Exposure Total Numbers by County

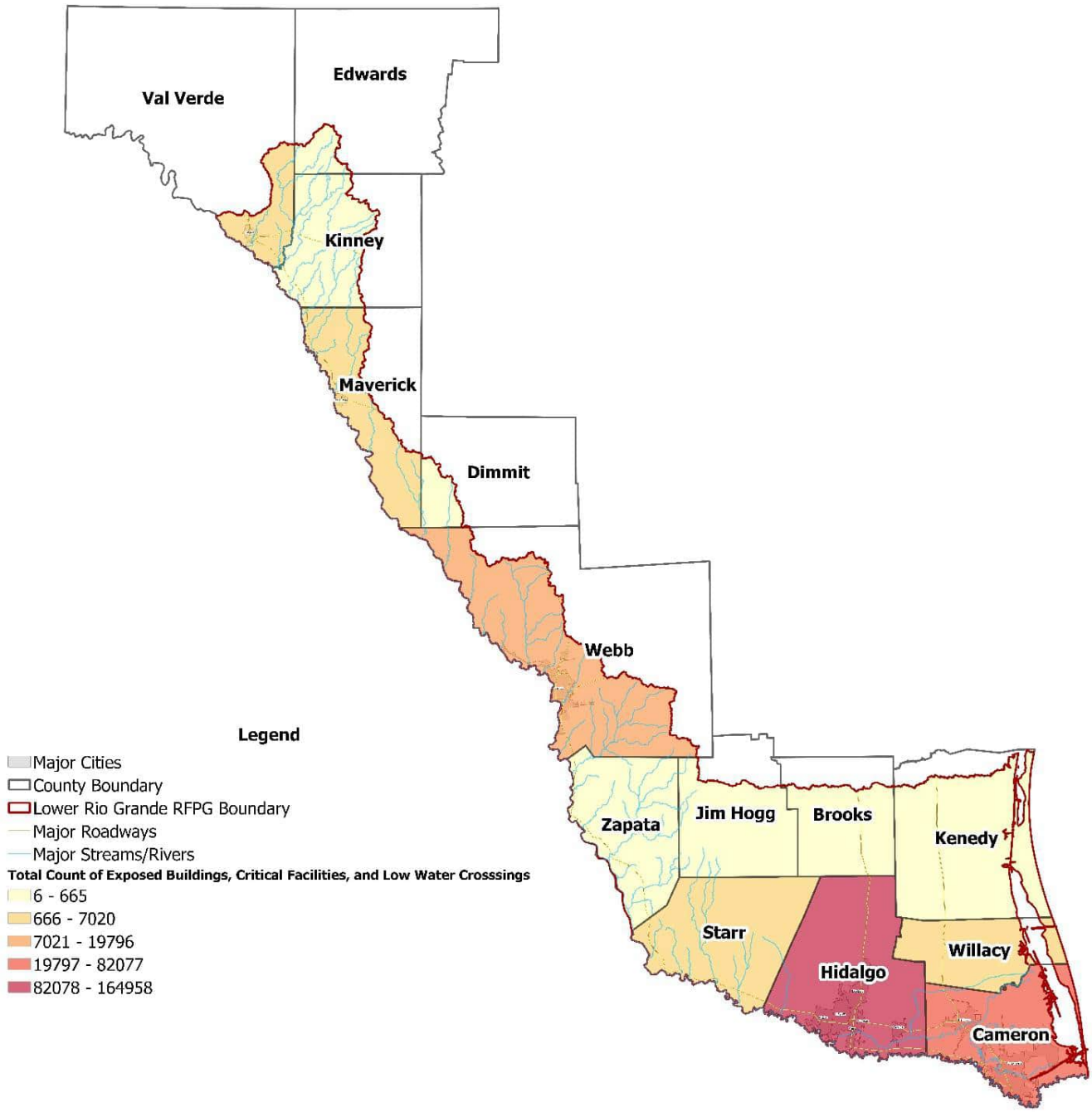
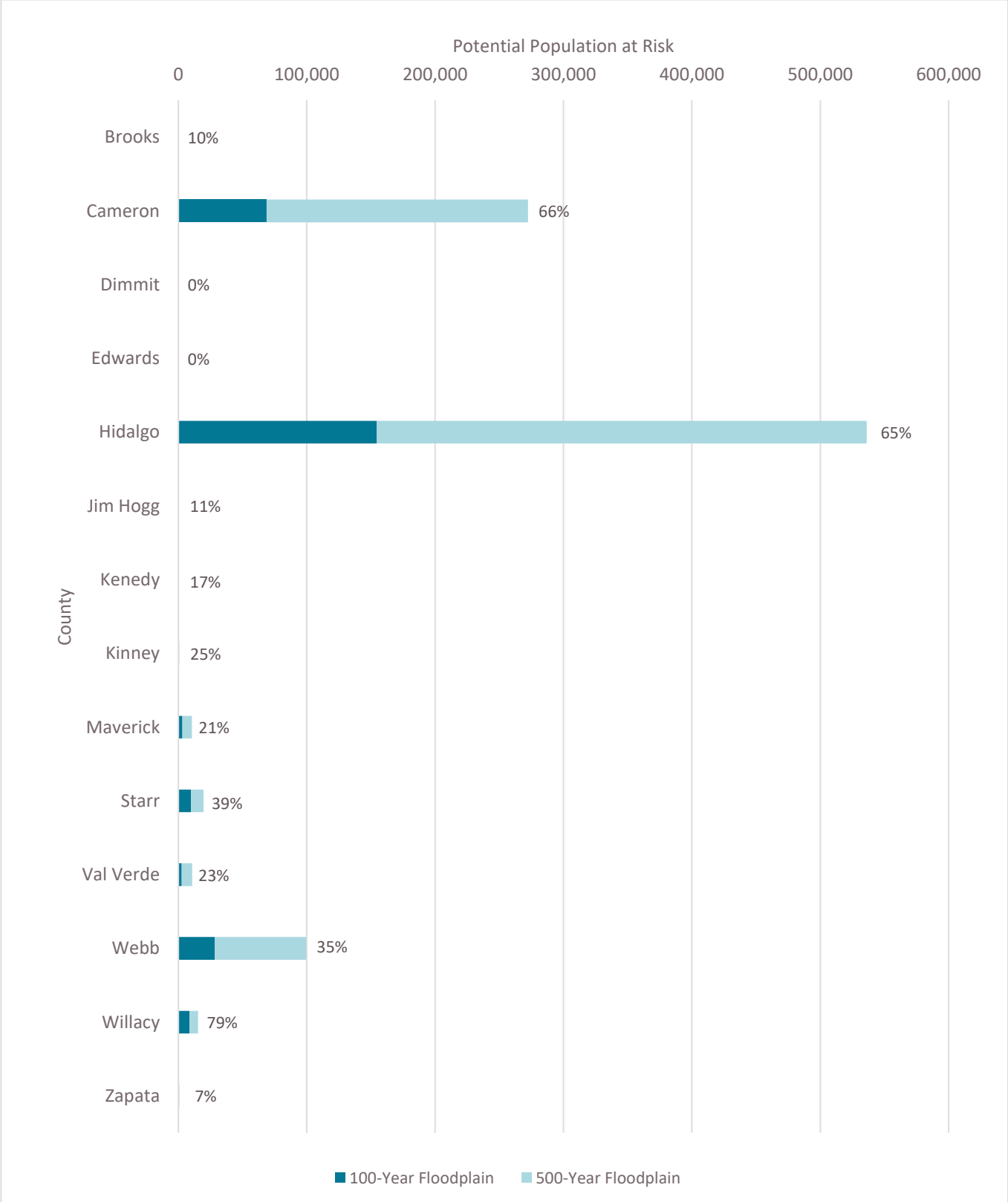
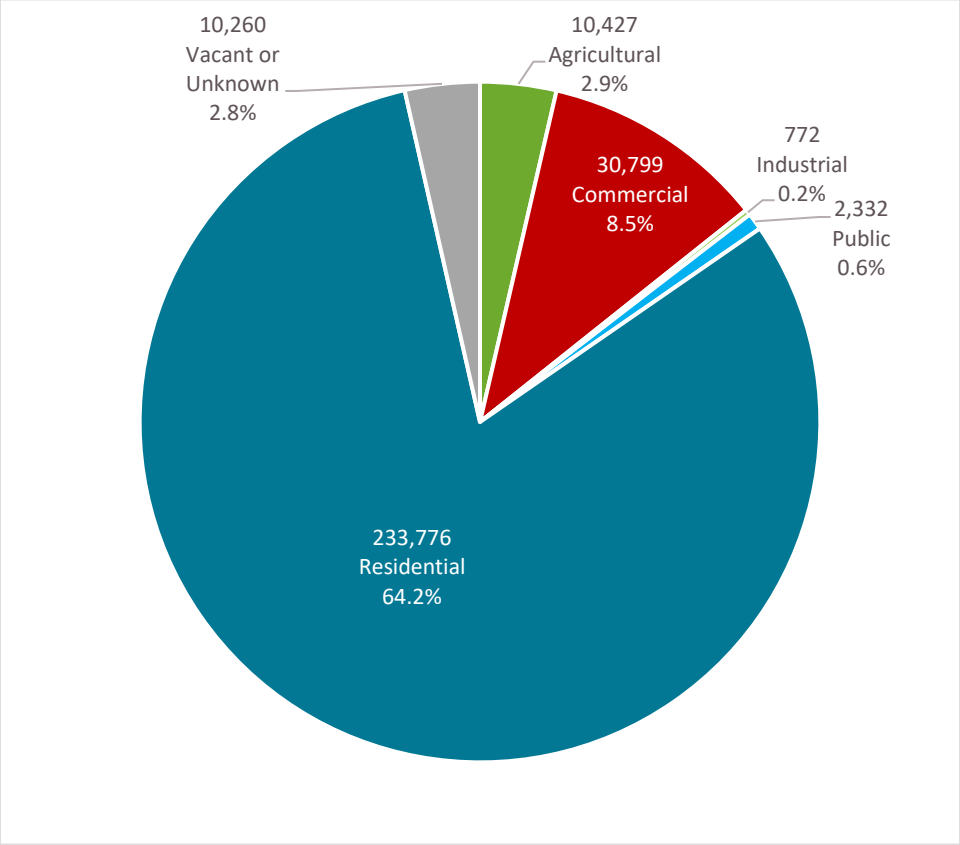


Figure 2.10 Population at Risk in Existing Conditions Floodplain Quilt by County



Regional building data collected for the Lower Rio Grande Planning Region were classified into two main categories: residential and non-residential. As shown in **Figure 2.11**, an estimated 64 percent are residential, and 9 percent are commercial. Buildings classified as vacant are structures for which the building type and/or use could not be determined.

Figure 2.11 Building Type Distribution in the Existing Conditions Floodplain Quilt

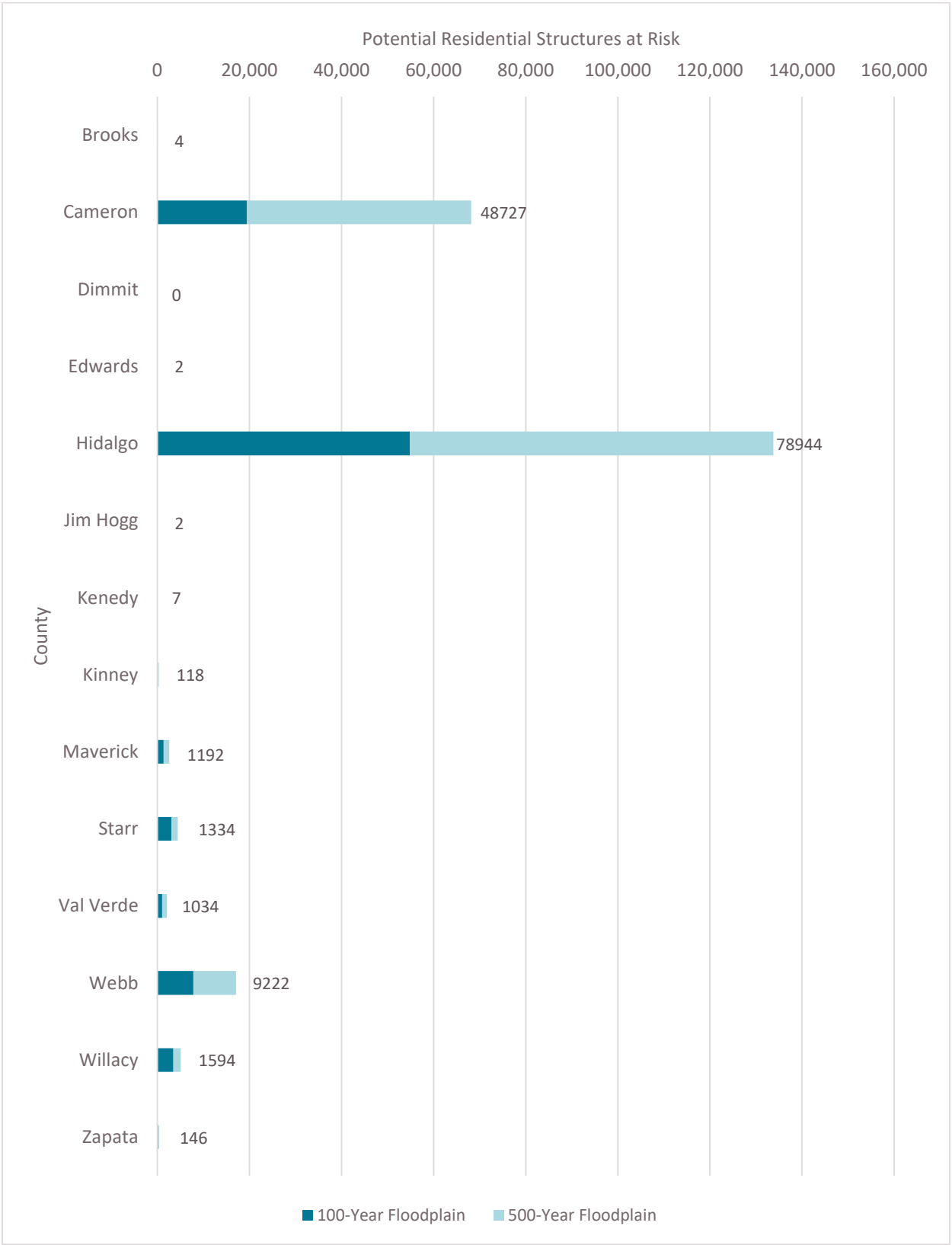


Residential Properties

Residential structure data used in the Lower Rio Grande Region included single-family homes, townhomes, mobile homes, and multi-family residences like apartments and condominiums. Over 417,989 residential building footprints were gathered for the Lower Rio Grande Planning Region, and an estimated 56 percent of these buildings were exposed to flooding. An associated population of over 276,662 is estimated to be at risk of flooding. **Figure 2.12** shows the total estimated number of residential structures by county exposed to the existing floodplain quilt. Hidalgo and Cameron counties have the highest number of residential buildings in the existing floodplain.

Val Verde, Edwards, and Dimmit counties show very little residential building exposure because only a very small portion of these counties are in the Lower Rio Grande Planning Region, most of which are their respective unincorporated areas.

Figure 2.12 Residential Structure Counts in Existing Conditions Floodplain Quilt



Non-Residential Properties

Non-Residential inventory data also included agricultural, commercial, industrial, and public buildings. Over 101,004 non-residential building footprints were gathered for the Lower Rio Grande Planning Region, and an estimated 54 percent of these buildings are exposed to flooding. An associated population of over 54,590 is estimated to be at risk of flooding. **Figure 2.13** and **Figure 2.14** shows the total estimated number of non-residential structures by county exposed to the existing floodplain quilt, and Hidalgo and Cameron counties have the highest numbers.

Figure 2.13 Non-Residential Structure Counts in Existing Conditions Floodplain Quilt

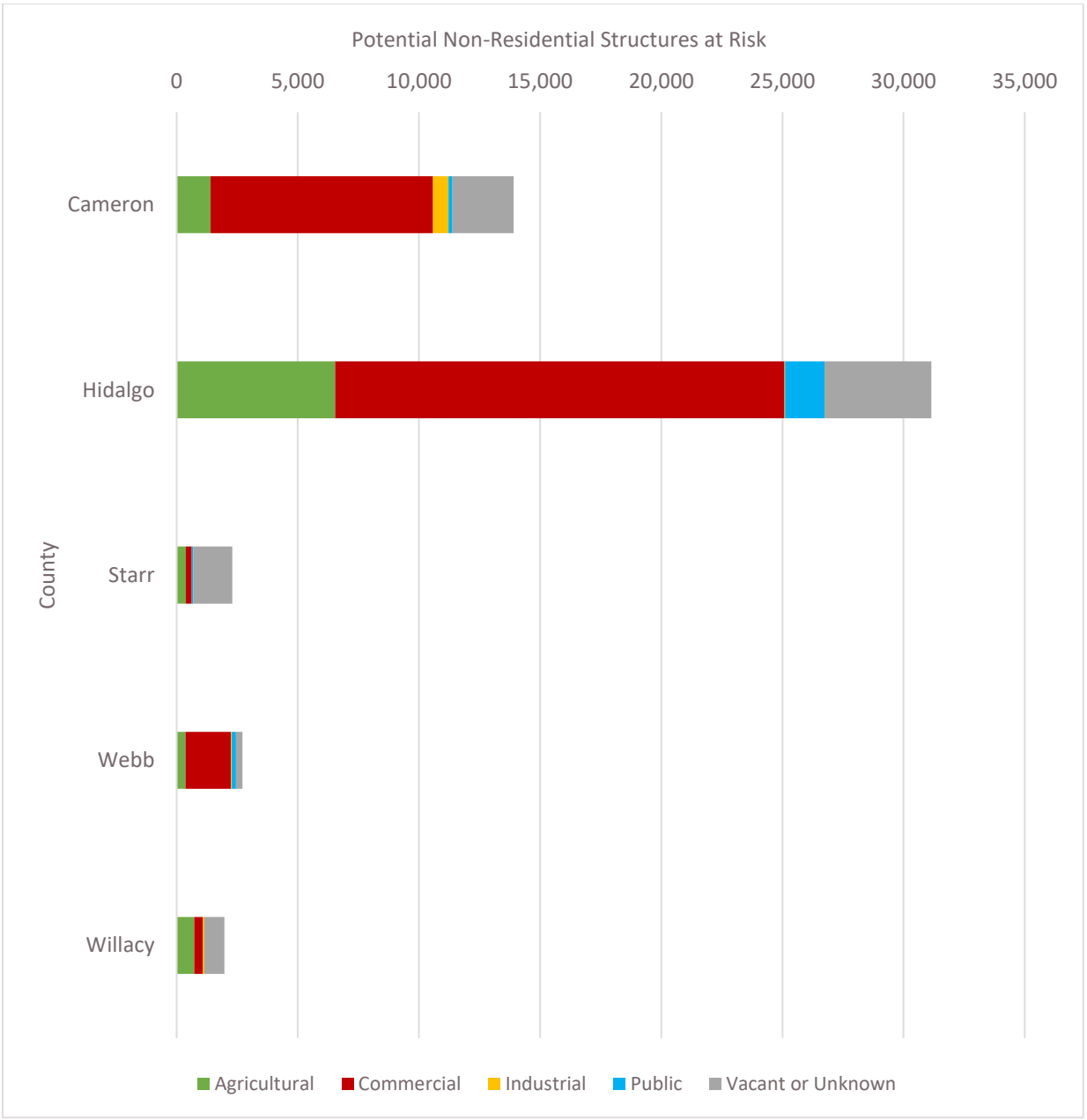
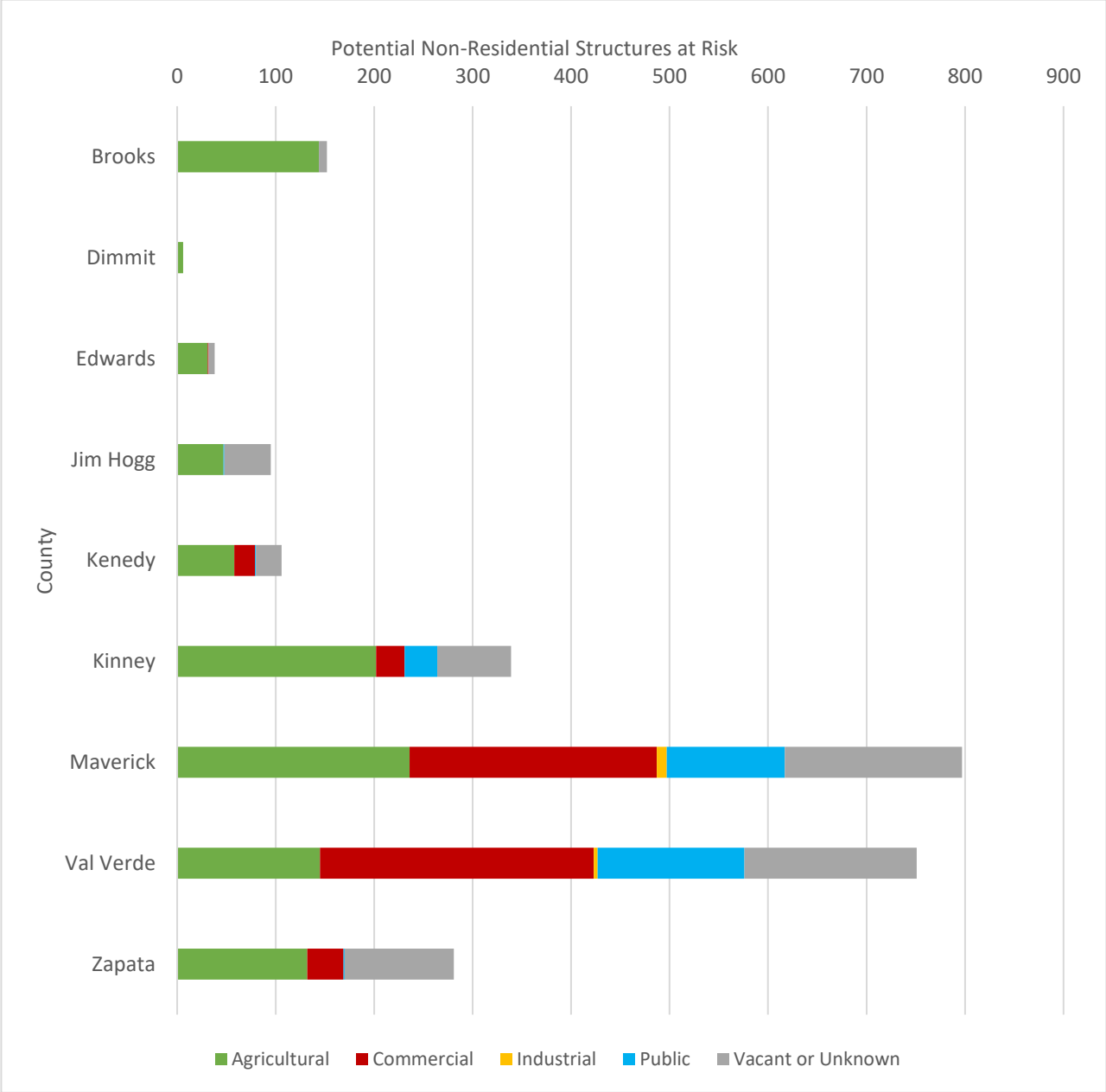


Figure 2.14 Non-Residential Structure Count in Existing Conditions Floodplain Quilt (Continued)



Critical Facilities and Public Infrastructure

A critical facility provides services and functions essential to a community, especially during and after a disaster. Critical infrastructure includes all public or private assets, systems, and functions vital to the state's or nation's security, governance, public health and safety, economy, or morale [*TWDB, 2021*]. Critical Facilities data gathered for the Lower Rio Grande Planning Region included fire stations, hospitals, nursing homes, police stations, emergency shelters, schools (Kindergarten through 12th grade), water and wastewater treatment facilities, TCEQ wastewater outfalls, water supply systems (well sites), and superfund sites. Lifeline utility systems data such as petrol storage tanks, power generating plants, as well as natural gas and electric transmission lines were collected for exposure analysis. Critical facilities data were from TWDB, TCEQ, Railroad Commission of Texas (RRC), HIFLD, and data from Lower Rio Grande Planning Region area communities.

The existing floodplain quilt was overlaid on the data gathered for critical facilities to estimate the flood exposures. **Figure 2.15** shows the total counts of exposed critical facilities to the existing floodplain quilt in the Lower Rio Grande Planning Region. Over 1,500 critical facilities data were identified for the Lower Rio Grande Basin, and an estimated 37 percent of these facilities are exposed to flooding. **Maps 6A and 6B**, found in **Appendix A**, show the Existing Conditions Flood Exposure for critical facilities, roadways, railroads, and utility facilities such as power, water, wastewater and gas.

Hidalgo and Cameron counties have the most critical exposure counts to the existing floodplain quilt.

Roadway Crossings and Roadway Segments

Transportation line data (roadways and railroads) from TxDOT was used to estimate road and railways crossings at risk of flooding. A combination of available flood depth information from Base Level Engineering (BLE) and Fathom data, as well as bridge deck elevation from Lidar data, was used to estimate flood exposure of the road and railroad bridges at stream crossings. Low Water Crossing (LWC) data provided by Lower Rio Grande Planning Region area communities and the TWDB was also used to identify exposed road and railway crossings.

There are over 126 LWCs in the Lower Rio Grande Planning Region. **Table 2.5** shows the LWC and bridge exposure totals, as well as the affected population per county. **Figure 2.16** shows the miles of road segment exposed to the existing floodplains. The highest mileage exposures are seen in Hidalgo and Cameron counties. **Maps 6A and 6B**, found in **Appendix A**, show the Existing Conditions Flood Exposure for roadways.

Figure 2.15 Critical Facilities in Existing Conditions Floodplain Quilt by County

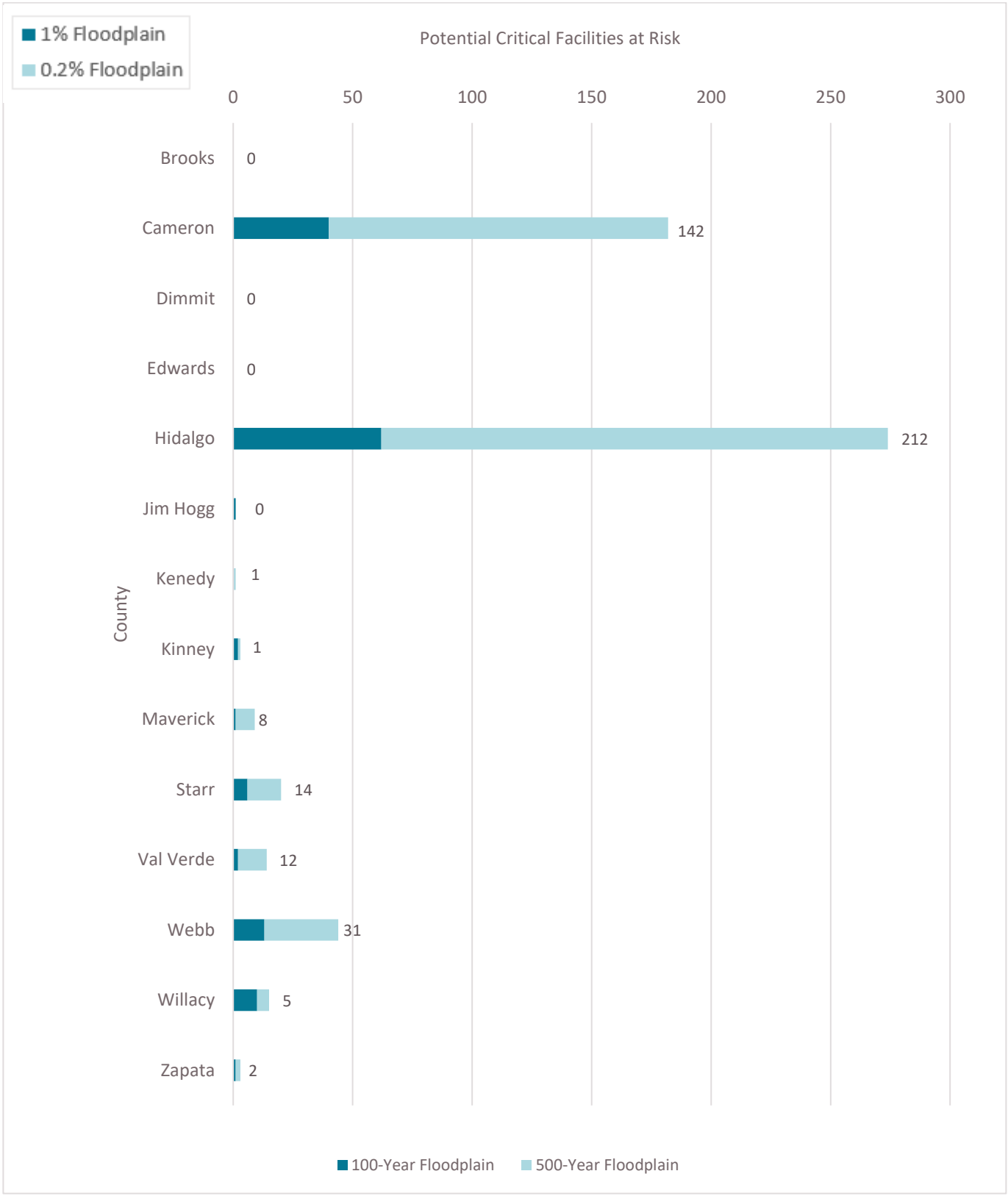


Figure 2.16 Linear Miles of Roadway at Risk in Existing Conditions Floodplain Quilt

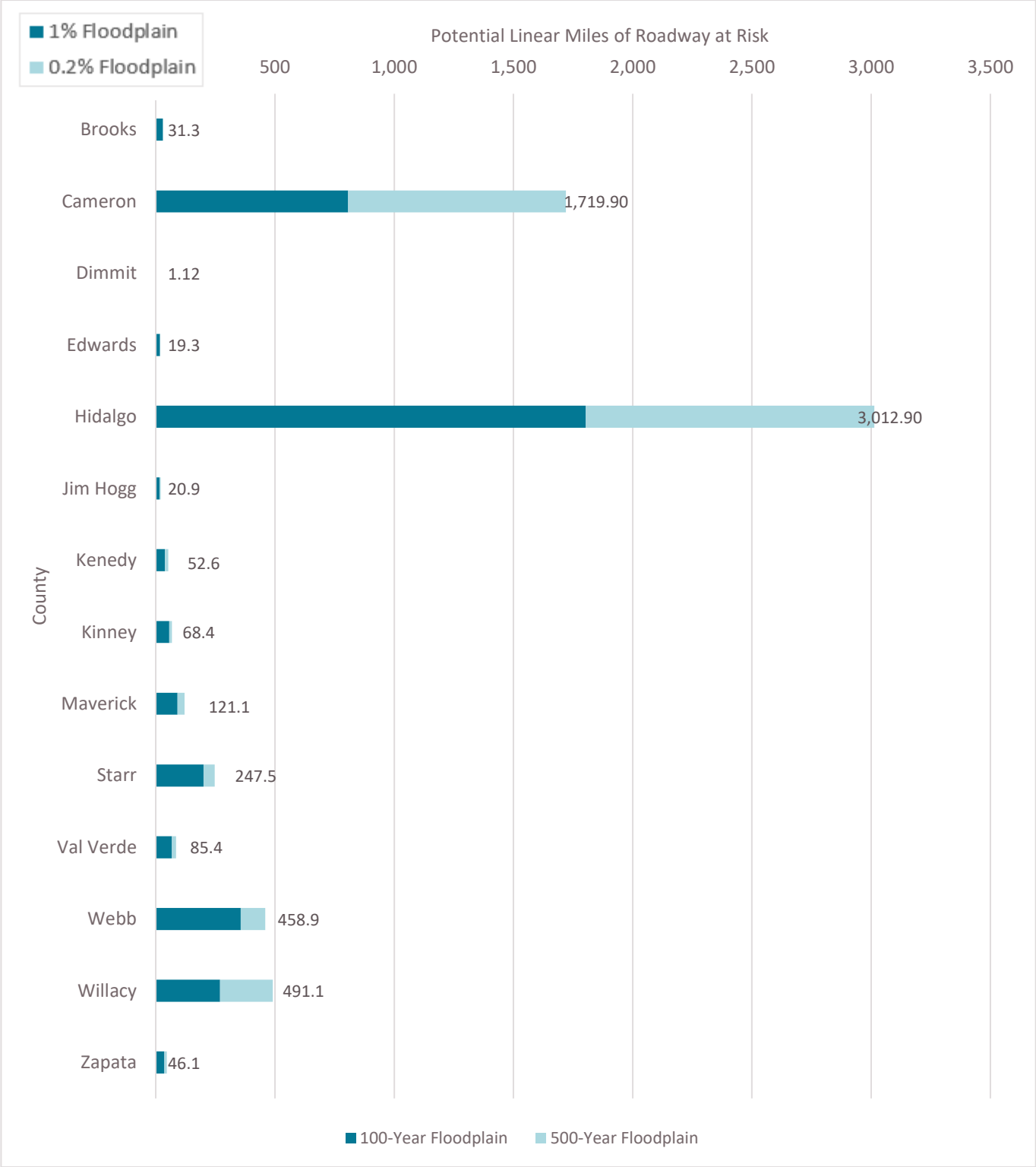


Table 2.5 Exposed Bridge and Low Water Crossings in Existing Conditions Floodplain Quilt

County	Number of Low Water Crossings
Brooks	0
Cameron	2
Dimmit	0
Edwards	6
Hidalgo	16
Jim Hogg	1
Kenedy	0
Kinney	44
Maverick	6
Starr	0
Val Verde	25
Webb	26
Willacy	0
Webb	0

Agricultural Area

Crops and livestock data used in the Lower Rio Grande Planning Region was obtained from the 2020 Texas Cropland Data layer developed by the USDA NASS. In the Lower Rio Grande Region, the increasing population significantly influences the continued loss of working lands, changing ownership sizes, and land values.

The 2020 FEMA National Risk Index (NRI) data was leveraged to show the value of crops and livestock exposed to flooding. The FEMA NRI uses data from the 2017 USDA CropScape and the Census of Agriculture to document the value of exposed crops and livestock. The CropScape data in dollars was used to calculate crop and livestock production value density per county. The county value is divided by the county's total crop and livestock land area to find its dollar value density (see **Equation 1**).

Equation 1 County Crop and Livestock Value Density

$$AgValueDen_{Co} = \frac{AgValue_{Co}}{AgArea_{Co}}$$

where:

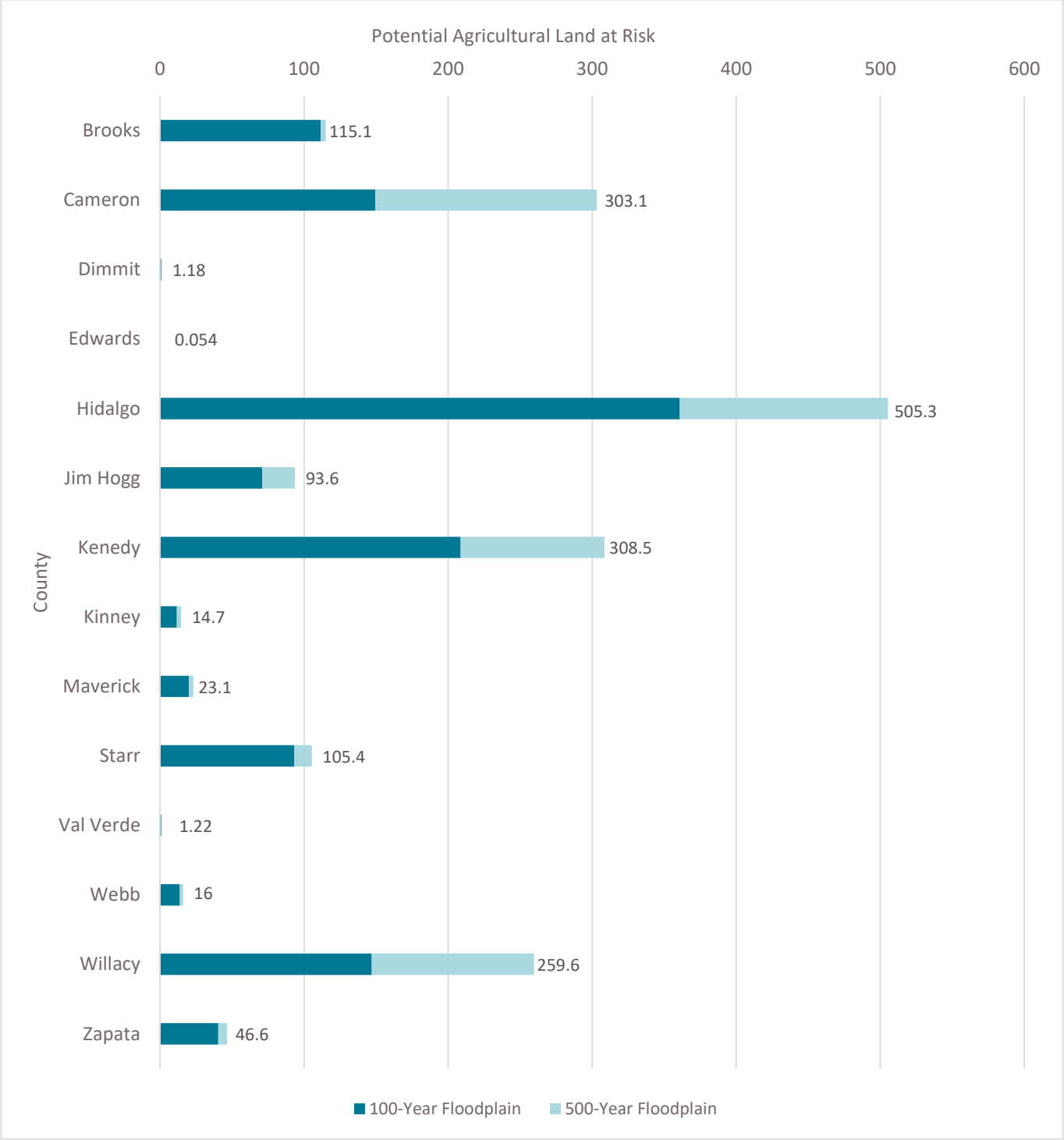
$AgValueDen_{Co}$ is the crop and livestock value density calculated at the county level (in dollars per square mile)

$AgValue_{Co}$ is the total crop and livestock production value of the county, as reported in the 2017 Census of Agriculture (in dollars)

$AgArea_{Co}$ is the total crop and livestock production area of the county (in square miles)

The crop and livestock areas exposed to flooding were determined by overlaying the existing floodplain quilt. Each county's crop and livestock value losses were then calculated as the product of the crop and livestock production value density per county and the associated crop and livestock areas exposed to flooding from the existing conditions floodplain. Hidalgo, Cameron, Kenedy, and Willacy counties have high agricultural exposure values. Dimmit, Edwards, and Val Verde counties had no agricultural exposure in the Lower Rio Grande Planning Region (less than 1 percent of the land area is in the Lower Rio Grande Planning Region). **Figure 2.17** shows the exposed agricultural areas (crops and livestock) in square miles.

Figure 2.17 Agricultural Land Exposure (in Square Miles) to Existing Conditions Floodplain Quilt



2A.2.E Expected Loss of Function

Severe flooding results in a loss of function of community infrastructure and economy, impacting the socioeconomic systems supported by them. These impacts include disruptions to life, business, and public services. Some public services are essential to a community during and after a flood event. Flood inundation depth and duration are typically considered the best flood characteristics in predicting expected functionality losses. **Maps 6A, 6B, and 6C,** found in **Appendix A**, show the Existing Conditions Flood Exposure for critical facilities, roadways, railroads, strucures, agricultural lands and utility facilities such as power, water, wastewater and gas.

Inundated Structures

Inundated buildings (structures) are often not functional during the flood event and through the recovery process. Structural inundation may result in physical damage, displacement costs, occupants' inability to work, as well as mental health and welfare impacts to occupants. These impacts are dependent on the severity of damage to the structure, interrupted access, and lingering health hazards. While all building types may experience these impacts, the loss of function of business in commercial and industrial services may also be extensive.

Critical Facilities

Critical facilities provide essential services for communities and are integral to maintaining stability after a flood event. During and after hazard events, the availability and functionality of first responders, health and human services, water supply and treatment, and operable utilities are vital. These facilities can become inoperable or impaired in the incidence of flooding, severely impacting their communities.

Health and Human Services

Floods can have an extensive impact on the public's health, directly and indirectly. Most flood-related deaths are from drowning, but physical trauma, heart attacks, electrocution, and carbon monoxide poisoning also account for flood-related mortalities. Furthermore, flooding can damage and restrict access and utilities to schools, hospitals, nursing homes, and assisted living facilities infrastructure, leading to loss of education and health care services.

Water Supply and Water Treatment

Water supply and wastewater treatment facilities generally operate 24 hours a day, seven days a week, 365 days of the year. Floods can contaminate water supply sources such as wells, springs, and lakes/ponds through polluted runoff laden with sediment, bacteria, animal waste, pesticides, and industrial waste and chemicals. Floods can also physically damage or render inoperable water treatment plants to further incapacitate a community's water supply.

Due to their usual proximity to active water bodies such as rivers and streams, multiple wastewater treatment plants are in low-lying areas within the region. These low-lying areas are generally within or near floodplains. Flooded wastewater treatment plants can cause physical damage, chemical spills, and raw sewage spills, among other issues. These facilities regularly receive chemical, material, and other critical equipment deliveries. Without those deliveries, operations may cease within a couple of days.

Additionally, shift changes enable safe operation. Without access to the facility, personnel is unable to relieve the shift on duty, causing unsafe conditions for on-duty staff.

Utilities and Energy Generation

Energy generating and distributing facilities generally operate 24 hours a day, seven days a week, 365 days of the year. Flooded energy generation and distribution facilities can cause physical damage and loss of operation. These facilities regularly receive chemical, hydrogen, and other critical equipment deliveries. Without those deliveries, operations may cease for a couple of days. Additionally, shift changes enable safe operation. Without access to the facility, personnel is unable to relieve the shift on duty, causing unsafe conditions for on-duty staff.

Transportation

Transportation systems are vital to the region's economy. This plan evaluates transportation as exposed roadway crossings or roadway segments that are impacted by flood events, such as poorly-drained stretches of road or low water crossings. Roadway segments impacted by flooding result in the loss of transportation routes needed by the first responders and the public alike.

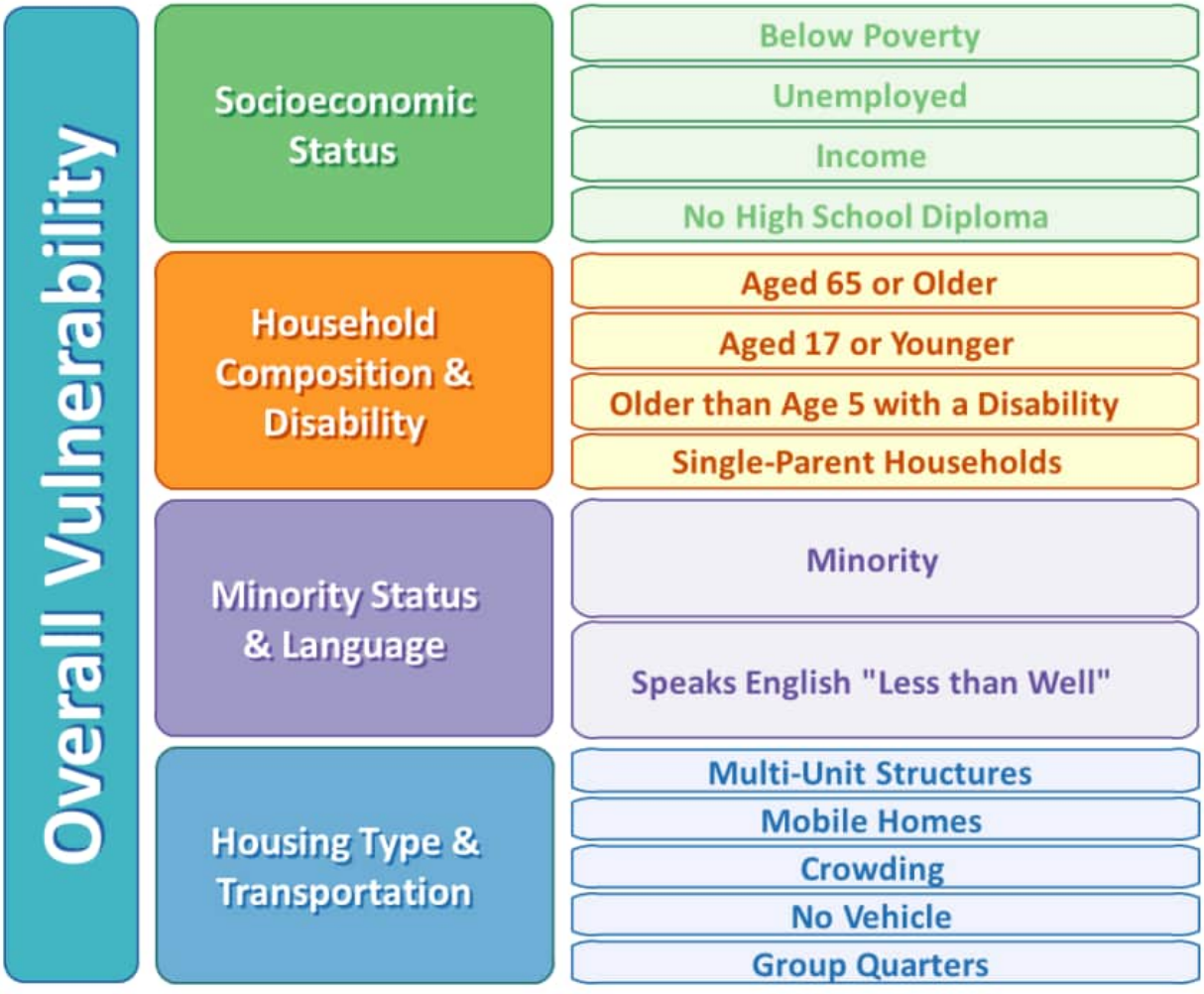
Agriculture

The impact of flooding on agriculture, ranching, and range/pasture can be severe and have serious local and regional economic consequences. Floods can delay the planting season as they immerse the fields and make them impassable for heavy equipment. This can lead to decreased crop size, lower yields, and reduced profits. When floods occur as crops grow in the fields, they can destroy an entire season's work and investment. Floods at harvest time can make it impossible for farmers to harvest mature crops and get them to market. Livestock could drown in floodwaters if they do not have access to a higher elevation where they can escape. Even if the livestock is safe, damage could occur to barns and other buildings, and cleanup of muck and debris can affect their feeding grounds. Forestry or orchard operations can lose trees to fast-moving waters and erosion, instantaneously wiping out years of growth.

2A.3 Existing Condition Vulnerability Analysis

Vulnerability is an assessment of the potential negative impact of the flood hazard to communities and a description of the impacts. This task uses the data from the existing flood exposure analysis to determine the vulnerability of exposed structures and populations to flooding. The existing condition vulnerability analysis uses the 2018 SVI data developed by the CDC. The CDC calculates the SVI at the census tract level within a specified county using 15 sociable factors, including poverty, housing, ethnicity, and vehicle access and groups them into four related themes: socioeconomic status, household composition, race/ethnicity/language, and housing/transportation. **Figure 2.18** shows the CDC themes used for SVI calculation. Each census tract receives a separate ranking for each of the four themes, as well as an overall ranking.

Figure 2.18 Graphic for CDC Themes



Source: CDC (https://svi.cdc.gov/Documents/Data/2018_SVI_Data/SVI2018Documentation.pdf)

2A.3.A Vulnerabilities of Structures, Agricultural Areas, Bridges, Low Water Crossings, and Critical Facilities

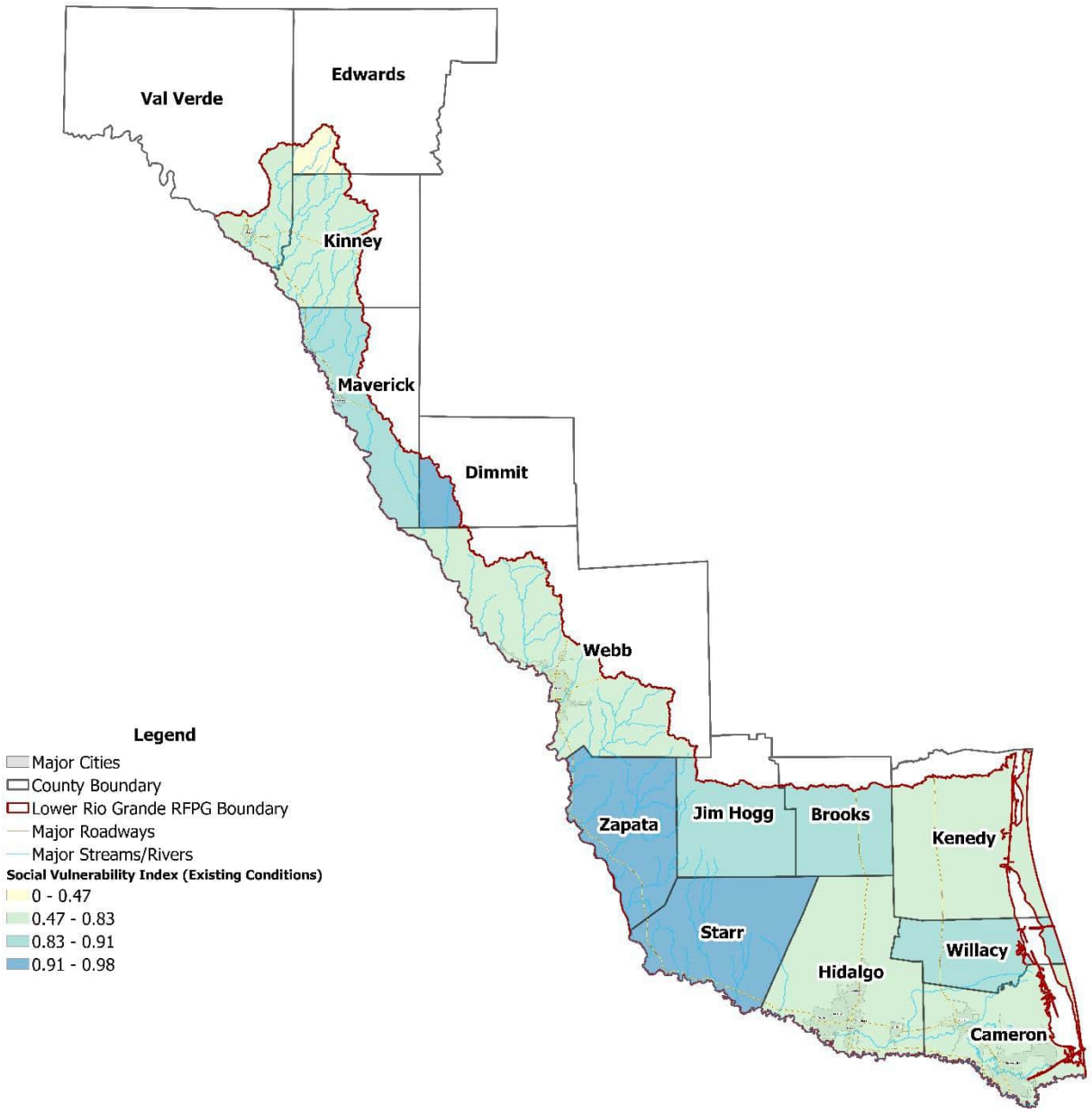
The 2018 CDC's SVI data was overlaid with the Lower Rio Grande Planning Region's buildings, critical facilities, bridges, low water crossings, and agricultural areas to attribute their associated SVI values. The SVI values for all the buildings, critical facilities, agricultural areas, bridges, and low water crossings exposed to the existing conditions floodplain quilt are summarized by county averages and shown in **Figure 2.19**.

A community's social vulnerability score is proportional to a community's risk. Social vulnerability is a consequence enhancing risk component and community risk factor that represents the susceptibility of social groups to the adverse effects of natural hazards like floods, including disproportionate death, injury, loss, or disruption of livelihood [*FEMA, 2021*]. An SVI score and rating represent the relative level of a community's social vulnerability compared to all other communities, with a higher SVI score resulting in a higher risk index score [*FEMA, 2021*].

Figure 2.19 shows Edwards County, Kinney County, and parts of Hidalgo County as the least vulnerable with respect to the existing exposure of buildings, critical facilities, agricultural areas, bridges, and low water crossings. The TWDB considers a threshold of 0.75 as an indicator for highly vulnerable areas. **Figure 2.19** shows the countywide average distribution of SVI with regard to the exposed buildings, critical facilities, agricultural areas, bridges, and low water crossings in the Lower Rio Grande Planning Region. Dimmit, Zapata, and Starr counties had the largest SVI countywide values. Twelve of the fourteen counties in the region have an SVI value over 0.75.

A large, detailed map for the vulnerability assessment at a local level is included as **Map 7** of **Appendix A**.

Figure 2.19 Existing Conditions Flood Exposure SVI Averages by County



2A.3.B Resiliency of Communities

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

- population over age 65
- population with a disability
- population without a high school diploma
- unemployed population
- population lacking health insurance
- households with limited english proficiency
- single-parent households
- households without a vehicle
- public schools per 5,000 residents
- hospitals per 10,000 residents

The community resilience score is inversely proportional to a community's risk. A higher community resilience score results in a lower Risk Index score. A score of zero is average resilience for similar communities. A positive number between zero and one indicates better resilience than similar communities, and a negative number between negative one and zero indicates less resilience than similar communities. **Table 2.6** shows the resiliency score for the counties in the Lower Rio Grande Planning Region as calculated by RAPT.

Table 2.6 Resiliency Rating by County

County	Resiliency Score
Brooks	-0.63
Cameron	-0.59
Dimmit	-0.65
Edwards	-0.40
Hidalgo	-0.64
Jim Hogg	-0.63
Kenedy	-1.03
Kinney	-0.60
Maverick	-0.77
Starr	-1.11
Val Verde	-0.49
Webb	-0.50
Willacy	-0.65
Zapata	-1.15

2A.4 Summary of Existing Conditions Flood Exposure and Vulnerability Analyses

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

Table 2.7 outlines the files in the TWDB-required geodatabase included with this chapter. These deliverables comply with *Exhibit D: Data Submittal Guidelines for Regional Flood Planning*.

Table 2.7 Geodatabase Layers Indicative of Existing Condition Flood Risk in the Region

Item Name	Description	Feature Class Name	Data Format Polygon/Line/ Point/GDB Table
Existing Flood Hazard	Perform existing condition flood hazard analyses to determine the locations and magnitude of both 1 percent and 0.2 percent annual chance flood events	ExFldHazard	Polygon
Flood Mapping Gaps	Gaps in the existing condition inundation boundary mapping	Fld_Map_Gaps	Polygon
Existing Exposure	High-level region-wide information was identified in the flood hazard analysis, indicating features (best represented as polygons) that may be at risk for the existing condition 1 percent and 0.2 percent annual chance flood events.	ExFldExpPol	Polygon
Existing Exposure	High-level region-wide information was identified in the flood hazard analysis, indicating features (best represented as polylines) that may be at risk for the existing condition 1 percent and 0.2 percent annual chance flood events.	ExFldExpLn	Line
Existing Exposure	High-level region-wide information was identified in the flood hazard analysis, indicating features (best represented as points) that may be at risk for the existing condition 1 percent and 0.2 percent annual chance flood events.	ExFldExpPt	Point

Item Name	Description	Feature Class Name	Data Format Polygon/Line/ Point/GDB Table
Existing Exposure	High-level region-wide information was identified in the flood hazard analysis, indicating all features (represented as points) that may be at risk for the existing condition 1 percent and 0.2 percent annual chance flood events.	ExFldExpAll	Point
Existing Exposure	High-level region-wide information was identified in the flood hazard analysis, indicating all active well features (represented as points) that may be at risk for the existing condition 1 percent and 0.2 percent annual chance flood events.	Ex_RRC_ ActiveWells	Point

Task 2B – Future Condition Flood Risk Analyses

2B.1 Future Condition Flood Hazard Analysis

The future flood risk assessment begins by estimating the increased extent of the future flood hazard. The future flood risk mapping extent is most determined under fully developed watershed conditions, which is the anticipated condition of the watershed after the watershed has undergone ultimate land use development. The determination of the general magnitude of potential increases in the Lower Rio Grande Basin's future 1 and 0.2 percent ACE is based on a "do-nothing" or "no-action" scenario of approximately 30 years of continued development and population growth under current development trends and patterns, and existing flood regulations and policies.

2B.1.A Future Conditions Based on "No Action" Scenario

Population Growth

Population projections were developed by watersheds (HUC-10) and sub-basins (HUC-8) using the earlier decades of the 50-year county and Water User Group (WUG) population projections developed for the 2022 State Water Plan. The Rio Grande (Region M) and Coastal Bend (Region N) Water Planning Region overlap the Lower Rio Grande Planning Region. Although some WUGs cross watersheds and sub-basins, the population projections used in this analysis only correspond within the Lower Rio Grande Planning Region. The 2022 State Water Plan population within the Lower Rio Grande Planning Region is projected to grow by 51 percent, or 1,448,481 people, from 2020 to 2050. A summary of population growth region-wide is shown in **Table 2.8**.

Table 2.8 Population Projections

Region	2020	2030	2040	2050	Percent Growth
Lower Rio Grande	2,822,674	3,290,547	3,757,180	4,271,155	51%

Anticipated Future Development

The future conditions analysis included distributing projected population growth spatially within the Lower Rio Grande Planning Region. The TWDB provided population projections at the WUG Level, the same level used in the State Water Plan. The process of deciding where anticipated development would occur takes into consideration regional infrastructure, undeveloped land, natural features, existing flood risk, jurisdictions, and current development trends. The input factors were combined using local knowledge to represent how likely new development could occur throughout the Lower Rio Grande Planning Region.

Future development was distributed within each WUG based on the following factors (in priority order):

- proximity to recent developments
- proximity to existing developments
- proximity to interstates and highways
- proximity to major local thoroughfares
- proximity to planned highways and local thoroughfares
- wetlands
- flood hazard areas
- areas within city limits or extraterritorial jurisdictions (ETJ)

Future development was restricted in the following areas:

- existing floodways
- existing parks, cemeteries, airports, golf courses
- government-owned land
- existing railroad right of way
- existing road right of way
- existing developments

The 2020 Census informed anticipated population densities, as shown in **Table 2.9**. The high population density was assigned to existing urban centers. Medium-density was used for all areas within 3 miles of existing urban centers (suburbs). Low density was used for the remaining area in the Lower Rio Grande Planning Region (rural areas).

Table 2.9 Approximate Future Population Densities

Population Density	People per Acre
High	20
Medium	12
Low	6

Future development was distributed within each WUG, beginning with the most desirable areas as determined by the factors listed above until all was anticipated population assigned. In heavily developed WUGs, population growth often exceeded land available to develop; in these scenarios, the population over the WUG capacity was transferred to the closest "County-Other" WUG. Areas anticipated to be developed were divided into individual parcels based on population densities from the areas of people per household determined in the 2020 Census. A single residential structure was created at the center of each parcel for inclusion in the future conditions flood risk exposure analysis.

Sea Level Change

Relative sea level change refers to the change in sea level compared to land elevation at a particular location. Sea level change is understood to be affected by global and local phenomena, including changes in:

- ocean mass associated with long-term forcing of the ice ages ultimately caused by small variations in the orbit of the earth around the sun
- density from total salinity
- heat content of the world's ocean
- estuarine and shelf hydrodynamics,
- regional oceanographic circulation patterns (often caused by changes in regional atmospheric patterns),
- hydrologic cycles (river flow), and
- local and/or regional vertical land motion (subsidence or uplift)

Relative sea level change can increase flood hazards in low-lying coastal communities. The Environmental Protection Agency (EPA) and the USACE developed a methodology for tracking relative sea level change by quantifying the average number of coastal flood events per year and estimating anticipated future relative sea level change. **Figure 2.20** shows the average number of coastal flood events per year for various Gulf Coast communities. The EPA found that each station experienced a significant increase in the quantity of annual coastal flooding compared to previous decades. From 1960 to the present, the NOAA tide gauges along the Texas and Louisiana coasts recorded a relative sea level increase of 10 to 20 inches, as shown in **Figure 2.20**. During this timeframe, the Port Isabel Gage in Cameron County has experienced 9.87 total inches of measured sea level rise.

The USACE has developed a methodology to estimate future relative sea level change by calculating "low," "intermediate," and "high" scenarios. The "Low" scenario projects a continuation of the currently observed linear sea level trend. The "Intermediate" scenario uses the National Research Council (NRC) I model with low assumed values for global and local phenomena. The "High" scenario uses the NRC III model with assumed values for global and local phenomena, as well as low assumptions for glacier melt.

Figure 2.20 Relative Sea Level Change Along Gulf Coast

Adapted from EPA's Climate Change Indicators in the United States: www.epa.gov/climate-indicators

2B.1.B Available Future Condition Hydrologic & Hydraulic Models

No future condition H&H models or floodplain mapping was available in the Lower Rio Grande Planning Region for use in Task 2B. As a result, the RFPG had to modify existing conditions data to create future condition flood hazard information; the process for doing so is discussed in *Section 2B.1.C*.

2B.1.C One and 0.2 Percent Annual Chance Exceedance Floodplains

The TWDB defined multiple methods for conducting future condition flood hazard analyses where data was unavailable, which apply transformations to existing flood hazard data. Per the Technical Guidelines for Regional Flood Planning, these methods are described below:

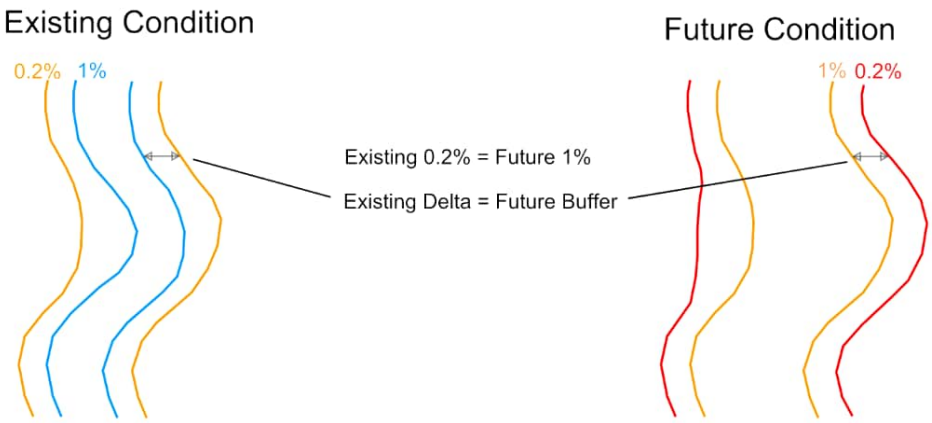
- **Method 1:** Increase water surface elevation based on projected percent population increase
- **Method 2:** Utilize the existing condition 0.2 percent ACE flood hazard area as a proxy for the future 1 percent ACE flood hazard area
- **Method 3:** Combination of Methods 1 and 2 or an RFPG-proposed method
- **Method 4:** Request the TWDB for a Desktop Analysis

Method 2 was discussed and approved at the Lower Rio Grande RFPG meeting on March 9, 2022, as well as using a horizontal buffer to create the 0.2 percent ACE future flood hazard area.

The future 1 percent ACE flood hazard area was set to match the existing 0.2 percent ACE flood hazard area. Then, typical horizontal buffer widths were estimated in each HUC-8 for “hilly” terrain and flat coastal areas to determine the existing thickness of the 0.2 percent ACE flood hazard area. This buffer

was then applied to the future 1 percent ACE polygons to determine the extent of the future 0.2 percent ACE polygons. This process is illustrated in **Figure 2.21**.

Figure 2.21 Future Condition Flood Hazard 1 and 0.2 percent Annual Chance



The average coastal buffer of 157 feet was applied to floodplains in Hidalgo, Cameron, Willacy, Kenedy, and Brooks counties. The average inland buffer of 56 feet was applied to all other counties.

Map 8 in **Appendix A** shows future condition flood hazard areas across the Lower Rio Grande River watershed. **Map 9** in **Appendix A** show flood hazard areas for 1 and 0.2 percent ACE by county compared to the complete area of each county in the Lower Rio Grande Planning Region.

Map 10 in **Appendix A** shows the changes in flood hazard data from existing to future conditions due to the buffering techniques described above. The increase in 0.2 percent ACE flood hazard area for the Lower Rio Grande Planning Region is 10 percent, **Table 2.10** summarizes the extent increase region-wide

Table 2.10 Increase in Flood Hazard Area for Future Condition Compared to Existing Condition

Flood Frequency	Existing Conditions Area (Sq. Mi)	Future Conditions Area (sq. mi.)	Increase (sq. mi.)	% Increase
1% Annual Chance	4,078	5,287	1,209	29%
0.2% Annual Chance	5,287	6,556	1,269	24%

2B.1.D Data Gaps

As previously mentioned, no future condition hydrologic and hydraulic models or floodplain mapping were available in the Lower Rio Grande Flood Planning Region for use in Task 2B. As a result, the entire region is reflected as a gap in inundation boundary mapping in **Map 9**, located in **Appendix A.**

2B.2 Future Condition Flood Exposure Analysis

2B.2.A Future Conditions Flood Exposure

Flood exposure for future conditions followed the same methodology as existing conditions as outlined in Section 2A. However, residential structures created based on projected future development and population projections were incorporated into the exposure analysis. Existing buildings, roadway crossings, and agricultural areas were maintained in the future conditions analysis. The summary of future flood exposure by county can be found in **Table 5** in **Appendix B** and **Map 11** in **Appendix A.** The increase in future conditions exposure compared with existing conditions exposure is summarized in **Table 2.11**.

Table 2.11 Summary of Increased Exposure in Flood Hazard Area

Feature	Existing Conditions	Future Conditions	Increase
Population	965,787	1,365,701	399,914
Total Structures	288,366	394,669	106,303
Residential Structures	233,776	320,563	86,787
Non-Residential Structures	54,590	74,106	19,516
Critical Facilities	566	865	299
Low Water Crossing	126	129	3
Roadway Segments (miles)	6,376	9,163	2,787
Agricultural Area (sq. mi)	1,793	2,258	465

Buildings, Critical Facilities, Infrastructure, and Agriculture Exposure Totals by County

Future flood exposure analysis included existing and anticipated future development and estimated the number of buildings, critical facilities, low water crossings, roadway segments, and agriculture areas potentially exposed to anticipated future flooding by overlaying the future conditions flood hazard area developed for the Lower Rio Grande Planning Region. **Table 5** in **Appendix B** shows the total number of buildings, critical facilities, and agriculture areas exposed to the future flood hazard areas, summarized by the county. **Maps 11A, 11B, and 11C** show the future condition flood exposure for buildings, critical facilities, low water crossings, roadway segments, and agriculture areas. These are found in **Appendix A**.

Population Totals by County

Population data for the future conditions flood risk exposure analysis accounted for population growth and existing population data. The population associated with existing structures was not altered for the

future exposure analysis. As discussed previously, the population of new structures was identified using population projections and population density.

Table 2.12 Counties with the Highest Population Exposure within the 0.2 percent ACE Flood Hazard Area

County	Existing Conditions Population	Future Conditions Population	Increase
Hidalgo	535,247	760,243	224,996
Cameron	272,340	383,522	111,182
Webb	99,649	141,863	42,214
Starr	19,248	25,054	5,806

As you can expect, future condition flood risk is concentrated around the metropolitan areas where there is a larger concentration of people, dwellings and critical infrastructure needed to support the communities.

Residential Properties

A total of 252,000 structures are exposed to flooding region-wide, with the overwhelming majority of the structures exposed being residential. A total of 212,000 structures, nearly 50 percent more than under existing conditions. Similar to the population exposed to flooding, the counties with the largest number of residential structures exposed to future flood risk include Cameron and Hidalgo counties. The complete list of residential properties exposed by county is included in **Table 5** in **Appendix B**. **Map 11 C** in **Appendix A** show potential future residential structures exposed to 1 and 0.2 percent ACE flood hazard by county compared to total residential structures for each county in the Lower Rio Grande Planning Region. Potential future residential structures include existing and approximate future residential structures.

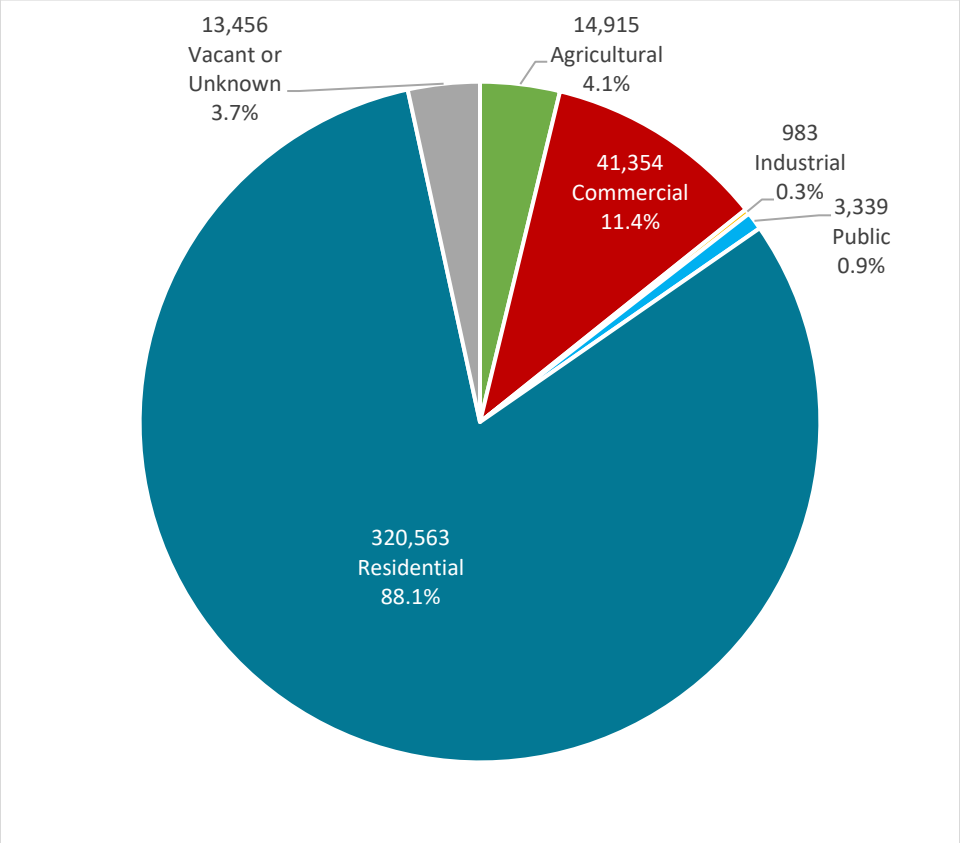
Table 2.13 Counties with the Highest Structural Exposure within the 0.2 percent ACE Flood Hazard Area

County	Existing Conditions Structures	Future Conditions Structures	Increase
Hidalgo	164,942	220,599	55,657
Cameron	68,171	112,880	44,709
Webb	19,770	32,456	12,686
Starr	6,696	8,648	1,952

Non-Residential Properties

Non-residential structure inventory data included agricultural, commercial, industrial, and public buildings. No additional non-residential structures were included in the analysis due to the uncertainty of where or how many structures could be expected in the future. The exposure of existing non-residential structures is anticipated to increase by 17 percent in future conditions, and the exposure of future non-residential structures is unknown. **Table 2.11** summarizes the change in structural flood exposure in future conditions compared to existing conditions. **Map 11C** in **Appendix D** show non-residential structures exposed to 1 and 0.2 percent ACE flood hazard by county compared to total non-residential structures for each county in the Lower Rio Grande Planning Region. As shown in **Figure 2.22**, of the structures exposed to the future flood hazard area, 88 percent are residential buildings, while the remaining 12 percent are non-residential. Buildings classified as vacant are structures for which the building type and/or use could not be determined.

Figure 2.22 Distribution of Structures at Risk of Flooding by Structure Type



Critical Facilities and Public Infrastructure

Critical facilities and public infrastructure were analyzed with the future flood hazard areas to determine the future flood risk exposure of these features. No additional features were added to the dataset compiled in the existing conditions flood exposure analysis previously described. The future condition scenario assumes that all new critical facilities are constructed outside the future flood hazard areas, and no exiting critical facilities are retrofitted to decrease the flood risk exposure. An additional 115 critical facilities were identified in the future condition flood exposure analysis that were not previously identified in existing conditions.

Table 2.14 summarizes the change in structural flood exposure for critical facilities in future conditions compared to existing conditions. A summary of all critical facilities in flood-prone areas in **Table 5** in **Appendix B**. **Maps 11A, 11B and 11C** in **Appendix A** show critical facilities exposed to 1 and 0.2 percent ACE flood hazard by county compared to total critical facilities identified for each county in the Lower Rio Grande Planning Region.

Table 2.14 Counties with the Highest Critical Facilities Exposure within the 0.2% ACE Flood Hazard Area

County	Existing Conditions Critical Facilities	Future Conditions Critical Facilities	Increase
Hidalgo	274	445	171
Cameron	182	267	85
Webb	44	65	21
Starr	20	25	5

Roadway Crossings and Roadway Segments

The future flood risk exposure analysis for roadways used only the existing roadway data available from TxDOT. Without considering additional future roads, the future flood risk exposure resulted in an 8 percent increase in roadway crossings and a 46 percent increase in miles of inundated roadways. Increases in the flood hazard area have less of an impact on roadway stream crossings as most crossings in the region were identified in the existing conditions analysis. Similar to the existing condition exposure analysis, bridge deck height was not considered in the future condition exposure analysis. Larger flood hazard areas resulted in a significant increase in inundated roadway miles. A summary of all roadway crossings and roadway segments in flood-prone areas is included in ***Table 5*** in **Appendix B. Maps 11A and 11B** in **Appendix A** show roadway miles exposed to 1 and 0.2 percent ACE flood hazard by county compared to total roadway miles for each county in the Lower Rio Grande Planning Region.

Agricultural Area

The agricultural area in the Lower Rio Grande Planning Region was also evaluated to determine future flood exposure. The same area determined in the existing exposure analysis as agricultural was used in the future flood risk exposure analysis. Without altering the agricultural land dataset, the future flood risk exposure resulted in a 7 percent increase in agricultural land in flood-prone areas. Of the 350 square miles of existing agricultural land, approximately 25 square miles are covered by projected future development. **Map 11C** in **Appendix A** show agricultural land area exposed to 1 and 0.2 percent ACE flood hazard by county compared to the total agricultural land in each county in the Lower Rio Grande Planning Region.

2B.2.B Potential Flood Mitigation Projects

The existing conditions flood hazard areas were developed using all data made available to the RFPG. Of the proposed and ongoing projects identified in Task 1, no post-project reduced flood hazard areas were provided for inclusion in the future conditions analysis. If reduced flood hazard areas were provided, this information would be incorporated into the base polygon features used to create future flood hazard areas. Without this information, the baseline used for future conditions is the existing conditions flood hazard areas presented in *Task 2A*. Future implemented flood mitigation projects should consider the increased flood risk anticipated over the structure's life.

2B.3 Future Condition Vulnerability Analysis

After identifying areas of future risk and the anticipated people and property exposed to that risk, the vulnerability of those affected people was studied. The vulnerability was assessed using the same methodology as the existing flood risk exposure analysis. All new residential structures developed to account for the projected population were assigned the existing SVI of the census tract. The vulnerability analysis results are summarized by county in **Table 5** of **Appendix B**. This information is also shown in **Map 12** of **Appendix A.** **Map 12** also includes the location of critical facilities in the basin identified in the existing conditions flood risk exposure analysis color-coded by their SVI. The highest vulnerability of features in flood-prone areas is found in Zapata and Dimmit counties. **Map 12** in **Appendix A** visually show the average SVI of features in flood-prone areas.

2B.4 Summary of Future Conditions Flood Exposure Analysis and Vulnerability

The future flood exposure analysis anticipates that 46 percent more structures and 64 percent more people are potentially impacted than under existing conditions. The future flood risk, exposure, and vulnerability for the Lower Rio Grande Basin are summarized in the TWDB-required ***Table 5*** of **Appendix B**. The table provides the results per county of the future flood exposure and vulnerability analysis outlined in the Technical Guidelines for Regional Flood Planning.

A geodatabase with applicable layers as well as associated in the TWDB-required **Maps 10 through 12** are provided in **Appendix A** as digital data.

Table 2.15 outlines the geodatabase deliverables included in this Technical Memorandum, as well as spatial files and tables. These deliverables align with the TWDB's Exhibit D: Data Submittal Guidelines for Regional Flood Planning.

Table 2.15 Geodatabase Layer and Tables

Item Name	Description	Feature Class Name	Data Format (Polygon/Line/Point/GDB Table)
Future Flood Hazard	Perform future condition flood hazard analyses to determine the location and magnitude of both 1 percent annual chance and 0.2 percent annual chance flood events	FutFldHazard	Polygon
Future Exposure	Develop high-level, region-wide, and largely GIS-based future condition flood exposure analyses using the information identified in the flood hazard analysis to identify who and what might be harmed within the region for, at a minimum, both 1 percent annual chance and 0.2 percent annual chance flood events	FutFldExpPol	Polygon
Future Exposure	Develop high-level, region-wide, and largely GIS-based future condition flood exposure analyses using the information identified in the flood hazard analysis to identify who and what might be harmed within the region for, at a minimum, both 1 percent annual chance and 0.2 percent annual chance flood events	FutFldExpLn	FutFldExpLn
Future Exposure	Develop high-level, region-wide, and largely GIS-based Future condition flood exposure analyses using the information identified in the flood hazard analysis to identify who and what might be harmed within the region for, at a minimum, both 1 percent annual chance and 0.2 percent annual chance flood events	FutFldExpPt	Point
Future Exposure	Combines the Exposure Poly, Line, and Point data into a single master layer also includes vulnerability data	FutFldExpAll	Point

Chapter 3

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Chapter 3: Floodplain Management Practices and Flood Protection Goals

This section provides a high-level assessment of current floodplain management practices throughout the Lower Rio Grande Planning Region, followed by a presentation of flood protection goals developed through a series of consensus-building activities performed with RFPG members and Lower Rio Grande Planning Region stakeholders. It looks at how Lower Rio Grande Planning Region is currently managing flood risk and where RFPG members would like to be in the future with respect to flood risk management. The task is presented in two (2) sections: Task 3A (Evaluation and Recommendations on Floodplain Management Practices) and Task 3B (Flood Mitigation and Floodplain Management Goals). A discussion of the work completed on both sub-tasks is presented below.

3A Evaluation and Recommendations on Floodplain Management Practices (361.35)

The goal of Task 3A is for the RFPG to evaluate and make recommendations on floodplain management practices throughout the Lower Rio Grande Planning Region Area. The intent of completing this evaluation is to:

- identify and reduce the risk and impact to life and property that already exists
- avoid increasing or creating new flood risks by addressing future development within the areas known to have existing or future flood risk

Entities responsible for managing flood risk for a community often employ floodplain management tools such as ordinances that regulate development and land use, land use maps, subdivision guidelines, unified development codes, master plans, and other similar documents. These regulations and associated maps and documents were collected and reviewed as available. Although some entities did provide links to their flood-related and land use regulations in the Lower Rio Grande Planning Region Data Collection Tool and Interactive Webmap, a good portion of the data that was collected online through municipal websites and/or state and nationwide platforms such as “Texas e-laws” and “Municode.” Where floodplain management documentation could not be located on the internet, the planning team requested the information directly, via email, utilizing the contact information included in the Texas Water Development Board (TWDB) Contact List. Of the 68 municipalities (counties or cities/towns/etc.) contained within the Lower Rio Grande Planning Region, approximately 50 percent had floodplain management regulations/ordinances available for review.

Sections 3A.1 and *3A.2* provide an overview of the findings resulting from this review process with respect to the region’s current and future flood risk implications. Based on the analysis discussed in these sections, combined with input from the RFPG and community members, *Section 3A.3* presents recommendations for minimum floodplain and land use practices and standards. *Section 3A.4* presents the recommended minimum practices that will be applied from a geographic standpoint. Finally, *Section 3A.5* discusses the RFPG’s consideration of example floodplain management and infrastructure

protection standards as provided by the TWDB in the Technical Guidance for Regional Flood Planning Document, dated April 2021.

3A.1 Extent to which Current Floodplain Management and Land Use Practices Encourage Increased Flood Risks

Floodplain management and land use practices were examined by looking at the region's regulations, policies, and trends. The purpose of these management practices is to help with the protection of life and property. Although floodplain management and land use practices vary from one entity to another, most communities in the region follow the rules and policies of the Federal Emergency Management Agency (FEMA). FEMA manages the National Flood Insurance Program (NFIP), which provides subsidies for private flood insurance for property owners in communities participating in the NFIP. The overall goal of the NFIP is to reduce exposure to flood risk, protect public safety, and prevent or minimize damage to property and public infrastructure.

Local entities become eligible to participate in the NFIP by adopting and enforcing minimum regulatory standards for land use, development, and other activities within floodplains. The delineation of regulatory floodplains is based on data provided by FEMA, which may include floodplain boundaries, base flood elevations (BFE), Flood Insurance Rate Map (FIRM) zones and floodway boundaries, Flood Boundary Floodway Map, and/or a Flood Insurance Study.

The NFIP minimum standard for floodplain regulation is the BFE, which is the water surface elevation resulting from a flood with a 1 percent chance of equaling or exceeding that level in any given year, commonly referred to as the 100-year floodplain (*FEMA*). Of note is that communities are encouraged by FEMA to go beyond minimums and adopt higher or more restrictive standards and requirements. The NFIP participants are also subject to audit by FEMA and/or the TWDB to ensure they follow minimum requirements.

The overall state of floodplain regulation in the Lower Rio Grande Planning Region is acceptable, as 91 percent of all entities with flood-related authority are participants in the NFIP in “good standing.” All counties except Edwards County participate in the NFIP, and all cities except Escobares, Granjeno, Penitas, Progresso Lakes, and Spofford are NFIP participants.

A table summarizing the current status of floodplain management and regulation in the Lower Rio Grande Planning Region is included in **Appendix B** as **Table 6**. This required table includes NFIP participation status, whether a county or city has adopted “higher” floodplain standards and requirements, a qualitative assessment of the level of enforcement, and whether a city has established a drainage or stormwater utility. Local Government Code, Title 13, Subtitle A, Chapter 552 authorizes cities to establish stormwater utilities and assess stormwater utility fees, also referred to as drainage fees. Only cities have the authority to establish and assess stormwater utility fees. As indicated in the **Table 6** in **Appendix B**, only three cities within the Lower Rio Grande Planning Region have drainage utilities and assess drainage fees – Austin, Fredericksburg, and Sunset Valley.

Many participating NFIP communities are using floodplain data and maps that are outdated. Older floodplain maps are often based on outdated and somewhat inaccurate topographic data, outdated

rainfall and hydrologic data, and/or outdated hydrologic and hydraulic models. To the extent that communities are using outdated maps for floodplain regulation, the current level of protection from flood damages through floodplain regulation may be less than the minimum level required by the NFIP (i.e., less than the benchmark 1 percent annual chance or 100-year event).

The National Weather Service published an updated rainfall statistical analysis for Texas in 2018 using additional historical data through 2017. This study, known as Atlas 14, shows that a large area of Texas, including roughly two-thirds of the Lower Rio Grande Planning Region, has experienced more intense rainfall, resulting in a greater amount of flood risk than previously thought.

3A.1.a Existing Population and Property

A listing of all counties, cities, towns, and districts with flood authority located either completely or partially within the region was first compiled to identify all community stakeholders. This list includes 14 counties, 54 cities/towns, and 17 districts. All counties and cities/towns were cross-referenced with the most recently available version of the FEMA Community Status Book Report for Texas to determine participation status with the NFIP. This analysis revealed a 93% participation rate amongst counties within or partially within the RFPG (13 out of 14) and a 94% participation rate amongst cities and towns (50 out of 53). The participation status of each municipal entity is indicated in the 4th column of **Table 3.4**. Similarly, the 3rd column denoting adoption of regulations pursuant to Texas Water Code Section 16.3145 was determined to be a "yes" if the entity was identified as an NFIP participant. Entries of "yes" in this column are those for which a floodplain management ordinance was obtained and reviewed, "no" indicates that the entity does not have an ordinance complying with Section 16.3145 of the Texas Water Code, and entries of "yes*" indicate that an ordinance was not obtained, but it is assumed that they have one in the compliance based on their listed NFIP status, and an entry of "N/A" was entered for all districts who are not eligible for NFIP participation.

A review of all collected floodplain management tools was then performed for each municipal entity. This assessment largely focused on adopted floodplain management ordinances, but other documents were also reviewed when available (Subdivision Guidelines, Master Plans, Drainage Studies, etc.). The third column of **Table 3.4** was then populated based on this review and whether floodplain management policies could be located for each entity. Most entries in this column were either "yes" if documents were located or "unknown" if they were not located. An entry of "no" was only entered when the Consultant Team could verify that a given entity did not utilize such documents.

Participation in the NFIP program indicates that a given entity has adopted a defined set of minimum standards. Amongst these standards are:

- adoption and enforcement of floodplain management regulations
- development of BFE data for all new subdivisions greater than 50 lots or 5 acres
- ensure that all newly constructed buildings are reasonably safe from flooding
- require permits for development in Special Flood Hazard Areas
- restriction of development in a floodway unless proven not to increase flood levels
- restriction of development when no floodway has been designated unless proven not to increase flood levels by more than 1-foot

- restriction of construction in AO and AH zones unless adequate drainage paths are provided and structures are built above the specified depth number (or at least 2 feet above the adjacent natural ground when no depth is provided)
- requirement on new construction in A zones such that the lowest floor must be above BFE (non-residential structures must also have utilities and sanitary facilities elevated or water-tight)
- new structures must be properly anchored (including buildings, manufactured homes, and recreational vehicles parked >180 days or not ready for highway use)

In reviewing the floodplain management documents of Lower Rio Grande Planning Region entities, these items were all consistently found to be present amongst the NFIP participating communities. However, some municipal entities have adopted greater than minimum NFIP standards to help further reduce flood risk throughout their communities. Specific standards that fall under this category amongst Lower Rio Grande Planning Region communities include:

- additional freeboard requirements on new buildings, ex. Lowest floor elevation between 1-2-ft above BFE
- establishing stream buffers, ex. 200-ft
- construction of critical facilities must occur outside of the 500-year floodplain
- requirement for on-site detention so that post-development runoff flows match that of pre-development flows
- design requirements for street stormwater storage capacity and drain time
- design requirements for storm sewer and open channel capacity

Of the 14 counties comprising the Lower Rio Grande Planning Region planning area, approximately 21 percent (3 out of 14) were found to have adopted higher than minimum NFIP standards in their floodplain management ordinances. Amongst Lower Rio Grande Planning Region cities, this number fell slightly to 21 percent (11 out of 53). While NFIP participation rates were high across the region, only a small percentage of participating communities enact more stringent floodplain management standards than the minimum required to participate in the NFIP.

Floodplain Management Practices characterization

There is a close relationship between NFIP participation requirements and the adoption of minimum standards in the set of ordinances. These factors are taken into consideration to rank the Floodplain Management Practices. Based on the availability of resources, the consultant team utilized the documentation and information of each entity, the information presented in **Table 3.4**, and the TWDB Exhibit C guidance document to rank each entity accordingly. During the review, it was required to acknowledge if any entities adopted higher standards than the NFIP minimum standards.

The information-gathering process through the Lower Rio Grande Planning Region data collection tool allowed each stakeholder to rank their entity based on self-criticism. The respondents had no assistance or standard to follow for ranking their floodplain management practices. **Table 3.1** summarizes the survey results as follows:

Table 3.1 Survey responses- Ranking Floodplain Management Practices

Floodplain Management Practice Response	Number of Respondents	Overall Percent
Strong	3	3%
Moderate	16	15%
Low	8	8%
I do not know	3	3%
No response	71	71%
Total	100	100%

Source: Lower Rio Grande Region Data Collection Tool and Interactive Webmap

The results show a high number of the jurisdictions, 71 percent of the entities are ranked as "No response," considering that the stakeholders did not answer the question or did not participate in the survey. A total of 3 percent of the stakeholders implied they could not rank their entities and therefore responded as "I do not know." Finally, based on the self-assessment, the respondents ranked themselves as follows: 8 percent "Low," 15 percent "Moderate," and 3 percent "Strong."

Given survey results, the consultant team gathered additional information to help better determine the characterization of the management practices. For this reason, The TWDB guidelines for evaluation of enforcement practices were used and are stated as follows:

- none (no floodplain management practices in place)
- low (regulations meet the minimum NFIP standards)
- moderate (some higher standards, such as freeboard, detention requirements, or fill restrictions
- strong (e.g., significant regulations that exceed NFIP standard with enforcement, or community belongs to the Community Rating System)

The characterization of the management practices was broken down into a set of requirements which will be used to determine if these are ranked as "Low, Moderate, Strong." As previously mentioned, the NFIP standards are considered minimum regulations; therefore, NFIP participation and minimum provisions pursuant to the Texas Water Code Section 16.3145 are considered low management practices. Further description of the requirements is found below in **Table 3.2**.

The consultant team proceeded to rank each level of floodplain management practices as follows:

Table 3.2 Ranking Criteria for Floodplain Management Practices across the region

Ranking	Ranking Criteria*
Low	1. NFIP Participant. 2. Minimum requirements (ordinance) pursuant to Texas Water Code Section 16.3145.

Moderate	1. NFIP Participant. 2. Minimum requirements (ordinance) pursuant to Texas Water Code Section 16.3145. 3. Adopted Higher Standards (Freeboard, detention requirements, or fill restrictions.)
Strong	1. NFIP Participant. 2. Specific requirements in place higher than an ordinance (standards or codes) 3. Entity adopted higher standards. 4. Part of Community Rating System.

The jurisdictions with "Low" floodplain management practices were based on their flood prevention ordinance established by the municipal authority. Most "Low" classified entities have at least the minimum required ordinance pursuant to the Texas Water Code Section 16.3145. These ordinances must comply with the Code of Federal Regulations (CFR) for the NFIP, specifically, the 44 CFR Parts 59, 60, 65, and 70. FEMA provides these regulations under NFIP Regulations. During the review process, it was clear to see that most entities established the minimum NFIP regulations in their ordinances, meaning that the action of establishing these provisions is correlated with NFIP Participation. For this reason, the only factors for low ranking are NFIP participation and minimum requirements in place.

The process for jurisdictions ranked with "Moderate" floodplain management practices was similar to the "Low" ranking process, except, the adoption of higher standards is considered for "moderate" classification. Some of the higher standards previously mentioned are additional freeboard requirements on new buildings (Ex. Lowest floor elevation between 1 to 2 feet above BFE) or establishing stream buffers (Ex. 200-ft). In addition, higher standards could be those found in Texas Floodplain Managers Association.

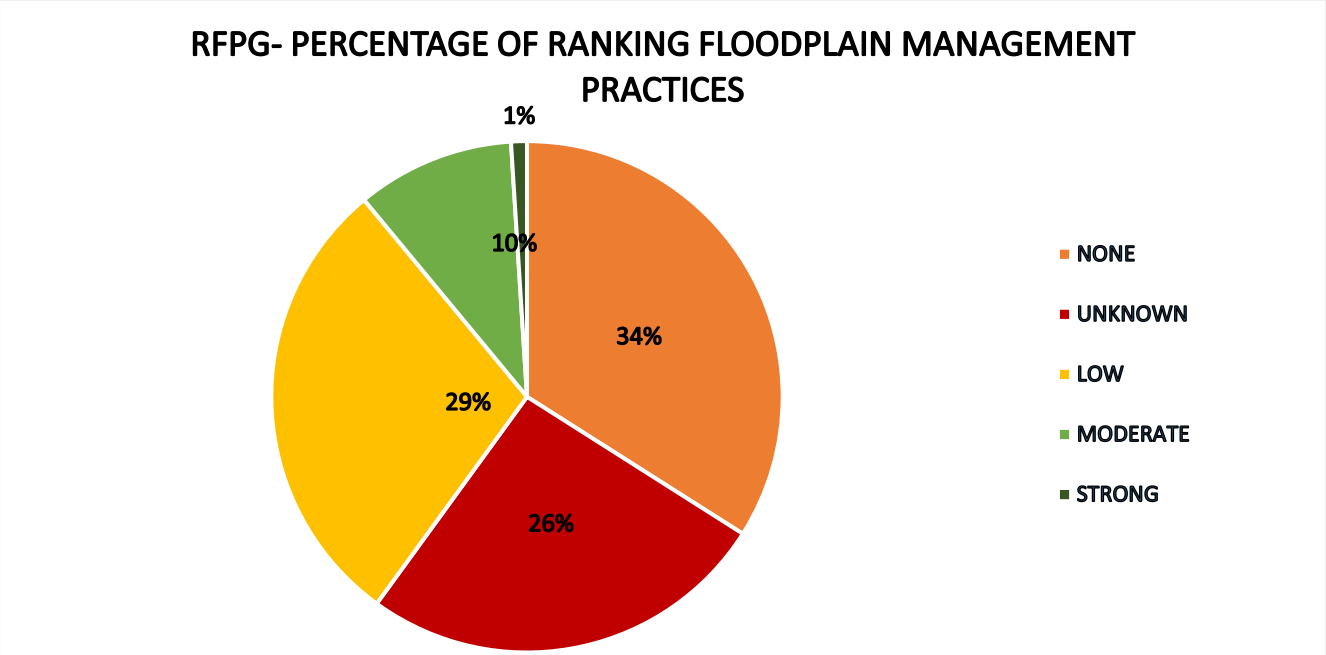
The number of jurisdictions with "Strong" floodplain management practices was very low; only one entity met above-average requirements. Aside from penalties for not complying and adopting higher standards, the main requirement for the highest ranking consisted of adopting practices that exceed the minimum requirements. For example, a manual with construction and development requirements where additional height above the base flood elevation of the lowest floor is strictly specified, exceeds the minimum lower base floor elevation requirement from an ordinance. The last requirement is regarding the Community Rating System, entities eligible to be part of this program exceed minimum NFIP requirements and aim to further improve the NFIP aspects, floodplain management practices, and protect property from flooding.

The methodology used by the consultant team helped determine that about 34 percent of the entities do not have management regulations; Therefore, these entities were ranked as "None." Due to the lack of information presented by the entities, about 26 percent of the entities are ranked as "Unknown." This actively demonstrates that the available information allowed for a total of 39 percent of the entities to be classified under the low, moderate, or strong categories. **Figure 3.1** summarizes these results:

Figure 3.1 shows the percentage of the entities within the Lower Rio Grande Planning Region that have floodplain management practices which can be ranked as low, moderate, strong, none, or unknown. The

shading on the map indicates that 34 percent of the communities have no floodplain management practices, and it is unknown whether 26 percent have any. The remaining communities rank their floodplain management practices as follows: 29 percent rank as Low, 10 percent as moderate, and 1 percent as high.

Figure 3.1 Percentage of Entities within the Region with Floodplain Management Practices that rank as Low, Moderate, Strong, None, or Unknown.



Source: Lower Rio Grande Region Data Collection Tool and Interactive Webmap

Based on the evaluation of the regulations, 86 percent of the entities meet minimum requirements on floodplain management practices. On the other hand, the consultant team could rank only one city that meets the above-average standards, which was ranked as having “strong” floodplain management practices. It was concluded that the city meets above-average standards since it adopted a 2014 Standards Manual consisting of Construction and Development Requirements. The established policy includes drainage, streets and roadways, water and sewer, construction plan submittals, and stormwater. The regulation established the below requirements:

- developments in flood-prone areas to be located at least two feet above the base of the flood elevation
- full mitigation is expected if a fill will be placed within a special flood hazard area
- no improvements shall be constructed if those will increase the frequency of flooding
- no access easements or streets may be constructed at an elevation lower than one foot below the base flood elevation
- any 100-year floodplain property must provide an amount of floodwater storage capacity
- parking developments should have a surface at elevations not lower than 6-inches below the base flood elevation

It is the recommendation that the rest of the entities follow this to reduce the risk and impact on life and property and avoid increasing or creating a new flood risk. It is expected that every entity will pursue the adoption of higher than minimum standards to ensure the safety of the respective jurisdictions' people, properties, and environment. It is concluded that many entities currently do not adopt higher standards or establish enforcement procedures to ensure compliance with their low floodplain management practices.

Level of Enforcement

The information gathered from the data collection tool included a question that evaluated the participant's level of enforcement of its floodplain management practices. The question instructed the respondents to rank their entities according to their own criteria. Based on the available responses, about 60 percent of the overall 27 participants described their level of enforcement as moderate or high activity; the rest responded as low or unknown. The results suggest that the participants do enforce regulations on their floodplain management. **Table 3.3** summarizes the overall results of this survey question:

Table 3.3 Survey Responses – Level of Enforcement Practices

Survey Responses of Jurisdiction Self-ranking Level of Enforcement of Floodplain Management Practice	Number of Responses	Overall Percent of Total Responses
High Activity	7	7%
Moderate Activity	9	9%
Low Activity	8	8%
I do not know	3	3%
No response	76	73%
Total	103	100%

Source: Lower Rio Grande Region Data Collection Tool and Interactive Webmap

The comparison between the survey results and the methodology used for classification suggested that even though seven out of the 27 entities that ranked their enforcement practices as high, all of those could be classified under the moderate activity level. Similarly, the respondents that considered their practices moderate activities did fall under that category, except two out of those nine respondents had no enforcement practices on record. The rest of the respondents had either low or unknown levels of enforcement.

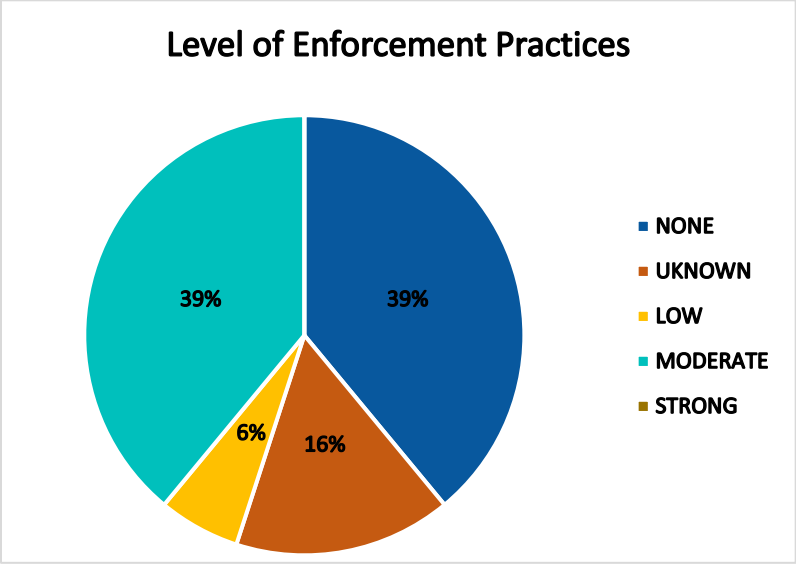
The TWDB Exhibit C Guidance document described enforcement activities as the following:

- high – actively enforces the entire ordinance, performs many inspections throughout the construction process, issues fines, violations, and Section 1316s where appropriate, and enforces substantial damage and substantial improvement

- moderate – enforce much of the ordinance, perform limited inspections, and are limited in issuing fines and violations
- low – provides permitting of development in the floodplain, may not perform inspections, may not issue fines or violations
- none – does not enforce floodplain management regulations

Following the TWDB guidelines for enforcement activities and analyzing the available information of each entity, the consultant group classified the level of enforcement practices. The overall result suggested that no entity has a high activity of enforcement. Most regulations only establish fines, perform limited inspections, and limit their issuance of fines and violations to the maximum available by law. As the TWDB states, the entity must enforce the entire ordinance, perform many inspections through the construction process, issue fines and violations, and enforce substantial damage and substantial improvement; therefore, it was concluded that no entity meets these requirements. It was clear that about 39 percent fall under moderate activity. Entities with moderate activity enforce most of the provisions in their ordinances (based on the minimum NFIP requirements). They perform limited inspections, for example, the floodplain development permit inspections, and issue fines or violations for non-compliance. Only 6 percent of the entities are classified as a low activity since they perform low or no inspections, do not issue any fines or violations, and do not have any other method to ensure compliance with their provisions. Due to the limited documentation, the rest of the entities, 16 percent have an unknown level of enforcement. **Figure 3.2** illustrates these results below:

Figure 3.2 Level of Enforcement of Floodplain Management Practices in the Lower Rio Grande Planning Region



Source: Lower Rio Grande Region Data Collection Tool and Interactive Webmap

Existing Stormwater or Drainage Fees

The Local Government Code Title 13, Subtitle A, Chapter 552, allows the municipal authority to establish or collect fees supporting drainage utility systems. The amount collected by establishing fees for the community could be used to improve systems that benefit the communities. During the survey, using

the Lower Rio Grande Planning Region data collection tool, entities were required to answer a question (if the entity had an existing stormwater utility fee and what its rate was) regarding any existing stormwater or drainage fee.

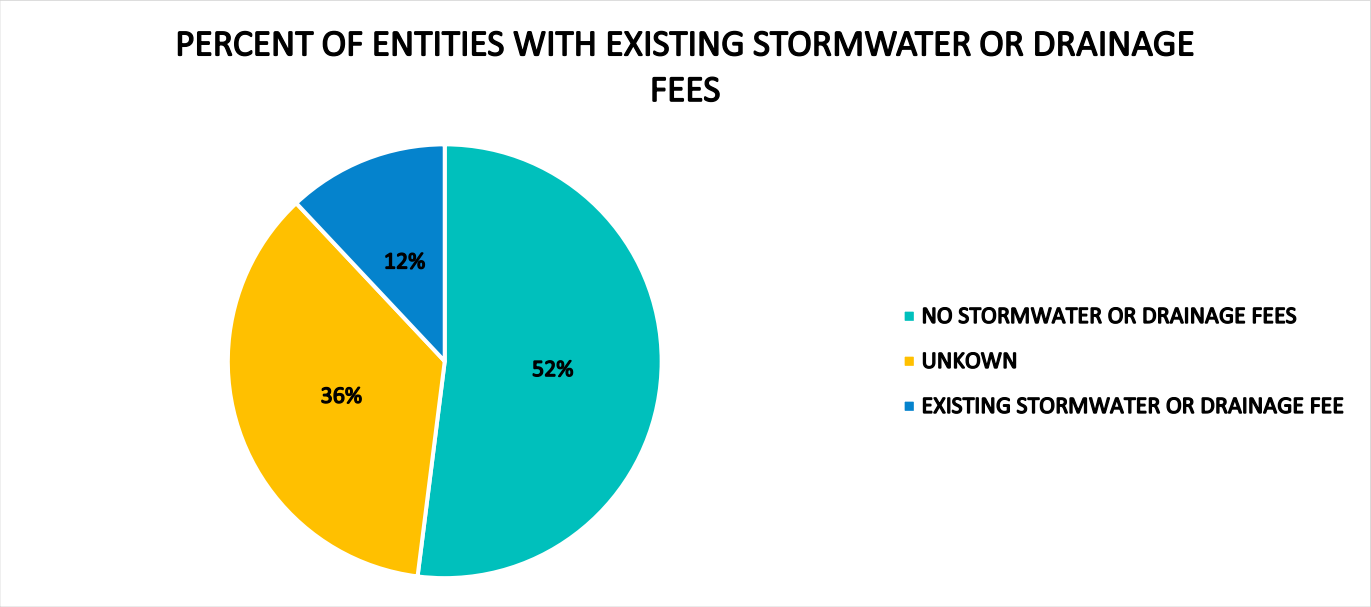
Based on the limited responses, some of the entities' drainage or stormwater rates were based on:

- fixed amount per equivalent residential or commercial unit
- permit application Fees
- fixed amount for increased runoff

The fees mentioned in the survey responses were rates for Equivalent Residential Unit (ERU) at $1.50 per ERU and $3.00 for commercial units. Several entities stated they had drainage or permit fees, in which an entity specified a stormwater inspection fee equivalent to 5 percent of a building permit value. Another entity established a $50 application fee plus a $500 deposit for review. The rest of the entities did not specify their permit fee. Only one of the entities had a fixed rate for increased runoff for a 4-hour storm, in acre-feet multiplied by $7,341.02 per acre-foot.

As part of the effort to gather as much information as possible, the RFPG attempted to contact each stakeholder who did not provide a survey response; most of the stakeholders informed the group that they do not have any stormwater or drainage fees. Based on these results, the responses provided in **Table 3.4** indicated that about 36 percent of the entities have no information that could confirm if they have any fees established; therefore, these entities have "unknown" utility fees, suggesting that there was no communication with the stakeholder, no survey response, or there was no information available to determine if there were existing fees. About 52 percent do not have existing stormwater or drainage fees, and 12 percent have a fixed rate. **Figure 3.3** illustrate these percentages as follows:

Figure 3.3 Percent of Entities with Existing Stormwater or Drainage Fees



Source: Lower Rio Grande Planning Region Data Collection Tool and Interactive Webmap

Table 3.4 Existing Floodplain Management Practices (part of TWDB Table 6)

Entity	Floodplain Management Regulations (Yes/ no/ Unknown)	NFIP Participant? (Yes/No)	Higher Standards Adopted? (Yes/No)	Floodplain Management Practices (Strong/ Moderate/ Low/ None)	Level of Enforcement of Practices (High/ Moderate/ Low/ None)
Brooks	Unknown	Yes			
Cameron	Yes	Yes	Yes	Moderate	High
Dimmit	Unknown	Yes			
Edwards	Yes	No	No	None	None
Hidalgo	Unknown	Yes			
Jim Hogg	No	Yes	No	Low	None
Kenedy	Unknown	Yes			
Kinney	Unknown	Yes			
Maverick	Yes	Yes	No	Low	Moderate
Starr	Unknown	Yes			
Val Verde	Yes	Yes	No	low	
Webb	Yes	Yes	Yes	Moderate	
Willacy	Yes	Yes	No	Low	Moderate
Zapata	Yes	Yes	No	Low	Low
Alamo	Yes	Yes	No	Low	Moderate
Alton	Yes	Yes	Yes	Strong	
Bayview	Yes	Yes	Yes	Moderate	Low
Brackettville	Unknown	Yes			
Brownsville	Yes	Yes	No	Low	
Combes	Unknown	Yes		Moderate	Moderate
Del Rio	Yes	Yes	No	Low	Moderate
Donna	Unknown	Yes			
Eagle Pass	Yes	Yes	Yes	Moderate	Moderate
Edcouch	Unknown	Yes			
Edinburg	Yes	Yes	Yes	Strong	Low

Entity	Floodplain Management Regulations (Yes/ no/ Unknown)	NFIP Participant? (Yes/No)	Higher Standards Adopted? (Yes/No)	Floodplain Management Practices (Strong/ Moderate/ Low/ None)	Level of Enforcement of Practices (High/ Moderate/ Low/ None)
El Cenizo	Unknown	Yes			
Elsa	Yes	Yes		Low	Low
Escobares	Unknown	No			
Granjeno	Unknown	Yes			
Harlingen	Yes	Yes	No	Low	High
Hidalgo	Unknown	Yes			
Indian Lake	Yes	Yes	No	Low	
La Feria	Yes	Yes	No	Low	Low
La Grulla	Unknown	Yes			
La Joya	Unknown	Yes			
La Villa	Unknown	Yes			
Laguna Vista	Yes	Yes	No	Low	Moderate
Laredo	Yes	Yes	Yes	Moderate	
Los Fresnos	Yes	Yes	No	Low	Moderate
Los Indios	Yes	Yes	No	Low	Low
Lyford	Yes	Yes	No	Low	Moderate
McAllen	Yes	Yes	Yes	High	Moderate
Mercedes	Unknown	Yes			
Mission	Yes	Yes	No	Low	
Palm Valley	Yes	Yes	No	Low	
Palmhurst	No	Yes	No	None	
Palmview	Yes	Yes	No	Low	Low
Penitas	Yes	No	No	None	None
Pharr	Yes	Yes	No	Low	Moderate
Port Isabel	Yes	Yes	Yes	Moderate	
Primera	Unknown	Yes	No	Low	Low
Progreso	Unknown	Yes			

Entity	Floodplain Management Regulations (Yes/ no/ Unknown)	NFIP Participant? (Yes/No)	Higher Standards Adopted? (Yes/No)	Floodplain Management Practices (Strong/ Moderate/ Low/ None)	Level of Enforcement of Practices (High/ Moderate/ Low/ None)
Progresso Lakes	Unknown	Yes			
Rancho Viejo	Yes	Yes	No	Low	
Rangerville	Unknown	Yes			
Raymondville	Unknown	Yes			
Rio Bravo	Unknown	Yes			
Rio Grande City	Unknown	Yes			
Rio Hondo	Yes	Yes	Yes	Moderate	Moderate
Roma	Yes	Yes	No	Low	High
San Benito	Yes	Yes	No	Low	
San Juan	Yes	Yes	No	Low	Moderate
San Perlita	Unknown	Yes			
Santa Rosa	Yes	Yes	Yes	Moderate	High
South Padre Island	Yes	Yes	No	Low	High
Spofford	Unknown	No			
Sullivan City	Unknown	Yes			
Weslaco	Yes	Yes	Yes	Low	High
_Bayview Irrigation District No. 11	Unknown	N/A			
Cameron County Drainage District No. 1	Yes	N/A		Low	
Cameron County Drainage District No. 3	Unknown	N/A		Moderate	Moderate

Entity	Floodplain Management Regulations (Yes/ no/ Unknown)	NFIP Participant? (Yes/No)	Higher Standards Adopted? (Yes/No)	Floodplain Management Practices (Strong/ Moderate/ Low/ None)	Level of Enforcement of Practices (High/ Moderate/ Low/ None)
Cameron County Drainage District No. 4	Unknown	N/A			
Cameron County Drainage District No. 5	Unknown	N/A		Low	
Cameron County Drainage District No. 6	Unknown	N/A			
Donna Irrigation District Hidalgo County	Unknown	N/A			
Fort Clark Municipal Utility District (MUD)	Unknown	N/A	no		
Hidalgo County Drainage District No. 1	Unknown	N/A			
La Feria Irrigation District Cameron County No. 3	Unknown	N/A			
Valley Municipal Utility District (MUD) No. 2	Yes	N/A		Moderate	Low

Entity	Floodplain Management Regulations (Yes/ no/ Unknown)	NFIP Participant? (Yes/No)	Higher Standards Adopted? (Yes/No)	Floodplain Management Practices (Strong/ Moderate/ Low/ None)	Level of Enforcement of Practices (High/ Moderate/ Low/ None)
Webb County Drainage District No. 1	Unknown	N/A			
Willacy County Drainage District No. 1	Unknown	N/A			
Willacy County Drainage District No. 2	Unknown	N/A			
Harlingen Irrigation District	No	N/A	No	None	None
Hidalgo and Cameron Counties Irrigation District No. 9	Unknown	N/A			
International Boundary and Water Commission	N/A	N/A			
Starr County Drainage District	Unknown	N/A			

3A.1.b Future Population and Property

Existing floodplain ordinances and building codes with higher standards will work to limit flood risk to future population and property, as long as they are being enforced. Future floodplain maps and models are anticipated to be updated with higher resolution data, the best available data, and advanced modeling techniques in the future. Applying higher standards and using flood hazard data that reflects current and future developed conditions should translate into improved protection of life and property from flood hazards.

Areas without flood maps and models or with outdated maps and models are at a greater danger of increased flood risk in terms of future population and property development within the floodplain.

Entities need comprehensive and updated maps to direct development away from flood-prone areas. Local floodplain regulations with higher standards need to be adopted and enforced to better reduce the flood risk to future population and property.

The Lower Rio Grande Planning Region encourages those cities and counties without floodplain ordinances or court orders to develop, adopt, implement, and enforce floodplain regulations that at least meet the NFIP minimum standard.

Some cities and counties have already developed watershed studies that include existing and future flood conditions. Sometimes the future flood conditions represent a future time period, often 30 years. In other cases, the future flood conditions are based on fully developed land conditions. Entities who currently apply future flood conditions as part of their design criteria essentially apply a factor of safety to better protect today's developments from future flood risks.

3A.2 Future Flood Hazard Exposure

Future flood hazard exposure is assessed in *Chapter 2* of this plan. This section of the report focuses on the potential impact floodplain management and land use practices may have in the future. Cities and counties that have and enforce floodplain regulations reduce the future flood hazard impact. As of September 16, 2021, the Lower Rio Grande RFPG data collection effort revealed 34 entities have these regulations but have a low, no, or unknown activity regarding enforcement. The Lower Rio Grande RFPG supports and encourages entities' abilities to enforce their regulations. The TWDB developed a sample Flood Damage Prevention Ordinance that communities can use as a starting point in developing their own floodplain ordinances. *(TWDB NFIP, 2021)*

Cities and counties implementing future land use plans consider areas of anticipated population growth and development within their communities. However, the existing and future floodplains are not necessarily a component in developing the future land use plan. Land use planning is addressed in *Chapter 1* of this plan in more detail. Incorporating the existing and future floodplains will provide cities and counties with additional direction as to where population and development should be directed to avoid flood risk to people and property.

It is challenging to define future floodplains with complete certainty. However, one should anticipate that the future floodplains will differ from existing floodplains in some areas within the region. Maps and models are regularly updated with new topography, survey, precipitation, runoff, and other data as development occurs in and around floodplains and the watershed. One should anticipate that the BFEs will increase in the future due to several conditions presented in *Chapter 2*. Cities and counties that require future conditions to evaluate and model proposed projects and seek to minimize the allowable increases in water surface elevations will reduce future flood hazards to new and existing developments.

One factor of safety that can be implemented today to reduce future flood hazard exposure is freeboard. As discussed previously, freeboard is the term used for the additional height provided above the BFE. Even if the BFE changes in the future, freeboard can allow the structure to remain above the future flood water surface if higher, as is often the case.

Another higher standard that can be implemented today to limit future flood hazard exposure is maintaining valley storage, also referred to as prohibiting fill without equivalent, compensatory excavation. Maintaining valley storage aids in "no rise" in water surface elevations. Reducing a river or stream's valley storage tends to increase downstream flooding. Currently, a property within the floodplain holds a certain volume of water during a flood event. After the proposed project is completed, the property must still hold the same volume of floodwater. The shape may be different, but the volume remains the same. Maintaining valley storage allows a property owner to move dirt around the property while still containing the volume of floodwaters before the earthwork activity. If the existing soil is not suitable for construction, then the soil can be replaced with appropriate soil. Typically, this is a one-to-one match meaning that an equal amount of dirt is removed for every amount of dirt brought into the floodplain. Some communities, however, may have different requirements on the amount of material removed and replaced.

Detention and retention ponds are often required to mitigate the impacts of impervious surfaces and more efficient drainage infrastructure on a developed property's runoff. The common requirement of the larger municipalities and counties is to manage runoff so that it discharges from the developed property at the existing rate that leaves the property in its natural state. Incorporating this requirement mitigates increased runoff in the future, which can reduce future flood hazard exposure for adjacent properties. However, detention does not mitigate the increases in runoff volume associated with development activity that cumulatively can increase flood risk for properties downstream. This design criteria could be applied in other areas of the Lower Rio Grande Planning Region.

3A.3 Recommendation of Minimum Floodplain Management and Land Use Practices

As part of Task 3A (Evaluation and Recommendations on Floodplain Management Practices) and Task 3B (Flood Mitigation and Floodplain Management Goals), minimum NFIP standards were revisited and presented to the public and to the RFPG members to introduce the fundamental measures or protocols required for entities to improve the flood management needs. It was important to establish the difference between goals and standards. Task 3B presents goals as "set specific timelines and goalposts to implement proven flood mitigation measures, reducing future risk for people and property." Standards are defined as "Establish consistent protocols for floodplain management that can be universally applied."

Examples of goals and standards are presented in **Figure 3.4**.

Figure 3.4 Examples of goals and standards

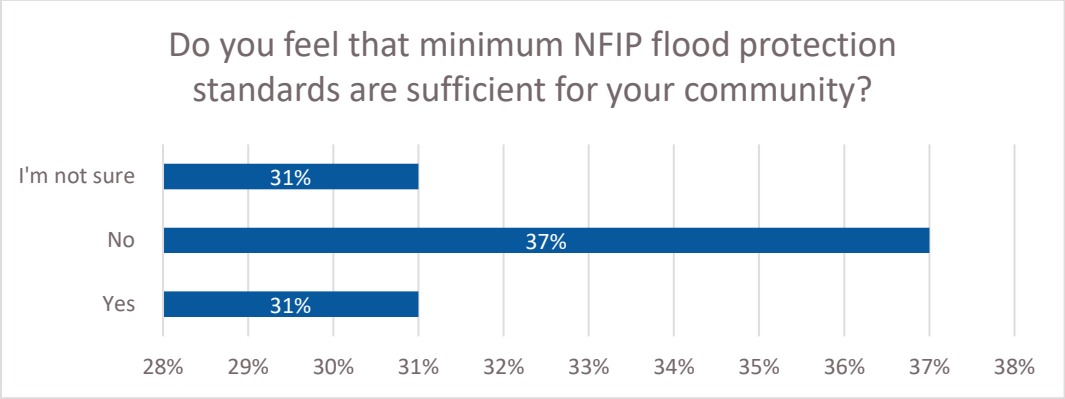
The goal of Task 3 was to evaluate entities with higher than minimum NFIP standards to then encourage those entities to recommend other effective floodplain management standards that would control or further reduce the flood risks experienced in the Region. To achieve this goal, the process began by collecting data to understand the practices across the region, collecting feedback or comments obtained at the RFPG meetings, and defining goals to address the risk to life and property. The best available information and feedback were used to assess the current practices and develop a list of minimum floodplain management or land use standards. The numerical results and visual representation of the data collection are presented below:

Based on the data collection, it was suggested that:

- 93 percent of the counties are participating in the NFIP
- 94 percent of the cities are participating in the NFIP
- 21 percent of the counties have higher than NFIP minimum standards
- 21 percent of the cities have higher than NFIP minimum standards

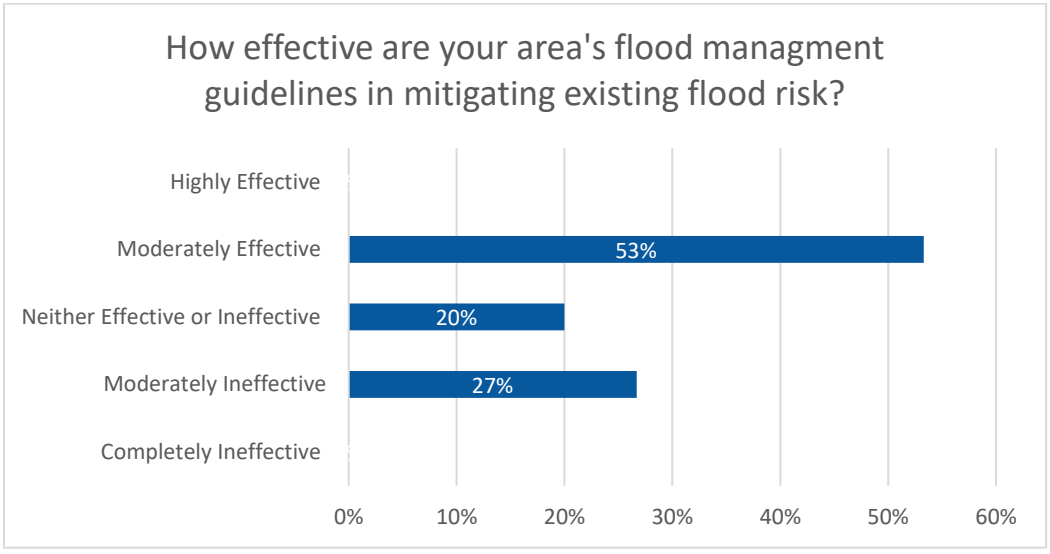
The RFPG members participated in several polling activities that would help perceive their floodplain management practices' effectiveness. When asked whether they felt minimum NFIP flood protection standards were sufficient for their community, most of the RFPG felt that NFIP standards were insufficient for their communities. The result of the polling question is included in **Figure 3.5**.

Figure 3.5 Polling question to RFPG asking whether minimum NFIP standards were sufficient for flood protection of their communities.



When asked about the flood management guidelines' effectiveness in mitigating existing flood risk in their areas, over half of the RFPG respondents expressed that they felt the existing flood management guidelines were moderately effective. No voters indicated that the existing flood management guidelines for their area were highly effective or completely ineffective. The remaining voters were split in their description of the effectiveness of the flood management guideline being moderately ineffective and "neither effective nor ineffective," with slightly more voters indicting the former. The result of the polling question is included in **Figure 3.6**.

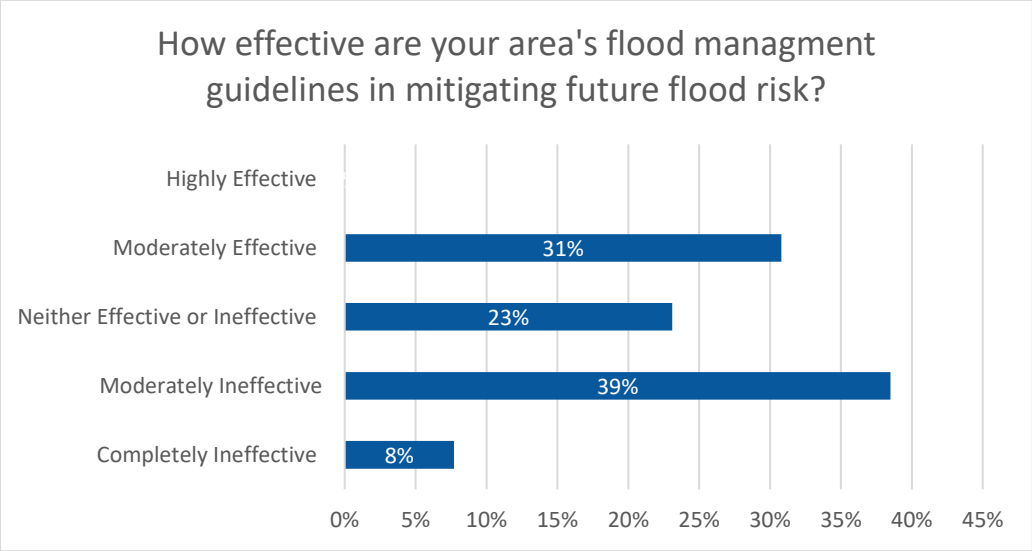
Figure 3.6 Polling question to RFPG asking how effective their area's flood management guidelines are in mitigating existing flood risk



When asked about the effectiveness of the flood management guidelines at mitigating future flood risk in their areas, the RFPG respondents were split. Most respondents (31 percent) expressed that the existing flood management guidelines were moderately ineffective in mitigating future flood risk. No voters indicated that the existing flood management guidelines for their area were highly effective at mitigating future risk, and 8 percent felt that their area's guidelines were ineffective at mitigating future flood risks. The remaining voters were split in their description of the effectiveness of the flood

management guidelines in mitigating future flood risk. Thirty-one percent indicated that their flood management guidelines were moderately effective, while the remaining 23 percent indicated that their guidelines for mitigating future flood risk were neither effective nor ineffective. The results of the polling question are included in **Figure 3.7**.

Figure 3.7 Polling question to RFPG asking how effective their area's flood management guidelines are in mitigating future flood risk



Based on the feedback received, it could be safe to say that entities believe that minimum NFIP flood protection standards are not sufficient for the entities in the Lower Rio Grande Planning Region. Although it may seem that flood management practices for existing flood risks are moderately effective, about 68 percent of the voters believe that management practices for future flood risks are ineffective or neutral. There are diverse factors that indicate that as the population increases, there is a chance that the future flood risk will increase proportionately. The region experiences a lack of planning for future flood risks. It is evident that higher than NFIP standards are needed to be recommended/adopted within the Lower Rio Grande Planning Region or specific Hydrologic Unit Codes (HUC)-8 to address current flood risk, but most importantly, to be planned to prevent future flood risks.

3A.4 Consideration of Adoption of Minimum Floodplain Management and Land Use Standards

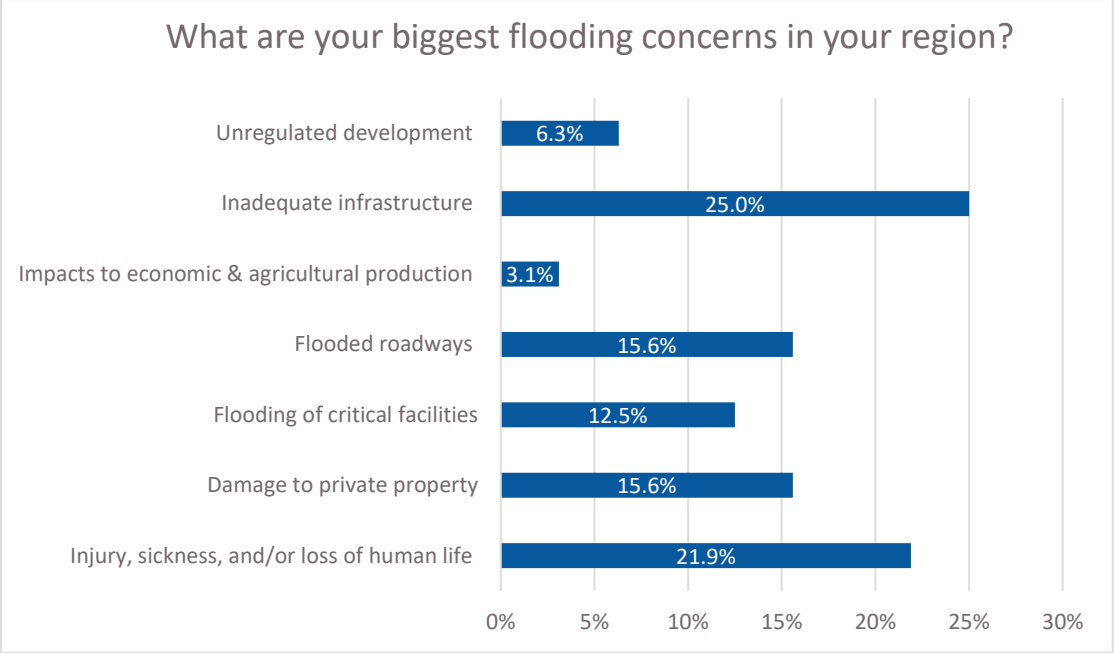
For this section, it is important to note that although the RFPG recommends and/or adopts region-wide floodplain management standards, in no way or form do they have the authority to enact or enforce these floodplain management or land use standards or any other infrastructure design standards. These floodplain management practices, which could include building, zoning, land use, or other special-purpose ordinance such as flood damage prevention ordinances, are up to the local governments, such as cities and counties, to choose to adopt as the power to enforce them lies within their authority alone.

With the aid of Exhibit C: Technical Guidelines for Regional Flood Planning and with the data collection and review process, a set of example floodplain management and infrastructure flood protection

standards were presented to the RFPG members. The TWDB surveyed 27 Texas communities in diverse geographic locations to identify a range of typical minimum and most stringent floodplain management practices.

To further discuss and review the possible recommended standards, the RFPG members were required to provide feedback on the biggest flooding concerns in the region. The voting members were asked to select their three biggest flooding concerns for the region. The RFPG determined that the top five flooding concerns in the region included the following, listed in order of the most votes to the least amount of votes: (1) Inadequate infrastructure, (2) Injury, sickness, and/or loss of human life, (3) Flooded roadways, (4) Damage to private property and (5) Flooding of critical facilities. The polling results are included in **Figure *3.8***.

Figure* 3.8 *Polling question to RFPG asking for the top three biggest flooding concerns in the region



Through the process of presenting example standards, the results of this polling question were considered to present specific standards that would address those top flooding concerns in the region. Guidance from the TWDB, as well as standards enforced in other regions, there were five recommended standards presented to the RFPG via a Google survey document. The standards were also presented at the RFPG public meeting.

Considering the top flooding concerns in the region as indicated by the voting members, they were presented with the following recommended standards:

- **Survey Question:** When considering the following, do you think Lower Rio Grande Planning Region should consider recommending that entities within the region define their base flood elevation (BFE) on the best available hydrologic and hydraulic (H&H) studies, and not necessarily FEMA Firm maps?

- **Survey Question:** To address the concern for inadequate infrastructure and to help mitigate the flood risk in Lower Rio Grande Planning Region, we are suggesting the following standard: **Storm drainage systems shall convey the 25-Year (4 percent annual chance) flood event underground (within a storm sewer/pipe system) and the 100-Year (1 percent annual chance) flood event within the right-of-way.** Do you like this standard as it is proposed?
- **Survey Question:** To address the concern of flooded roadways within the Lower Rio Grande Planning Region, we suggest the following standard: Roadways shall have a 10-Year (10 percent annual chance) flood event water surface elevation below the top of the curb. Do you like this standard as it is proposed?
- **Survey Question:** To address the concern of damage to private property caused by flooding within the Lower Rio Grande Planning Region, we are suggesting the following standard: **New construction and the retrofitting of pre-existing residential/commercial buildings outside of coastal areas shall have a finished floor elevation of 1 foot above the 100-yr Base Flood Elevation (BFE). New construction and retrofitting of pre-existing residential/commercial buildings in coastal areas shall have a finished floor elevation of 1 foot above the highest elevation of either the riverine or coastal BFE, including combined riverine and coastal effects**. Do you like this standard as it is proposed?
- **Survey Question:** To address the concern of possible injury, sickness, and/or loss of human life caused by flooding in the Lower Rio Grande Planning Region, we are suggesting the following mitigation practice (Non-structural): **Where injury, sickness, or loss of life has happened, or where structural flood mitigation alternatives are not practical or are otherwise infeasible, communities should have a Buyout program to buy out properties. The program should assist owners in relocating to areas with reduced flood risk. Do you like this mitigation strategy as it is proposed?**

The purpose of the recommended standards presented to the RFPG was to present an insight into what practices would assist in reducing or preventing the flood risks in the region. During the survey exercise, voting members had the opportunity to agree, reject or modify the standards presented to them. On the other hand, they also had the chance to recommend their own standards that they believed would address the flooding concerns in the region. The feedback received in this survey was then revisited and presented in the RFPG meeting to receive an answer from every voting member to ultimately decide which of these standards would be recommended or adopted, and if so, which standards would apply region-wide or to specific HUC-8s.

3A.5 Consideration of Floodplain Management and Infrastructure Protection Standards

The consultant team presented a set of potential standards for discussion and a decision on whether each should be recommended or adopted as a minimum standard. The standards were discussed among the members, and every member had the opportunity to share their knowledge, engineering judgment, and opinion on why these standards should be adopted or recommended. As mentioned, RFPGs had the

opportunity to make recommendations of practices that regional entities should implement. They may adopt minimum standards that each entity in the region must adopt before the RFPG, including in the Regional Flood Plan any Flood Management Evaluations (FMEs), Flood Management Strategies (FMSs), or Flood Mitigation Projects (FMPs) that are sponsored by or that will be implemented by that entity. The discussion resulted in revising the standards to appropriately word the standards in such a manner that would not restrict entities in any way; instead, that would only endorse the standards to positively impact all entities in the region. The standards were recommended as follows:

- **Recommended, region-wide:** Entities should base their BFEs on FEMA Firm maps in the absence of detailed Hydrologic and Hydraulic (H&H) studies or Base Level Engineering (BLE) studies.
- **Recommended, region-wide:** Where injury, sickness, or loss of life has happened, or where structural flood mitigation alternatives are not practical or are otherwise infeasible, communities should have a Buyout program to buy out properties if funding is available. The program should assist owners in relocating to areas with reduced flood risk.
- **Recommended, region-wide:** Storm drainage systems should convey the 4 percent annual chance (25-Year) flood event underground (within a storm sewer/pipe system) and the 1 percent annual chance (100-Year) flood event within the right-of-way.
- **Recommended, region-wide:** New and significantly altered roadways with curb and gutter should have a 10 percent annual chance (10-year) flood event water surface elevation below the top of the curb and a 25-year design for culverts.
- **Recommended, region-wide:** New construction shall (and the retrofitting or pre-existing residential/ commercial buildings outside of coastal areas should) have a finished floor elevation of 1-foot above the 1 percent annual chance event BFE. New Construction shall (and retrofit pre-existing residential/commercial buildings in coastal areas) should have a finished floor elevation of 1-foot above the highest elevation of either the riverine or coastal BFE, including combined riverine and coastal effects.

To reiterate, the RFPGs may choose only to recommend and or adopt region-wide floodplain management standards, but in no way or form do they have the authority to enact or enforce floodplain management or land use standards or any other infrastructure design standards. At the July 21, 2022 regular meeting for the RFPG, the RFPG affirmed that not standard was approved for adoption. All proposed flood management standards are recommended. The standards mentioned above are subject to change, these may be modified or removed until a certain decision is made among RFPG members and or until other representatives or officials agree to these.

3B Flood Mitigation and Floodplain Management Goals

A critical component of the development of the Regional Flood Plan is the identification and definition of flood mitigation and floodplain management goals for the region. These goals will guide the plan's overall approach and recommendations and ensure the entire plan's coherence. As such, the Lower Rio Grande RFPG spent significant time and resources exploring values and measurable goals the region should aspire to reach.

As set out in the Guidance Principles in 31 TAC §362.3, the overarching intent of the region's goals must be "to protect against the loss of life and property." This is further defined to:

- identify and reduce the risk and impact to life and property that already exists
- avoid increasing or creating new flood risks by addressing future development within the areas known to have existing or future flood risk

The goals, when implemented, must demonstrate progress towards the fundamental goal set forth by the state. This section summarizes the results of the Lower Rio Grande RFPG's efforts and the initial flood mitigation and floodplain management goals for the Lower Rio Grande Planning Region.

3B.1 Flood Mitigation and Floodplain Management Goals

Six overarching goals categories have been developed to guide the subsequent development of the FMSs, FMEs, and FMPs for the Lower Rio Grande Planning Region. They build upon TWDB regional flood planning guidance and provide a comprehensive organizational structure for future strategy development to adequately preserve life and property while not negatively affecting neighboring areas. The overarching categories were selected to create a one-to-one connection with the FMS types as outlined in the Data Submittal Guidelines for Regional Flood Planning while still meeting already established objectives as defined by municipal entities within the Lower Rio Grande Planning Region. The proposed six overarching goal categories, as reviewed and approved at the November 17, 2021, Regional Flood Planning Group meeting, include:

1. Flood Infrastructure Projects
2. Flood Warning and Readiness
3. Flood Studies and Analysis
4. Guidance
5. Property Acquisition, Structure Elevation, and Floodproofing
6. Education and Outreach

The six overarching goal categories are detailed below and include specific goal statements that are achievable, measurable, and time specific. Per the TWDB requirements and guidelines, the goals selected by the Lower RFPG must be specific and achievable and include the information listed below:

- description of the goal
- term of the goal is set at 10 years (short-term) and 30 years (long-term)
- extent or geographic area to which the goal applies
- residual risk that remains after the goal is met

- measurement method that will be used to quantify goal attainment
- association with the overarching goal categories

The seven categories are further discussed in detail later in this chapter.

Category 1. Flood Infrastructure Projects

Reduce flood risk and mitigate flood hazards to life and property by implementing structural flood infrastructure projects. **Table 3.5** includes four detailed goal statements to accomplish this goal category that aligns with the TWDB's fundamental goal of protecting against the loss of life and property by reducing flood risk.

Table 3.5 Goal Category 1. Flood Infrastructure Projects

Specific Goal Statements	Short Term (2033)	Long Term (2053)	Measurement
Increase the number of nature-based flood risk reduction projects	20% - 30%	>50%	percent of nature-based flood risk reduction projects relative to projects that are not nature-based
Reduce the number of newly constructed vulnerable critical facilities within the existing and future 1% annual chance floodplain event	> 70%	100%	percent of critical facilities in the region within the existing or future 1% annual chance floodplain
Increase community access routes to critical facilities and evacuation routes during and after a flooding event	Perform Study to Establish Baseline	2 x the baseline percent	percent of residential areas with safe access routes during and after flooding events
Increase the number of entities that provide regional detention that could be used for water reuse applications or as part of their floodplain management program	> 30%	>60%	percent of entities that provide regional detention as part of their floodplain management program

Category 2. Flood Warning and Readiness

Improve the dissemination of information regarding early flood recognition and danger, emergency response procedures, and post-flood recovery actions. **Table 3.6** includes four detailed goal statements to accomplish goal category 2 – Flood Warning and Readiness, which also align with the TWDB's

fundamental goal of protecting against the loss of life by keeping the public informed, prepared, and aware of flood risk.

Table 3.6 Goal Category 2. Flood Warning and Readiness

Specific Goal Statements	Short Term (2033)	Long Term (2053)	Measurement
Develop a regionally coordinated warning and emergency response program that can detect the flood threat and provide timely warning of impending flood danger to the most populated areas of the region.	40% - 50%	> 70%	percent of the Lower Rio Grande Planning Region population covered by a warning and emergency response program
Increase the number of flood gauges (rainfall/stream) in the region	30% - 40%	> 70%	percent of watershed and streams with active gauges
Increase the number of entities that use reverse 911, TV, radio, social media, and billboards to communicate flood warnings, evacuation routes, and shelter locations	> 40%	> 70%	percent of entities using real-time media services and/or reverse 911 to warn of flood risks, evacuation routes, and shelter locations
Increase the number of entities that integrate National Weather Service and USGS Texas Water Science Center (TXWSC) flood warning system information into their local capabilities to disseminate warnings	> 30%	> 50%	percent of entities integrating NWS and TXWSC flood warning system information into their own systems

Category 3. Flood Studies and Analysis

Increase the number and Extent of regional flood planning evaluations/studies and analyses to identify flood risk and better prepare entities for implementing flood mitigation projects. **Table 3.7** provides details on the three specific goal statements that support this goal category of flood studies and analysis, as well as the TWDB's fundamental goal of protecting against the loss of life and property by utilizing the best available data when performing flood analyses.

Table 3.7 Goal Category 3. Flood Studies and Analysis

Specific Goal Statements	Short Term (2033)	Long Term (2053)	Measurement
Decrease the average age of FEMA Flood Insurance Rate Maps used to define SFHAs in the region	30% - 40%	> 70%	percent of entities that have FIRM maps that are less than 20 years old
Increase the coverage of available flood hazard data in the region, including at ports of entry, airports, and seaports, by completing studies with identified construction projects to address flooding hazards in areas identified as having gaps in flood mapping data	30% - 40%	> 70%	percent of entities that have completed studies (less than 10 years old) identifying flood hazards as described
Develop and maintain an operational stormwater asset management plan	40% - 50%	> 70%	percent of entities that utilize a stormwater asset management plan

Category 4. Guidance

Increase the number and extent of protective regulatory measures and programs to limit future risk and reduce flood damage in the flood planning region. **Table 3.8** provides information on four-goal statements that directly supports the TWDB's fundamental goal of protecting against the loss of life and property by reducing current and future flood risk in low-lying areas.

Table 3.8 Goal Category 4. Guidance

Specific Goal Statements	Short Term (2033)	Long Term (2053)	Measurement
Increase the number of the Lower Rio Grande Planning Region communities participating in the NFIP	100%	Maintain	percent of entities in the Lower Rio Grande Planning Region enrolled in NFIP
Increase the number of entities that adopt higher than NFIP-minimum standards	40% - 50%	60% - 70%	percent of entities that adopt higher than NFIP minimum standards
Increase participation in the Community Rating System by encouraging the Lower Rio Grande Planning Region floodplain management programs to incorporate dedicated drainage fees to implement future FMEs and FMPs; incorporate non-compliance penalties; and who regulate development in the future conditions floodplain	30% - 40%	> 50%	percent of entities in the Lower Rio Grande Planning Region actively participating in the Community Rating System
Increase the number of entities that have multi-year drainage CIP list	> 40%	> 70%	percent of entities in the Lower Rio Grande Planning Region with 20-year drainage CIPs

Category 5. Property Acquisition, Structure Elevation, and Floodproofing

Reduce the amount of existing and future vulnerable properties within the Lower Rio Grande Planning Region through property/easement acquisition, improved elevation, and other floodproofing programs and initiatives. **Table 3.9** includes three specific goal statements that aim to protect property and people and align with the TWDB's fundamental goal of protecting against the loss of life and property by reducing current flood risk and providing more awareness to the public.

Table 3.9 Goal Category 5. Property Acquisition, Structure Elevation, and Floodproofing

Specific Goal Statements	Short Term (2033)	Long Term (2053)	Measurement
Reduce the number of structures that have been subject to repeated flooding events through property buyouts	< $10M	$20M - $50M	Estimated $ value of benefits incurred through property buyout programs annually
Increase the acreage of publicly protected open space in critical flood risk areas that are reused for a beneficial public use	< 300,000 acres	600,000 – 800,000 acres	Number of acres of publicly protected open space in critical flood risk areas that are reused for a beneficial public use
Increase the amount of publicly owned land in the region that can be utilized for future regional stormwater infrastructure	> 30%	> 50%	percent increase in county-owned land in the region

Category 6. Education and Outreach

Increase the amount of flood education and outreach opportunities to improve awareness of flood hazards and future participation throughout the Lower Rio Grande Planning Region. The goal category aligns with the TWDB's fundamental goal of reducing loss of life and property by helping people understand and avoid flood risk. **Table 3.10** includes three specific goal statements to meet the goal category.

Table 3.10 Goal Category 6. Education and Outreach

Specific Goal Statements	Short Term (2033)	Long Term (2053)	Measurement
Increase the number of outreach and education activities, specifically targeting municipal floodplain managers throughout Region 15, hosted by Region 15 RFPG and available on the website.	20% - 30%	>60%	percent increase in the number of outreach activities
Increase the number of entities and public stakeholders participating in the regional flood planning process	30% - 40%	>70%	percent of entities and stakeholders annually performing outreach activities.
Increase the proficiency of floodplain managers by increasing the number of them certified as Certified Floodplain Managers (CFM) with the Texas Floodplain Management Association.	>25%	>70%	percent of the regions floodplain managers who have CFM certifications

3B.2 Residual Risk after Goals are Met

The goal statements were developed in a manner to set the stage for specific actions that can be quantified and measured in future regional flood planning cycles. Implementation efforts will also demonstrate progress towards the overall purpose and intent of the regional flood planning process. They will result in various benefits to individuals, communities, and the region as a whole. In selecting the region's flood risk reduction and protection goals, however, the RFPG is also determining the flood planning region's accepted 'residual' flood risk. According to the TWDB's Technical Guidelines for Regional Flood Planning, "any flood risk not avoided or reduced through meeting a goal will remain a residual risk."

The residual risk should be minimal if the goals are fully achieved. However, residual risks should be anticipated for each overarching goal category. Overall, the goal categories fall into one or more of the following residual risks:

- storm events exceeding the design capacity of the infrastructure

- implementation limitations (environmental, jurisdictional, funding, and scheduling)
- human behavior
- funding limitations for maintenance
- policy and regulation changes

In broad terms, the residual risks can be summarized as follows for each of the goal categories:

Goal Category 1 – Flood Infrastructure Projects: Flood infrastructure improvements can only be expected to perform based on the design capacity. In other words, if any storm that exceeds the design capacity were to occur, the infrastructure would still be at risk. Due to cost constraints, most community stormwater collection systems are not designed to collect the 1 percent ACE. Even if the system were designed for that storm, a larger storm would still overwhelm the system. Likewise, storm intensities can overwhelm stormwater collection systems resulting in flooded roadways, bridges, culverts, and other damages. Also, routine maintenance of infrastructure is required to maintain the design capacity. Maintenance is sometimes overlooked due to budget, staff, and time constraints.

Goal Category 2 – Flood warning and Readiness: Flood warnings and public safety residual risk depend on public response to flood warnings. Drivers may choose to ignore flood warning signs or barricaded roads for a variety of reasons. Despite an entity's best effort, risk will remain at LWCs.

Goal Category 3 – Flood Studies and Analysis: Reducing residual risk associated with improving flood analyses involves technology that is always changing and improving. Due to the change and updates to terrain, land use, precipitation, and other data, the risk associated with the floodplains may change over time. While a new development may be constructed outside the 1 percent ACE floodplain, future improvements in technology and other data may change the floodplain boundary resulting in some structures being located within the floodplain.

Goal Category 4 - Guidance: Floodplain preservation allows floodplains to serve their natural and intended purpose of mitigating floods. The residual risk depends on people stepping back and allowing space for flooding to remain in natural areas.

Goal Category 5 – Property Acquisition, Structure Elevation, and Floodproofing: Reducing the residual risk of property damage and loss depends on the local community's floodplain management policies and political leaders. Getting every community within the Lower Rio Grande Planning Region to adopt and enforce NFIP minimum standards, let alone higher standards, may prove to be challenging. The lack of local enforcement of floodplain regulations also creates risk.

Goal Category 6 – Education and Outreach: Flood education and outreach primarily benefit when implemented. The primary risks associated with public education and outreach are misunderstandings and lack of attention. Misunderstandings happen when the public becomes confused about the message, possibly due to its length or complexity.

The residual risks anticipated for this region after all the goals are met are listed in **Table 3.11** below.

Table 3.11 Regional Flood Plan Flood Mitigation and Floodplain Management Goals (part of TWDB Table 11)

Goal ID	Goal	Target Year	Applicable to	Residual Risk
15000001	Increase the number of nature-based flood risk reduction projects by 20% - 30%	2023	entire RFPG	Existing flood risk remains after the implementation of nature-based projects unless the project specifically addresses existing flood risk.
15000002	Increase the number of nature-based flood risk reduction projects by greater than 50%	2053	entire RFPG	Existing flood risk remains after the implementation of nature-based projects unless the project specifically addresses existing flood risk.
15000003	Reduce the number of newly constructed vulnerable critical facilities within the existing and future 1% annual chance floodplain event by over 70%	2023	entire RFPG	Existing flood risk remains for existing critical facilities and 30% of future critical facilities.
15000004	Reduce the number of newly constructed vulnerable critical facilities within the existing and future 1% annual chance floodplain events by 100%	2053	entire RFPG	Existing flood risk remains for existing critical facilities.
15000005	Increase community access routes to critical facilities, and evacuation routes, during and after a flooding event by performing a study to establish a baseline	2023	entire RFPG	Existing flood risk is unaffected by the study to determine a baseline.
15000006	Increase community access routes to critical facilities, and evacuation routes, during and after a flooding event by two times the baseline %	2053	entire RFPG	Existing flood risk will remain for residential areas that do not have a project to mitigate flooding that impedes access routes.
15000007	Increase the number of entities that provide regional detention that could be used for water reuse applications or as part of their floodplain	2023	entire RFPG	Existing flood risk will remain for project areas where the proposed regional detention facility does not address existing flood risk.

Goal ID	Goal	Target Year	Applicable to	Residual Risk
	management program by over 30%			
15000008	Increase the number of entities that provide regional detention that could be used for water reuse applications or as part of their floodplain management program by over 60%	2053	entire RFPG	Existing flood risk will remain for project areas where the proposed regional detention facility does not address existing flood risk.
15000009	Develop a regionally coordinated warning and emergency response program that can detect the flood threat and provide timely warning of impending flood danger to 40% to 50% of the most populated areas of the region.	2023	entire RFPG	Risk of inundation will remain unaltered; however, the risk of loss of life is expected to be reduced for half of the most populated areas due to an advanced warning and emergency response program.
15000010	Develop a regionally coordinated warning and emergency response program that can detect the flood threat and provide timely warning of impending flood danger to over 70% of the most populated areas of the region.	2053	entire RFPG	Risk of inundation will remain unaltered; however, the risk of loss of life is expected to be reduced for 70% of the most populated areas due to an advanced warning and emergency response program.
15000011	Increase the number of flood gauges (rainfall/stream) in the region by 30% to 40%.	2023	entire RFPG	Flood risk will remain unaltered by the placement of the gauges. It intends to use data from gauges to implement flood mitigation projects, validate models and advance warning programs.
15000012	Increase the number of flood gauges (rainfall/stream) in the region by over 70%.	2053	entire RFPG	Flood risk will remain unaltered by the placement of the gauges. It intends to use data from gauges to implement flood mitigation projects, validate models and advance warning programs.
15000013	Increase the number of entities that use reverse 911, TV, radio, social media, and billboards to communicate flood warnings, evacuation	2023	entire RFPG	Risk of inundation will remain unaltered; however, the risk of loss of life is expected to be reduced in 40% of the entities due to these measures.

Goal ID	Goal	Target Year	Applicable to	Residual Risk
	routes, and shelter locations to over 40%			
15000014	Increase the number of entities that use reverse 911, TV, radio, social media, and billboards to communicate flood warnings, evacuation routes, and shelter locations to over 70%	2053	entire RFPG	Risk of inundation will remain unaltered; however, the risk of loss of life is expected to be reduced in 70% of the entities due to these measures.
15000015	Increase the number of entities that integrate National Weather Service and USGS Texas Water Science Center (TXWSC) flood warning system information into their local capabilities to disseminate warnings by over 30%	2023	entire RFPG	Risk of inundation will remain unaltered, however, the risk of loss of life is expected to be reduced in 30% of the entities due to these measures.
15000016	Increase the number of entities that integrate National Weather Service and USGS Texas Water Science Center (TXWSC) flood warning system information into their local capabilities to disseminate warnings by over 50%	2053	entire RFPG	Risk of inundation will remain unaltered, however, the risk of loss of life is expected to be reduced in 50% of the entities due to these measures.
15000017	Decrease the average age of FEMA Flood Insurance Rate Maps used to define SFHAs in the region by 30% to 40%	2023	entire RFPG	Flood risk will remain, however, the population of the entities with the updated FIRM maps will have access to maps that better represent their flood risk and for use when making decisions.
15000018	Decrease the average age of FEMA Flood Insurance Rate Maps used to define SFHAs in the region by over 70%	2053	entire RFPG	Flood risk will remain, however, the population of the entities with the updated FIRM maps will have access to maps that better represent their flood risk for use when making decisions.
15000019	Increase the coverage of available flood hazard data in the region, including at ports of entry, airports, and seaports, by completing studies with identified	2023	entire RFPG	Flood risk will remain, however, the population of the entities with the updated floodplain mapping will have access to maps that represent their flood risk and for use when making decisions.

Goal ID	Goal	Target Year	Applicable to	Residual Risk
	construction projects to address flooding hazards, in areas identified as having gaps in flood mapping data by 30% to 40%			
15000020	Increase the coverage of available flood hazard data in the region, including at ports of entry, airports, and seaports, by completing studies with identified construction projects to address flooding hazards, in areas identified as having gaps in flood mapping data by over 70%	2053	entire RFPG	Flood risk will remain, however, the population of the entities with the updated floodplain mapping will have access to maps that represent their flood risk and for use when making decisions.
15000021	Have 40% to 50% of entities develop and maintain an operational stormwater asset management plan	2023	entire RFPG	Flood risk will remain at existing conditions levels unless strategic efforts identified in the plan are implemented to mitigate additional flood risk.
15000022	Have over 70% of entities develop and maintain an operational stormwater asset management plan	2053	entire RFPG	Flood risk will remain at existing conditions levels unless strategic efforts identified in the plan are implemented to mitigate additional flood risk.
15000023	Increase the number of Region 15 communities participating in the National Flood Insurance Program to 100%	2023	entire RFPG	Existing flood risk will remain.
15000024	Maintain the number of Region 15 communities participating in the National Flood Insurance Program at 100%	2053	entire RFPG	Existing flood risk will remain.
15000025	Increase the number of entities that adopt higher than NFIP-minimum standards by 40% to 50%	2023	entire RFPG	Existing flood risk will remain through region and future flood risk will be mitigated to a greater degree in half the region's entities
15000026	Increase the number of entities that adopt higher than NFIP-	2053	entire RFPG	Existing flood risk will remain through region and future flood risk will be

Goal ID	Goal	Target Year	Applicable to	Residual Risk
	minimum standards by 60% to 70%			mitigated to a greater degree in half the region's entities
15000027	Increase participation in the Community Rating System by encouraging Region 15 floodplain management programs to incorporate dedicated drainage fees to implement future FMEs and FMPs; incorporate non-compliance penalties; and who regulate development in the future conditions floodplain by 30% to 40%	2023	entire RFPG	Existing flood risk will remain in region and future flood risk will be mitigated to a greater degree in 40% of region's entities.
15000028	Increase participation in the Community Rating System by encouraging Region 15 floodplain management programs to incorporate dedicated drainage fees to implement future FMEs and FMPs; incorporate non-compliance penalties; and who regulate development in the future conditions floodplain by over 50% of entities	2053	entire RFPG	Existing flood risk will remain in region and future flood risk will be mitigated to a greater degree in over 50% of region's entities.
15000029	Increase the number of entities that have multi-year drainage CIP list by over 40%	2023	entire RFPG	Existing flood risk will remain in region until identified project in CIP are constructed that address existing flood risk.
15000030	Increase the number of entities that have multi-year drainage CIP list by over 70%	2053	entire RFPG	Existing flood risk will remain in region until identified projects in CIP are constructed that address existing flood risk.
15000031	Reduce the number of structures that have been subject to repeated flooding events through property	2023	entire RFPG	Existing flood risk will remain for those structures subject to repeated flooding that were not purchased.

Goal ID	Goal	Target Year	Applicable to	Residual Risk
	buyouts by over $10 million			
15000032	Reduce the number of structures that have been subject to repeated flooding events through property buyouts by $20 million to $50 million	2053	entire RFPG	Existing flood risk will remain for those structures subject to repeated flooding that were not purchased.
15000033	Increase the acreage of publicly protected open space in critical flood risk areas that is reused for a beneficial public use by over 300,000 acres	2023	entire RFPG	Existing flood risk will remain unchanged unless a project is constructed in these protected open spaces to mitigate existing flood risk.
15000034	Increase the acreage of publicly protected open space in critical flood risk areas that is reused for a beneficial public use by 600,000 to 800,000 acres	2053	entire RFPG	Existing flood risk will remain unchanged unless a project is constructed in these protected open spaces to mitigate existing flood risk.
15000035	Increase the amount of publicly owned land in the region that can be utilized for future regional stormwater infrastructure by over 30%	2023	entire RFPG	Existing and future flood risk will remain unchanged unless a project is constructed in these publicly owned spaces to mitigate future flood risk in that location.
15000036	Increase the amount of publicly owned land in the region that can be utilized for future regional stormwater infrastructure by over 50%	2053	entire RFPG	Existing and future flood risk will remain unchanged unless a project is constructed in these publicly owned spaces to mitigate future flood risk in that location.
15000037	Increase the number of outreach and education activities, specifically targeting municipal floodplain managers throughout Region 15, hosted by Region 15 RFPG and available on the website by 20% to 30%.	2023	entire RFPG	Existing and future flood risk will remain unchanged unless a municipal floodplain manager leverages the information and partnerships, they gained from the program to implement mitigation efforts.

Goal ID	Goal	Target Year	Applicable to	Residual Risk
15000038	Increase the number of outreach and education activities, specifically targeting municipal floodplain managers throughout Region 15, hosted by Region 15 RFPG and available on the website by over 60%.	2053	entire RFPG	Existing and future flood risk will remain unchanged unless a municipal floodplain manager leverages the information and partnerships they gained from the program to implement mitigation efforts.
15000039	Increase the number of entities and public stakeholders participating in the regional flood planning process by 30% to 40%	2023	entire RFPG	Existing and future flood risk will remain unchanged until entities implement mitigation efforts outlined in the Regional Flood Plan.
15000040	Increase the number of entities and public stakeholders participating in the regional flood planning process by over 70%	2053	entire RFPG	Existing and future flood risk will remain unchanged until entities implement mitigation efforts outlined in the Regional Flood Plan.
15000041	Increase the proficiency of floodplain managers by increasing the number of them that are certified as Certified Floodplain Managers (CFM) with the Texas Floodplain Management Association by over 25%.	2023	entire RFPG	Existing and future flood risk will remain unchanged unless a floodplain manager leverages the information and partnerships they gained from the program to implement mitigation efforts.
15000042	Increase the proficiency of floodplain managers by increasing the number of them that are certified as Certified Floodplain Managers (CFM) with the Texas Floodplain Management Association by over 70%.	2053	entire RFPG	Existing and future flood risk will remain unchanged unless a floodplain manager leverages the information and partnerships they gained from the program to implement mitigation efforts.

Chapter 4

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Chapter 4: Assessment and Identification of Flood Mitigation Needs

Utilizing the flood risk analysis and flood planning goals adopted by the Regional Flood Planning Group (RFPG), this chapter outlines the process used to identify areas within the Lower Rio Grande Planning Region with the greatest risk of flooding and the need for flood management and mitigation activities. The assessment conducted in this task provides a high-level evaluation to help guide the identification of Flood Management Evaluations (FMEs), Flood Mitigation Projects (FMPs), and Flood Management Strategies (FMSs) in Chapter 5.

4A Flood Mitigation Needs Analysis

This chapter describes the process adopted by the Region 15 Lower Rio Grande Regional Flood Planning Group (Lower Rio Grande RFPG) to conduct a Flood Mitigation Needs Analysis (Task 4A) to identify the areas of greatest known flood risk and areas where the greatest flood risk knowledge gaps exist. The Task 4A process is a high level assessment that helps guide the subsequent Task 4B effort of identifying Flood Management Evaluations (FMEs), Flood Mitigation Projects (FMPs), and Flood Management Strategies (FMSs). **Table 4.1** summarizes the Texas Water Development Board (TWDB) guidance and factors considered in the Flood Mitigation Needs Analysis.

Table 4.1 TWDB Guidance and Factors to Consider

Guidance	Factors to Consider
1. Most prone to flooding that threatens life and property	• Buildings and critical facilities within 100-year floodplain • Low water crossings (LWCs) • Agricultural and ranching areas in 100-year floodplain
2. Locations, extent, and performance of current floodplain management and land use policies and infrastructure	• Communities not participating in National Flood Insurance Program (NFIP) • Disadvantaged/underserved communities • City/county design manuals • Land use policies • Floodplain ordinance(s)
3. Inadequate inundation mapping	• No mapping • Presence of Fathom/base level engineering (BLE)/Federal Emergency Management Agency (FEMA) Zone A flood risk data • Detailed FEMA models older than 10 years
4. Lack of hydrologic and hydraulic (H&H) models	• Communities with zero or limited models
5. Emergency need	• Damaged or failing infrastructure • Other emergency conditions

6. Existing modeling analyses and flood risk mitigation plans	• Exclude FMPs already in implementation • Leverage existing models, analyses, and flood risk mitigation plans
7. Previously identified and evaluated flood mitigation projects	• Exclude FMPs already in implementation • Leverage existing FMPs
8. Historic flooding events	• Disaster declarations • Flood insurance claim information • Areas with a history of flooding according to survey responses • Other significant local events
9. Previously implemented FMPs	• Exclude areas where FMPs have already been implemented unless significant residual risk remains
10. Additional other factors deemed relevant by the Lower Rio Grande RFPG	• Alignment with Lower Rio Grande RFPG goals • Alignment with TWDB guidance principles • Social Vulnerability Index (SVI)

Table 4.1 lists the TWDB's guidance and asks the RFPGs to consider when analyzing the region's greatest flood risk knowledge gaps, areas of known flood risk, and flood mitigation needs. The list includes (1) Most prone to flooding that threatens life and property; (2) Most prone to flooding that threatens life and property; (3) Inadequate inundation mapping; (4) Lack of hydrologic and hydraulic (H&H) models; (5) Emergency need; (6) Existing modeling analyses and flood risk mitigation plans; (7) Previously identified and evaluated flood mitigation projects; (8) Historic flooding events; (9) Previously implemented FMPs; and (10) Other factors deemed relevant by Lower Rio Grande RFPG.

4A.1 Process and Scoring Criteria

Task 4A analysis is based on a geospatial process that combines information from multiple datasets representing several factors listed in **Table 4.2** below and provides a basis for achieving the Task 4A objectives. The geospatial process was developed in a geographic information system (GIS) based on the data collected in Tasks 1 through 3. Various data sources were used in this assessment, including GIS data collected directly from stakeholders during outreach efforts. During the data collection phase, stakeholders participated in an online survey where they could respond geographically on a map.

A Hydrologic Unit Code (HUC) is a unique code assigned to watersheds in the United States. As the watersheds get smaller, the number of units used to identify them gets longer. Therefore, the smallest division unit used to identify a watershed is 12 digits or a HUC-12. The geospatial assessment was prepared at a HUC-12 watershed level of detail, which is consistent with the minimum watershed size for Task 4B specified in the Technical Guidelines (at least one square mile). The Lower Rio Grande Planning Region has a total of 257 HUC-12 watersheds, with an average size of 68 square miles.

A total of 13 data categories (see **Table 4.2**) were used in the geospatial assessment. A scoring range was determined for each data category based on the statistical distribution of the data. The scoring ranges vary for each category based on the HUC-12s with the smallest and largest quantity. A uniform scoring

scale of zero to five was adopted, and each HUC-12 was assigned an appropriate score for each category. The scores for each HUC-12 under each category were then added to obtain a total score used to reveal the areas of greatest known flood risk. The Areas Without Adequate Inundation Mapping category (see *Section 4A.1.c*) was selected to determine the areas where the greatest flood risk knowledge gaps exist.

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

4A.1.a Areas Most Prone to Flooding that Threatens Life and Property

Buildings in the 100-year Floodplain

The TWDB provided the building footprints dataset on the Data Hub. This dataset was divided into point values based on the total number of buildings in the 100-year floodplain within each HUC-12. The count ranged widely throughout the region, with rural HUC-12s only having one to two buildings in the floodplain, while major urban centers may have over 1,000 buildings in the floodplain.

Low Water Crossings (LWC)

Low Water Crossings were identified in Tasks 1 (*Chapter 1*) and 2 (*Chapter 2*) and were downloaded from the TWDB Data Hub. Communities also provided LWC data through the data collection portal developed for the Lower Rio Grande Planning Region. Task 2 also identified a few more based on bridge deck elevation from Light Detection and Ranging (lidar) data and flood depths. This category is scored based on the quantity of LWCs occurring in a HUC-12.

Agricultural Areas at Risk of Flooding

Agricultural areas have been defined for this task as land used for either farming or ranching. Impacted agricultural areas intersect the 100-year floodplain as determined in the flood exposure analysis (See *Chapter 2*). This layer will emphasize rural HUC-12s where agricultural impacts due to flooding are most prominent. The total impacted agricultural area in each HUC-12 was the criteria for assigning points.

Existing Critical Facilities

Critical facilities for this assessment include hospitals, schools (K-12th grade), fire stations, police stations, emergency shelters, nursing homes, water and wastewater treatment facilities, Superfund sites, and electric and gas lines. Critical facilities within the 100-year floodplain were identified as part of the flood exposure analysis (See *Chapter 2*). The stakeholders were able to update the existing critical facilities by adding or removing facilities in the web GIS survey from Task 2. This category is scored based on the total number of critical facilities identified within the 100-year floodplain.

Inundated Roadway Segments

As described in *Chapter 2: Flood Risk Analysis,* inundated roadway segments were identified by clipping the Texas Department of Transportation (TxDOT) geospatial linework with the existing condition of 1

percent annual chance (100-year) floodplain. Using this dataset, each HUC-12 was populated with the miles of inundated roadway segments located within each HUC-12 boundary. The inundated roadway mileage ranged widely across the region, with most HUC-12s having less than five miles of roadway in the floodplain, while coastal HUC-12s may have over 30 miles of inundated roadway segments.

Table 4.2 Task 4A Scoring Ranges for Data Categories to Rank Areas Most Prone to Flooding that Threatens Life and Property

Score (points)	0	1	2	3	4	5
Number of Buildings	0	1-50	51-250	251-500	501-750	751+
Number of LWCs	0	1-5	6-10	11-15	16-20	21+
Total Agricultural Area (sq. mi.)	0	0.01-0.35	0.36-2	2.01-3	3.01-5.5	5.51+
Number of Critical Facilities	0	1-5	5-10	11-25	26-50	51+
Miles of Inundated Roads	0	0-5	5.1-10	10.1-15	15-30	30+

Table 4.2 shows scoring ranges for data categories most prone to flooding threatening life and property. The tables show that the data categories of (1) number of buildings, (2) number of low water crossings, (3) total agricultural areas, (4) number of critical facilities, and (5) miles of inundated roads will range from 0 to 5, depending on the total amount of each measure in the HUC-12 areas of the region.

4A.1.b. Current Floodplain Management and Land Use Policies and Infrastructure

Communities Not Participating in the NFIP

Participation in the NFIP was considered a proxy for adequate floodplain management regulations in each community. The NFIP participation status for each community is presented in *Chapter 3*. Non-participating communities are not eligible for flood insurance under the NFIP. Furthermore, if a presidentially declared disaster occurs because of flooding, no federal financial assistance can be provided to non-participating communities for repairing or reconstructing insurable buildings in Special Flood Hazard Areas (SFHAs). Therefore, this analysis considered non-NFIP communities more vulnerable to flooding risks. If most of the HUC-12 (greater than 50 percent) intersected a non-NFIP community, it

was assigned five points. Otherwise, no points were allocated. Non-NFIP communities are mostly clustered in the mid-basin area, with others dispersed throughout the region.

Table 4.3 Task 4A Scoring Range: Current Floodplain Management and Land Use Policies and Infrastructure

Score (points)	0	5
Community	NFIP Participant	Non-NFIP Participant

Table 4.3 shows scoring ranges for data categories related to the current floodplain management, land use policies, and Infrastructure. The tables show that if the community participates in the NFIP, they will get 5 points; otherwise, the HUC-12 would receive a score of 0.

4A.1.c. Areas Without Adequate Inundation Maps

Inadequate Inundation Mapping

This analysis was completed using the ExFldHazard layer. This layer contains existing seamless floodplain quilt inundation boundaries gathered for the Lower Rio Grande Planning Region in Task 2. The floodplain quilt attributes include the source of the floodplain data. Based on the definitions of the source data from the TWDB (see https://twdb-flood-planning-resources-twdb.hub.arcgis.com/pages/flood-quilt-pri), the Lower Rio Grande RFPG assumed that the sources that represented adequate inundation mapping data are:

- National Flood Hazard Layer (NFHL) Preliminary Data (Zones AE, AH, AO, VE, and X)
- NFHL Effective Data (Zones AE, AH, AO, VE, and X)

The following data sources were considered inadequate inundation mapping data in this assessment as they are not considered appropriate for regulatory purposes:

- BLE
- NFHL Zone A
- First American Flood Data Services (FAFDS)
- Fathom

The total floodplain area (from all sources in the floodplain quilt) and the amount of inadequate floodplain data in each HUC-12 were calculated. This computation produced a percentage of the HUC-12 floodplain data that is considered inadequate for the purposes of this assessment.

Table 4.4 Task 4A Scoring Range: Areas Without Adequate Inundation Maps

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

Table 4.4 shows scoring ranges for data categories related to areas without adequate inundation maps. The tables show that depending on the amount of the floodplain that was defined in Chapter 2 that

utilizes inadequate inundation mapping data such as BLE, NFHL Zone A, FAFDS, and Fathom, a score of 0 to 5 is assigned, with a rank of 5 indicating that inadequate data defined over 90% of the HUC-12 area floodplain.

4A.1.d. Areas Without Hydrologic & Hydraulic (H&H) Models

The existing H&H models identified for the Lower Rio Grande Planning Region are presented in *Chapter 2*. Separate scoring criteria were not developed for this category since the risk associated with lack of technical data is already being considered by the "Inadequate Inundation Mapping" category (Section 4A.1.c.1). Any areas with detailed details mapping are presumed to have H&H modeling.

4A.1.e. Areas with Emergency Needs

The Lower Rio Grande RFPG has developed a definition for emergency needs as an area with critical facilities within the 1 percent annual chance flood (ACF) area and areas where a Presidential Major Disaster Declaration has been made.

4A.1.f. Existing Modeling Analyses and Flood Risk Mitigation Plans

Hazard Mitigation Action Plans were identified for all 8 of 14 counties within the Lower Rio Grande Planning Region. Ten of the 14 counties have regulatory floodplain maps with an effective date before 2012. In the Lower Rio Grande Planning Region, only five counties have effective, non-Modernized mapping, and not only four local modeling efforts use Atlas 14 rainfall data.

4A.1.g. Previously Identified Flood Mitigation Projects

Ninety-four ongoing projects were identified with dedicated funding (Shown in Chapter 1). Due to the lack of location data associated with the location of these projects, this criteria were not included in the analysis.

4A.1.h. Historic Flooding Events

Report Flood Concerns

This category was generated by the community responses to the survey in Task 2. Survey participants provided a total of two data point locations. This dataset primarily included flood concerns related to undersized storm drain systems and localized street flooding. The score for this factor was based on the number of flood concern locations inputted by survey participants within each HUC-12. The points breakdown for this metric is shown in **Table 4.5**.

FEMA Claims

This dataset compiles all the FEMA flood claims within the Lower Rio Grande Planning Region as of July 31st, 2021. The geospatial data assigned to the claims was highly redacted. Therefore, the Lower Rio Grande RFPG opted for using the cities to which the flood claims were assigned. Each city was divided into the HUC-12s that intersected the city limits. The number of flood claims for each city was divided proportionately amongst the HUC-12s composing each city. The points breakdown for this metric is shown in **Table 4.5**.

Historic Storm Events

The occurrence of historical storm events was evaluated using the National Oceanic and Atmospheric Administration (NOAA) National Centers for Environmental Information **Storm Events Database** (see https://www.ncdc.noaa.gov/stormevents/details.jsp). This database compiles historical storm events from 1950 to 2021. This dataset is an official NOAA publication that documents the:

- occurrence of storms and other significant weather phenomena having sufficient intensity to cause loss of life, injuries, significant property damage, and/or disruption to commerce
- rare, unusual weather phenomena that generate media attention
- other significant meteorological events, such as record maximum or minimum temperatures or precipitation that occurs in connection with another event

Storm events are included in this database following the procedures established in the National Weather Service (NWS) Directive number 10-1605 – Storm Data Preparation (see https://www.nws.noaa.gov/directives/sym/pd01016005curr.pdf). Storm events are subdivided into 48 categories, including flood-related events and other natural hazards. Two primary event categories were selected for this assessment: floods and flash floods. A total of 588 storm events were reported for the Lower Rio Grande Planning Region between 2000 and 2022, consisting of 124 floods and 464 flash flood events. Each event includes the source of data and a narrative describing the details of the event.

The number of historical storm events occurring within each HUC-12 was tabulated, and scores were assigned according to the points breakdown shown in **Table 4.5**.

Damages from Historic Storms

In addition to the frequency of historical storm events, the severity of these events was also considered in the assessment. As recorded in the Historical Storm Events database, event severity was represented by reported damages, injuries, and deaths associated with each event. A score of zero to five points was first assigned based on reported property damages (see scoring scale in **Table 4.5**). One additional point was added if injuries were reported and two additional points if deaths were reported.

Table 4.5 Task 4A Scoring Ranges: Historic Flood Events

Score (points)	0	1	2	3	4	5
Number of Flood Concerns	0	1	2	3	4	5+
Number of FEMA Claims	0	1-5	6-10	11-30	31-50	51+
Number of Historic Storms Events	0	1-2	3-4	5-6	7-8	9+
Property Damages ($)*	0	1-10,000	10,001-30,000	30,001-100,000	100,001-500,000	500,000+

4A.1.i. Previously Implemented FMPs

Per the data collection survey responses, no FMPs were identified as previously implemented (see *Chapter 2*); therefore, this category was not included in this assessment.

4A.1.j. Other Factors

Social Vulnerability Index

As discussed in *Chapter 2*, SVI refers to the potential negative effects on communities caused by external stresses on human health. Such stresses include natural or human-caused disasters or disease outbreaks. SVI values for the State of Texas were downloaded from the Centers for Disease Control and Prevention's (CDC) Agency for Toxic Substances and Disease Registry (ATSDR) website (see https://www.atsdr.cdc.gov/placeandhealth/svi/index.html). The most recent SVI values published on the website (2018) were used in this assessment. SVI values are assigned per census tract, which needed to be converted to SVI per HUC-12. SVI values were assigned to each HUC-12 based on an area-weighted average. The percentage of a census tract intersecting a HUC-12 was multiplied by the SVI. This procedure was followed for all census tracts intersecting a HUC-12 boundary, and those weighted SVI values were added together to produce one SVI value for each HUC-12. The SVI ratings varied between zero and one and were scored according to **Table 4.6**. The higher the SVI, the higher the vulnerability of a community; the lower the SVI, the higher the resilience. Overall, the HUC-12s in the middle and lower portions of the region resulted in the highest SVI values.

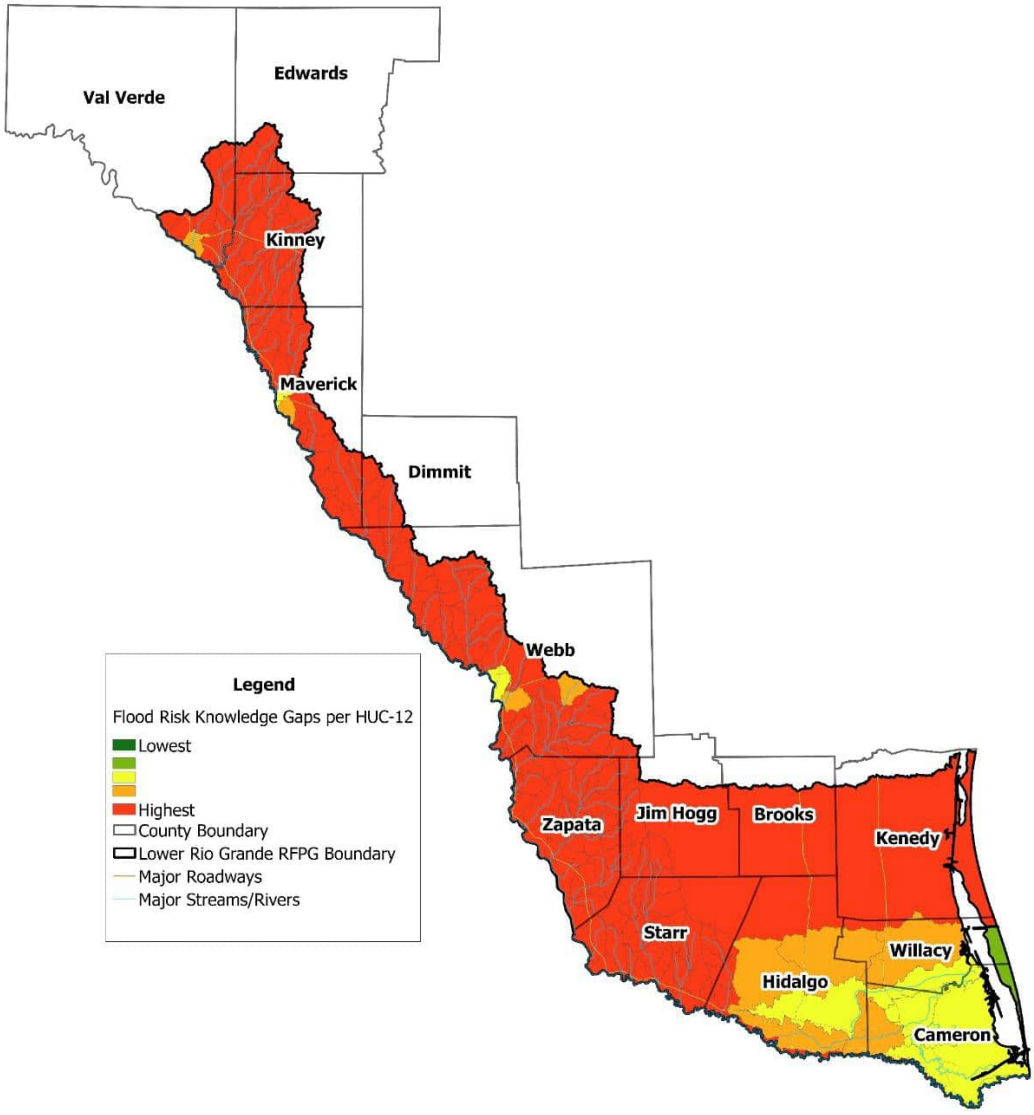
Table 4.6 Task 4A Scoring Ranges: Historic Flood Events

Score (points)	1	2	3	4	5
SVI rating	0.01-0.16	0.17-0.33	0.34-0.50	0.51-0.67	0.67+

4A.3 Analysis Results

The process and scoring methodology described above was implemented across the entire Lower Rio Grande Planning Region. As previously discussed, this assessment was performed to address the two goals of Task 4A. The first goal is to identify the areas where the greatest **flood risk knowledge gaps** exist. The inadequate inundation mapping category was selected as the basis for identifying these areas. Based on the data utilized in this preliminary assessment, approximately 80 percent of the Lower Rio Grande Planning Region is considered inadequately mapped (as indicated by the red HUC-12s in **Figure 4.2**). Note that the red HUC-12s may contain studies that have been completed but are not yet regulatory products.

Figure 4.1 Flood Risk Knowledge Gaps

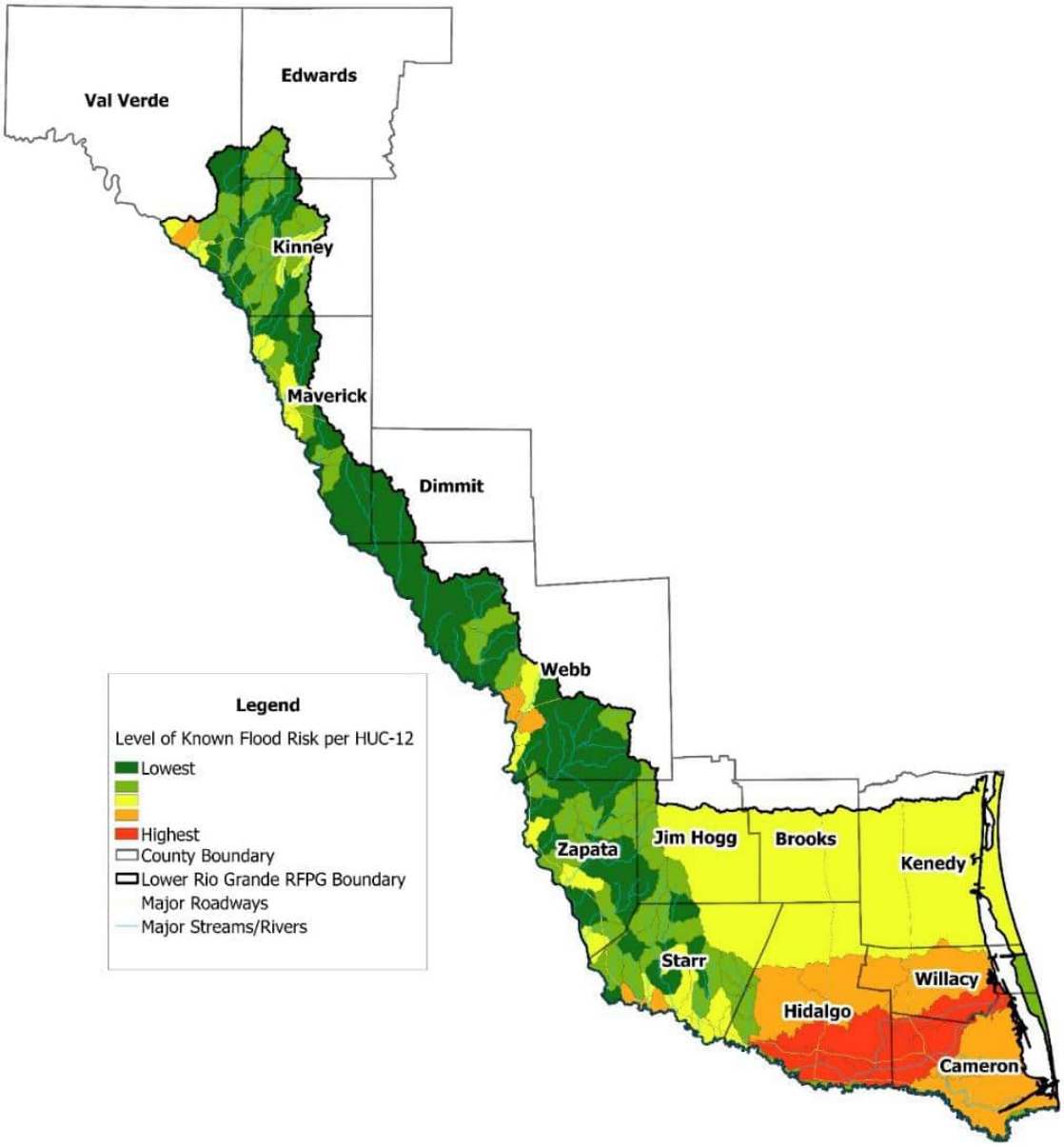


The second goal is to determine the areas of greatest **known flood risk** and flood mitigation needs. For each HUC-12 in the Lower Rio Grande Planning Region, the scores from the 10 categories were added to obtain a total score. All categories have an equal representation in the total score. This analysis also included the inadequate inundation mapping category because uncertainty itself is a risk. Based on the distribution of the final scores in this preliminary assessment, the top 10 percent were colored red, and the top 30 percent were colored either red or orange to highlight the areas with the greatest known flood risks (**Figure 4.2**). It is important to note that a HUC-12 with a low score does not necessarily mean that there is no flood risk in this area, only that this risk is relatively low compared to the others.

The maps resulting from the Task 4A assessment guided the Lower Rio Grande RFPG's subsequent efforts in Task 4B. The red and orange HUC-12s are in *Error! Reference source not found.* highlight the areas in t he Lower Rio Grande Planning Region where potentially feasible flood risk studies (FMEs) should be

considered as part of Task 4B. The red and orange HUC-12s are in **Figure 4.2** emphasize watersheds where the Lower Rio Grande RFPG should strive to identify and implement FMSs and FMPs as part of Task 4B to reduce the known flood risks within those areas.

Figure 4.2 Areas of Greatest Known Flood Risk



4B Identification and Evaluation of Potential FMEs, Potentially Feasible FMSs, and FMPs

4B.1 Process to Identify FMEs, FMSs, and FMPs

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

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

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

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

Once these datasets were identified and evaluated through initial screening and data gathering under this task, then the FMEs, FMSs, and FMPs were further evaluated to compile the necessary technical data for the Lower Rio Grande RFPG to decide whether or not to recommend these actions, or a subset of these actions, as part of Task 5.

This first regional flood planning cycle relies primarily on compiling readily available information to determine appropriate flood mitigation actions to recommend for inclusion in the Regional Flood Plan, rather than performing technical analyses to identify new actions.

The list of potential FMEs and potentially feasible FMSs and FMPs were compiled based on contributions from the Lower Rio Grande RFPG and other regional stakeholders from sources such as previous flood studies, drainage master plans, flood protection studies, and capital improvement studies. In addition, plans considered in the flood planning process include local and countywide Hazard Mitigation Plans (HMPs); various ordinances, planning and zoning documents; and FEMA NFHL data. These documents and datasets provide insight into the jurisdiction's capabilities, the guidelines of each location, and the potential challenges of implementing FMEs, FMSs, and FMPs within the flood planning area.

4B.2 Classification of Potential FMEs and Potentially Feasible FMSs and FMPs

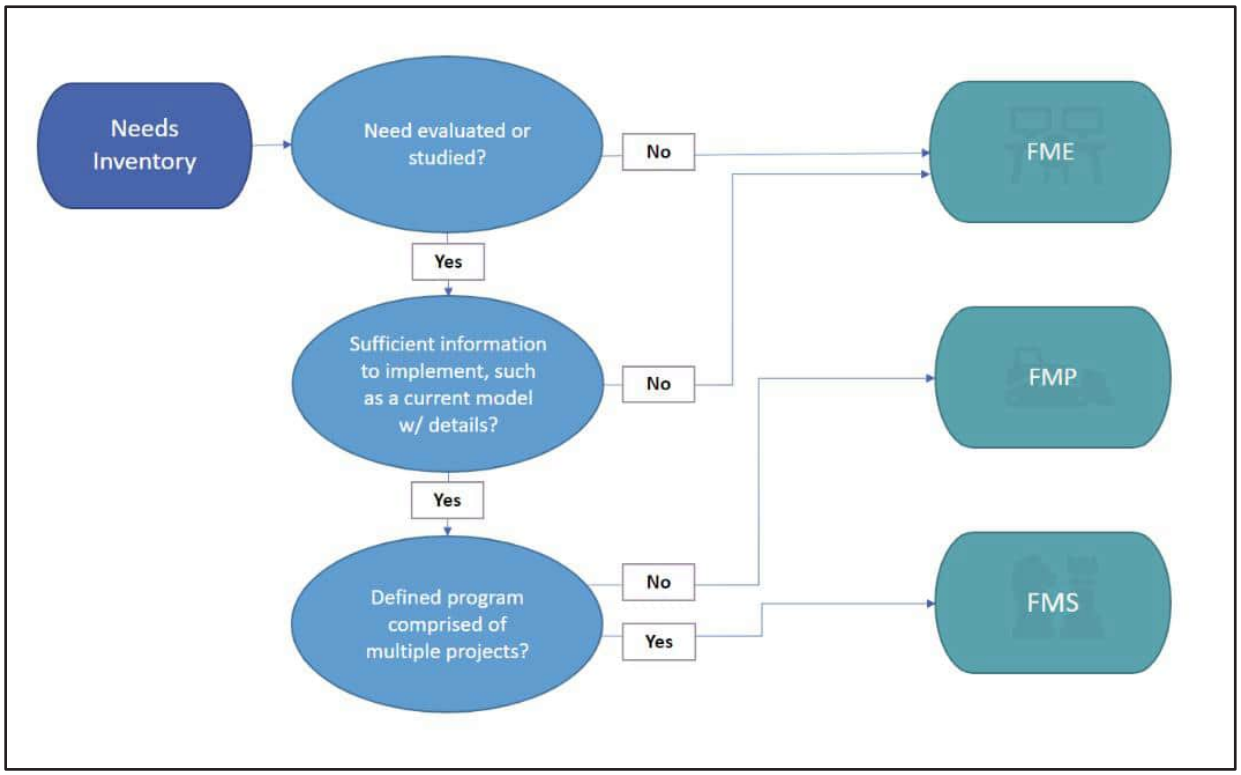
Several different general action types provided by the TWDB considered are listed in **Table 4.7**. Once potential flood risk reduction actions were preliminarily identified using this list, a high-level screening process was used to confirm that potential actions had been sorted into their appropriate categorization. The screening process is shown in **Figure 4.3**.

Table 4.7 FEMA Flood Insurance Studies

Flood Risk Reduction Action Category	Action Types
FME	Watershed Planning
	H&H Modeling
	Flood Mapping Updates
	Regional Watershed Studies
	Engineering Project Planning
	Feasibility Assessments
	Preliminary Engineering (alternative analysis and up to 30% design)
	Studies on Flood Preparedness

Flood Risk Reduction Action Category	Action Types
FMP	Structural LWCs or Bridge Improvements Infrastructure (channels, ditches, ponds, stormwater pipes, etc.) Regional Detention Regional Channel Improvements Storm Drain Improvements Reservoirs Dam Improvements, Maintenance, and Repair Flood Walls/Levees Coastal Protections Nature Based Projects – living levees, increasing storage, increasing channel roughness, increasing losses, de-synchronizing peak flows, dune management, river restoration, riparian restoration, run-off pathway management, wetland restoration, low impact development, green infrastructure Comprehensive Regional Project
FMP	Non-Structural Property or Easement Acquisition Elevation of Individual Structures Flood Readiness and Resilience Flood Early Warning Systems, including stream gauges and monitoring stations Floodproofing Regulatory Requirements for Reduction of Flood Risk
FMS	None specified; RFPGs were instructed to include at a minimum any proposed action that the group wanted to consider for inclusion in the plan that did not qualify as either an FME or FMP.

Figure 4.3 Potential Flood Risk Reduction Action Screening Process



Generally, an action was considered an FME if it was meant to study and quantify flood risk in an area, as well as define potential FMPs and FMSs to address the risk. Potential actions that could be considered FMPs were screened to determine if they have been developed in enough detail and include sufficient data to meet the technical requirements for these action types. Actions that were initially considered for FMPs that did not meet these requirements were adapted and repurposed as FMEs. Potential solutions that did not easily meet the criteria of FMEs or FMPs could be included as FMSs. The specific requirements for each action type are described in subsequent sections.

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

4B.3 Evaluation of Potential FMEs

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

- Previous Flood Studies
- Capital Improvement Plans
- Drainage Master Plans

- Flood Insurance Studies (FIS)
- Hazard Mitigation Action Plans (HMAP)
- Flood Infrastructure Fund (FIF) applications not chosen for funding
- Direct input from Lower Rio Grande RFPG

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

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

4B.3.a. FME Types

The definition of an FME allows for various study types to help assess flood risk and potentially define future FMPs and FMSs. A general list of study types was previously summarized in **Table 4.7**. The following section describes these project types in more detail and summarizes the different potential FMEs identified in the Lower Rio Grande Planning Region.

Watershed Planning

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

- **Flood Mapping Updates**: Flood mapping data helps communities quantify and manage their flood risk. It also provides communities a pathway to access flood insurance administered through the NFIP. Flood mapping FMEs were identified for all counties within the Lower Rio Grande Planning Region. The FMEs included developing regulatory maps where none exist and updating existing maps to account for revised rainfall data, recent development conditions, and advances in floodplain modeling and mapping methodologies.
- **Drainage Master Plans**: Drainage master plans support the development and analysis of H&H models to evaluate flood risk within a given jurisdiction, evaluate potential alternatives to mitigate flood risk, and develop capital improvement plans.

- **H&H Modeling**: The objective of H&H modeling FMEs is to evaluate and define flood risk, identify flood-prone areas, and evaluate alternatives for mitigating such risks at a local level.
- **Regional Watershed Studies:** Regional watershed studies are large-scale H&H studies that will likely benefit multiple jurisdictions.
- **Flood Mapping for Dam Failure**: Studies are conducted to develop dam failure inundation maps and models. Per the Texas Commission on Environmental Quality (TCEQ) regulations, dams are required to be evaluated for hydrologic capacity for minimum design flood based on the Probable Maximum Flood (PMF) event. In addition to evaluating the design flood capacity, the hydrologic models are used to establish peak water surface elevations (WSELs) and reservoir inflow hydrographs, which are in turn utilized for performing the breach analysis and generating breach inundation mapping.
- **Flood Mapping for Levee Failure** – Studies are conducted to develop levee failure inundation maps and models. These hydrologic studies help to determine the threat, risk, and potential impacts of flooding from levee failure.

Engineering Project Planning

FMEs classified as engineering project planning include studies to evaluate potential construction projects. These evaluations include feasibility assessments, preliminary alternatives analysis, and preliminary engineering design. The scope of the flood planning process defines a 30 percent design level as the cut-off between the study phase associated with an FME and the design and implementation phase associated with an FMP. The following engineering project planning subcategories were identified in the Lower Rio Grande Planning Region:

- channelization
- culvert improvements
- erosion control
- LWC improvements
- road/bridge improvements
- storm drain improvements
- stream stabilization
- other

Flood Preparedness Studies

FMEs classified as studies on flood preparedness include proactive evaluations of a community's readiness to respond to a flood event. These types of evaluations consider factors such as early warning systems, public awareness about flooding, capabilities of emergency operations personnel, and the development of emergency operations and evacuation plans.

FME Classification Summary

An overall summary of the identified FMEs is provided in **Table 4.8.** All identified potential FMEs are listed with their supporting technical information in TWDB-Required **Table 12** (**Appendix B***)*. In total, 356 potential FMEs were identified and evaluated.

Table 4.8 FME Types and General Description

FME Type	FME Description	# of Potential FMEs Identified
Watershed Planning	**Flood Risk Modeling/ Mapping** Promotes the development and/or refinement of detailed flood risk maps to address data gaps and inadequate mapping. Creates FEMA mapping in previously unmapped areas and updates existing FEMA maps as needed.	24
Project planning	**Flood Mitigation Alternative Analysis/ Feasibility Study** Supports the development and analysis of H&H models to evaluate flood risk within specific problem area, evaluate potential alternatives to mitigate flood risk, and develop a project.	85
Other	**Preliminary Engineering** Evaluation of a proposed project to determine whether implementation would be feasible OR initial engineering assessment that includes conceptual design, alternative analysis, and up to 30 percent engineering design.	24
	Total	**133**

4B.3.b. Planning Level Cost Estimates

Following the Technical Guidelines, a planning level cost estimate was developed for each FME. The process of producing these cost estimates for each FME project type is outlined in the following sections. Cost estimates presented in this section are for planning purposes only and are not supported by detailed scopes of work or workhour estimates. The Lower Rio Grande RFPG anticipates that the local sponsor will develop detailed scopes of work and associated cost estimates before submitting any future funding application through the TWDB or other sources.

Watershed Planning

Separate planning level cost estimates were developed for drainage master plans depending on whether the sponsor is a county or city. Initially, the cost of each countywide drainage master plan was generated using a cost per square mile methodology, based on the cost of previous countywide drainage master plan studies. This quantity included basic services such as project management, coordination, collaborative work sessions, data collection, screening assessment, targeted H&H modeling and

alternatives analysis, a technical report, and public outreach. A 30 percent contingency was applied to account for uncertainties associated with planning level estimates. After a comparative analysis of the results, it was noted that a uniform cost estimate of $500,000 would be appropriate to complete each countywide plan. It is anticipated that this placeholder budget will provide sufficient funds for each county to broadly evaluate their jurisdiction and develop potential FMEs and FMPs that could be included in future Regional Flood Plans.

The same scope and basic services were applied for citywide drainage master plans. However, the cost varied based on each city or town's population size, which was taken from 2020 United States Census data. Three categories were identified for the population sizes, and a corresponding cost estimate was assigned based on professional engineering experience.

Table 4.9 FME Citywide Drainage Master Plan Cost Estimate Ranges

Relative City Size	Population (2020 Census)	Cost Estimate
Small	< 25,000	$250,000
Medium	25,000 - 100,000	$500,000
Large	> 100,000	$1,000,000

4B.3.c. Process to Determine Flood Risk Indicators

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

4B.3.d. Comparison and Assessment of FMEs

As previously stated, most of the counties within the Lower Rio Grande Planning Region have been submitted as a flood mapping update FME due to a lack of current fully detailed, model-backed H&H floodplain analyses. Current mapping of the Lower Rio Grande Planning Region does not reflect the increase in rainfall resulting from the NOAA Atlas 14 release, prompting a significant need for FME flood mapping updates in the whole region.

Twenty-four drainage master plan FME projects were collected for inclusion in TWDB-required **Table 12**. Drainage master plan areas were based on either city or county boundaries.

Over 60 percent of the FME engineering project planning projects collected were in Cameron, Hidalgo, and Willacy. The analysis obtained from these proposed projects did not meet the full requirements to be included as an FMP and was relegated to an FME for further refinement. Four FME projects listed

were contained within Hill County, which has the second highest flood exposure SVI within the Lower Rio Grande Planning Region. The total engineering project planning project areas contain a combined 205,732 structures at risk, with over 44 percent of the structures being classified as residential.

4B.3.e Determination of Emergency Need

The term emergency need can be interpreted in multiple ways, and each region has been tasked with defining the term for each individual flood planning region. Lower Rio Grande RFPG used the following criteria to determine areas of emergency need: critical facilities are impacted by the 1 percent annual chance flood (ACF), or a Presidential Major Disaster Declaration has been issued for the county affected.

Emergency needs FMEs, FMPs, and FMSs would remove critical facilities from the 1 percent ACF area through various types of FMEs, FMPS, and FMSs including, but not limited to acquisition, demolition, or elevation; floodproofing or retrofitting; and through infrastructure projects that would improve roads or bridges that cause critical facilities to be inaccessible. Designating these critical facility structures as emergency need enables mitigation measures in the form of FMEs, FMPs, and FMSs to be enacted to reduce future risk.

4B.4 Evaluation of Potentially Feasible FMPs and FMSs

Potentially feasible FMPs were identified based on responses to surveys, reviews of previous studies, FIF applications not selected for funding, and direct coordination with stakeholders. FMSs and FMPs are required to be developed in sufficient detail to be included in the RFP and recommended for state funding. In most cases, this includes having recent H&H modeling data to assess the impacts of the project and an associated project cost to develop the project's benefit-cost ratio (BCR). The development and use of the technical information to evaluate potentially feasible actions are described in the following subsections.

Potentially Feasible FMPs

The Lower Rio Grande RFPG identified 38 potentially feasible FMPs for the Lower Rio Grande Planning Region. Technical information for each FMP is summarized in TWDB-required **Table 13** (**Appendix B***).* Each project is unique, and the specific FMPs recommended by the Lower Rio Grande RFPG will be described in detail in *Chapter 5*. A general description of the potentially feasible FMPs is presented in Error! Reference source not found..

The identified potentially feasible FMPs for this first planning cycle are primarily located along the lower Rio Grande Planning Region. These were the only actions for which a sponsor provided sufficient information to be considered as a potentially feasible FMP or that an existing unfunded FIF application was potentially available. The potential sponsors and their associated number of FMPs are listed below:

- City of Alton (6)
- City of Eagle Pass (10)
- City of Pharr (5)
- City of Weslaco (8)

- Hidalgo County Precinct 4 (9)

Potentially Feasible FMSs

The Lower Rio Grande RFPG identified 51 potentially feasible FMSs for the Lower Rio Grande Planning Region. The technical information for each FMS is summarized in TWDB-required **Table 14 *(Appendix B)*.**

A variety of FMS types were identified. Some establish and implement public awareness and educational programs to better inform communities of the risks associated with flood waters. Other FMSs improve preventative maintenance programs to maximize the operational efficiency of emergency response procedures, develop stormwater management manuals to encourage best management practices, or establish community-wide flood warning systems. A significant number of property acquisition programs were also identified. These programs include a variety of purposes, such as acquiring floodplain and environmentally sensitive areas to convert them into open space land and acquiring repetitive loss structures. A summary listing of FMS types is provided in **Table 4.10**.

Table 4.10 Summary of FMS Types

FMS Type	FMS Description	# of Potential FMSs Identified
Education and Outreach	NFIP Education; Flood Education; Floodplain Regulatory Awareness; Emergency Contact Awareness	8
Flood Measurement and Warning	Flood Warning Systems; Mass Notifications during Natural Hazard Incident; Dam Inundation Studies	25
Regulatory and Guidance	City Floodplain Ordinance Creation/Updates; Zoning Regulations; Land Use Programs;	18
	Total	**51**

4B.4.b. Effects on Neighboring Areas of FMSs or FMPs

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

No community in the Lower Rio Grande Planning Region has established a no negative flood impact policy for a proposed development. The *Technical Guidelines* and *Rules* governing state flood planning require the impacts analysis to be performed for the 1 percent annual chance event (ACE). Additionally,

the *Technical Guidelines* require the following criteria to be met, as applicable, to establish no negative flood impact:

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

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

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

A comparative assessment of pre-project and post-project conditions for the 1 percent ACE (100-year flood) was performed for each potentially feasible FMP based on their associated H&H models. The floodplain boundary extents, resulting WSELs, and peak discharge values were compared at pertinent locations to determine if the FMP conforms to the no negative impacts requirements. This comparative assessment was performed for the entire zone of influence of the FMP.

The comparative assessment to determine "no negative flood impact" on upstream or downstream areas or neighboring regions was performed based on currently available regional planning level data. The local sponsor will ultimately be responsible for proving the final project design has no negative flood impact before initiating construction.

4B.4.c. Estimated Benefits of FMP or FMS

To be recommended, each FMP or FMS must align with a regional floodplain management goal established under Task 3 and demonstrate a flood risk reduction benefit. To quantify the flood risk

reduction benefit of each FMP or FMS, the anticipated impact after project implementation was evaluated according to the following criteria:

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

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

4B.4.d. Potential Impacts and Benefits from the FMS or FMP to other resources

According to the Texas A&M AgriLife Extension Service economists, Hurricane Harvey caused more than $200 million in crop and livestock losses in Texas. Flood waters have the potential to destroy standing crops, create water-logged conditions that delay planting or harvesting, wash away productive topsoil, and damage farm equipment and infrastructure. FMSs or FMPs potentially reduce extremely high flows in rivers and streams, thereby preventing flood waters from inundating areas outside the floodway, including agricultural areas. Structural FMSs or FMPs, like small flood control ponds, also have the potential to assist in agricultural production by serving a dual purpose of flood mitigation and water supply. Non- structural FMSs or FMPs have similar impacts on flood peak flow reduction and flooding, including agricultural conservation practices such as conservation tillage, residue management, cover crops, and furrow dikes. These practices reduce downstream flooding by reducing surface runoff and increasing infiltration on agricultural lands and also experience sediment and nutrient losses, thereby improving downstream water quality.

4B.4.e. Estimated Capital Cost of FMPs and FMSs

Cost estimates for each FMP were acquired from the engineering report used to generate the FMP. Cost estimates were adjusted as needed to account for inflation and other changes in the price of labor and commodities that had taken place since the publication date of the original reports. In addition, cost estimates were adjusted as needed to include any applicable non-recurring and recurring project costs

as listed in *Table 22* of the *Technical Guidance*. The cost estimates listed in the TWDB-required **Table 13** and **Table 14** are expressed in September 2020 dollars (see **Appendix B**).

Cost estimates for each FMS were acquired from the HMAPs used to generate the FMS. Cost assumptions from **Table 4.11** were used if the HMAPs did not have associated costs or if the reported costs were lower than the cost assumptions. The cost assumptions are expressed in 2020 dollars and were developed based on engineering experience and other similar projects.

FMS cost estimates presented in this section are for planning purposes only and are not supported by detailed scopes of work or workhour estimates. The Lower Rio Grande RFPG anticipates that the local sponsor will develop detailed scopes of work and associated cost estimates before submitting any future funding application through the TWDB or other sources.

Table 4.11 FMS Cost Estimates Assumptions

FMS Type	Cost Estimate Range	Scope and Assumptions
Education and Outreach	$50,000	"Turn Around Don't Drown" Campaign: Assume $50,000 based on other similar educational programs.
Education and Outreach	$50,000	NFIP Public Education: Assume $50,000 based on other similar educational programs.
Flood Warning and Readiness	$250,000 to $500,000	Early/Local Flood Warning System: Assume $250,000 based on similar projects that have received TWDB FIF grants.
Flood Warning and Readiness	$250,000 to $500,000	Rain/Stream Gauge and Weather Station Installation: Assume $250,000 based on similar projects that have received TWDB FIF grants.
Flood Warning and Readiness	$250,000 to $500,000	LWC Warning Devices: Assume $250,000 based on similar projects that have received TWDB FIF grants.
Flood Studies and Analysis	$500,000 to $35,000,000	Hazardous Roadway Crossings: There is one strategy identified within the region that consists of strategically improving hazardous road crossings within a community. This program cost is estimated at $35,000,000 for a single community.
Flood Studies and Analysis	$500,000 to $35,000,000	Capital Improvement Plan (CIP): Community planning tool including a compilation of drainage infrastructure projects. Costs are included in the CIP and aggregated for the assigned FMS.
Guidance	$50,000 to $5,000,000	Debris Clearing Maintenance Program: Assume $100,000 based on a similar project in the region.

FMS Type	Cost Estimate Range	Scope and Assumptions
Guidance	$50,000 to $5,000,000	Channel Maintenance and Erosion Control: Assume $250,000 based on a high-level engineering consultant's estimate
Guidance	$50,000 to $5,000,000	Dam Inspection Program: Assume $100,000 per dam per year based on a high-level engineering consultant estimate.
Guidance	$50,000 to $5,000,000	Levee Inspection Program: Assume $50,000 per levee system per year based on a high-level engineering consultant estimate.
Guidance	$50,000 to $5,000,000	Establish City Parks: Assume $1,000,000 based on a high-level engineering consultant estimate.
Guidance	$50,000 to $5,000,000	Implement Green Infrastructure: Assume $500,000 based on a high-level engineering consultant estimate.
Property Acquisition, Structural Elevation, and Floodproofing	$5,000,000 to $50,000,000	Acquire High Risk and Repetitive Loss Properties: Assume $5,000,000 to acquire as many properties as possible with this cost. This assumption is based on other similar projects in the region.
Property Acquisition, Structural Elevation, and Floodproofing	$5,000,000 to $50,000,000	Acquire and Preserve Open Space: Assume $5,000,000 based on other similar projects in the region.
Flood Infrastructure Projects	$100,000 to $1,000,000	City Floodplain Ordinance Creation/Update: Assume $100,000 to cover engineering consultant fees.
Flood Infrastructure Projects	$100,000 to $1,000,000	Zoning Regulations and Land Use Programs: Assume $100,000 to cover engineering consultant fees.
Flood Infrastructure Projects	$100,000 to $1,000,000	Stormwater Management Plan: Assume $300,000 to cover engineering consultant fees.
Flood Infrastructure Projects	$100,000 to $1,000,000	Levy Stormwater Fee: Assume $200,000 based on another similar project.

4B.4.f. Benefit Cost Ratio for Flood Mitigation Projects

Benefit-Cost Analysis (BCA) is the method by which the future benefits of a hazard mitigation project are determined and compared to its costs. The end result is a BCR, which is calculated by dividing the project's total benefits, quantified as a dollar amount, by its total costs. The BCR is a numerical expression of the relative "cost-effectiveness" of a project. A project is generally considered cost-effective when the BCR is 1.0 or greater, indicating the benefits of a prospective hazard mitigation project are sufficient to justify the costs (*FEMA, 2009*). However, a BCR greater than 1.0 is not a requirement for inclusion in the Regional Flood Plan. The Lower Rio Grande RFPG can recommend a project with a lower BCR with appropriate justification.

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

4B.4.g. Residual, Post-Project, and Future-Risks of Flood Mitigation Projects

While it is not possible to protect against all potential flood risks, the evaluation of FMPs should consider their associated residual, post-project risks, and future risks, including the risk of potentially catastrophic failure and the potential for future increases to these risks due to lack of maintenance. For more details on the approach and the TWDB's proposed scoring guidelines, please see the TWDB's Exhibit C: Technical Guidelines for Regional Flood Planning (*TWDB, 2021*).

Residual Risk

Residual risk describes the risks after structural or non-structural FMPs have been implemented (*UNDRR, 2020*). Residual flood risk will remain even after meeting the FMP goals (*TWDB, 2021*). The flood planning group must consider and identify residual risk for each goal identified. For example, if the goal is to protect all life and property from the 1 percent flood (100-year flood) events, the residual risk to life and property remains for flood events exceeding a 1 percent likelihood.

The group's overarching goals should be determined first with a clear summary of the residual risk, including 'transformed' risk, that would remain in the region even after the stated goals are met. The USACE defines transformed risk as the change in nature of flood risk for some areas associated with the presence of flood hazard reduction infrastructure. The construction of flood mitigation structures often reduces flood risk but, as a result, may also be 'transformed' into a different type of risk; for example, in the form of risk from structural failure of that mitigation infrastructure (e.g., a dam or levee).

Residual risks, by nature, have a low probability of occurrence. Keeping residual risks low requires continuing maintenance of FMPs and effective emergency services for preparedness, response, and recovery as a holistic approach.

Post-Project Risk

Post-project risk analysis is typically utilized to gather information for evaluating the final risk impacts after a project. The project manager uses a report of the post-project risk analysis to give stakeholders and decision-makers a general idea of what worked well and what did not in the PMP so that future projects can benefit from the lessons learned. The post-project information can be used to prioritize a list of recommended FMPs with a set of criteria, including:

- post-project 100-year flood risk reduction
- post-project 100-year critical facilities damage reduction
- post-project 100-year flood damage reduction
- post-project improvement of mobility

Post-Project 100-year Flood Risk Reduction

After a project is constructed, this analysis indicates the reduced flood risk by the percentage of structures removed from a 100-year floodplain in the post-project condition, using the data of:

- 100-year floodplain shapefiles with elevations in the pre- and post-project conditions
- structures within the 100-year floodplains in the pre- and post-project conditions
- land elevations and structure shapefiles
- other available data

Post-Project 100-year Flood Damage Reduction

After construction, this analysis indicates flood damage reduction (property protection) by a percentage of 100-year damage reduction calculation using:

- data of the average depth of a 100-year flood in the pre-project condition
- shapefiles, elevations, or average depth/reduction of the 100-year flood in the post-project condition
- shapefiles, land elevations, and structure shapefiles
- other available data

Post-project 100-year Critical Facilities Damage Reduction

Following construction, this analysis indicates reduced flood risk by the percentage of critical facilities removed from a 100-year floodplain in the post-project condition using the data of:

- average depth of the 100-year flood in the pre-project condition
- floodplain shapefile, elevations, or average depth/reduction of the 100-year flood in the post-project condition
- critical facilities in the 100-year floodplains in the pre- and post-project conditions

Mobility

This criterion indicates project improvement and protection of mobility during flood events, with particular emphasis on emergency service access and other major access routes, using the data of:

- 100-year floodplain shapefile with elevations in the pre- and post-project conditions
- TxDOT Functional Classification Shapefile
- project shapefiles and other available data

Future Risks

Future flood risks shall be determined by considering three components:

- flood hazards in future condition
- additional exposure and vulnerability
- operations and maintenance (O&M) and design standards

Flood Hazards in Future Condition

Future risk analysis of FMPs should consider the changes in flood risks in future conditions. The factors that may result in such altered flood hazards include increased impervious surface cover, change in sea level and/or land subsidence, anticipated erosion, and sedimentation in flood control structures. In particular, any future flood risk analysis should consider the potential effects of climate change on future rainfall patterns, flood frequency, and magnitude, possibly leading to substantial increases in future flood risks over areas with greater population.

Information from any existing resources like H&H model results and maps should be summarized with details in terms of the source of flood hazard data, associated dates, timeframe of future conditions (fully developed land use conditions, 30-year, 50-year, etc.), and a brief description of each existing dataset compiled for flood hazard analysis. If the flood hazard data for the future condition is not available in the region of FMPs, the TWDB suggested to perform one of the following methods (*TWDB, 2021*):

- **Method 1:** Increase WSEL based on projected percent population increase (as a proxy for the development of land areas)
- **Method 2:** Utilize the existing condition of 0.2 percent ACF as a proxy for the future 1 percent level
- **Method 3:** Combination of methods 1 and 2 or an RFPG-proposed method
- **Method 4:** Request desktop analysis from the TWDB

Additional Exposure and Vulnerability

Exposure and vulnerability analyses identify the existing and future flood hazard areas if the current development practices continue in FMPs. According to *Section 2B.3* and *Section 2B.4* of this plan, a rapid increase in structures and population is projected in the Lower Rio Grande Planning Region over the next 30 years. This implies that the potential exposure and vulnerabilities of the population, structures, critical facilities, and public infrastructure to flood hazards may increase. For communities interested in future exposure and vulnerability, they may contact FEMA for FIRMs for future conditions in 1 percent annual chance floodplains (*FEMA, 2001*). While the future condition floodplain maps cannot be used for an emergency operation and insurance rating purposes, they can be used to enhance public awareness

of future flood risks, exposure, and vulnerability. The detailed information on flood exposure and vulnerability analyses for future conditions are included in *Section 2B.2* and *Section 2B.3* of this plan.

O&M and Design Standards

O&M, as well as the standards of public infrastructure design, can greatly distress future flood risks. FMPs can fail to function as designed due to improper operations and poor maintenance. Examples of catastrophic dam failures include the Oroville Dam in California in 2017 and the Edenville Dam in Michigan in 2020. Both resulted in massive floods from the combination of intense rainfall events and lack of maintenance.

Future risks of structural failures can increase if the FMPs are not properly managed and maintained. Thus, re-evaluating the design standards and requirements of O&M of FMPs should be considered to reduce future risks. Minimum and most stringent specifications of the design standards of FMPs should be followed to prepare for flood hazards in the future.

4B.4.h. Implementation Issues of FMPs

Project implementation issues include conflicts pertaining to rights-of-way, permitting, acquisitions, utility, or transportation relocations, amongst other issues that might be encountered before an FMP can be fully implemented. Such issues are an inherent part of FMPs.

A right of way is a public path across private land, and it can create issues when securing access to projects for construction and maintenance. The acquisition of right of way or utility relocation located near or on property impacted by a project requires close coordination between the state, cities, counties, and other forms of local government, as well as private entities and landowners. Coordination with the appropriate entities is key to facilitating projects. The Right of Way Division of the Texas Department of Transportation (TxDOT) coordinates the acquisition of land to build, widen, or enhance highways, and provides relocation assistance when needed.

Most FMPs will require a variety of permits so that they are following best practices, meeting code requirements, following regulations, and adhering to the laws and regulations. During the implementation of any project, the goal is to obtain and acquire all necessary and required permits and approvals as efficiently as possible. Although acquiring permits can also be a lengthy process, it is an essential step in any FMP.

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

Voluntary property acquisition is not a simple process and requires agreement by the property owner and local jurisdiction. If state or federal funding is involved, the property acquisition could also include other governmental officials, the state, and the federal agencies. Voluntary buyout programs are a

specific subset of property acquisitions in which private lands are purchased, existing structures are demolished, and the land is returned to its natural undeveloped state for public use in perpetuity. Buyouts are voluntary, and no one is required to sell their property which provides no guarantee of acquisition. The process can also be financially burdensome as well as lengthy.

Additional issues can arise with utility relocation. Utilities may include water lines, wastewater lines, storm drain systems, telecommunication, power lines, and other similar infrastructure. Utilities may be buried below the surface, attached to the side of bridges, or aerial. Utilities located in a road or highway right of way may need to be relocated to allow for the construction of a mitigation project. The local government is usually responsible for utility relocations; however, TxDOT may assume responsibility, particularly for projects along the state highway system. Developers may also assume responsibility for utility relocations depending on the project. Utility relocation means adjusting a utility facility required to construct a project. It includes removing and reinstalling the facility, including necessary temporary facilities; acquiring necessary right of way in a new location; moving, rearranging, or changing the type of existing facilities; and taking any necessary safety and protective measures. Such measures can be time-consuming as well as costly.

4B.5 Potential Funding Sources

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

Chapter 5

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Chapter 5: Recommendation of Flood Management Evaluations (FMEs), Flood Management Strategies (FMSs), and Associated Flood Mitigation Projects (FMPs)

The objective of Task 5 is for Region 15 Lower Rio Grande Regional Flood Planning Group to use the information developed under Task 4 to recommend flood mitigation actions (FMEs, FMSs, and FMPs) for inclusion in the Regional Flood Plan. While Chapter 4B discussed the technical evaluations of the potential FMEs and potentially feasible FMSs and FMPs identified by the Lower Rio Grande Planning Region, Chapter 5 focuses on how this data is used to make a recommendation for a given flood mitigation action. Generally, this chapter summarizes and documents:

- process undertaken by the Lower Rio Grande Planning Region to make final recommendations on the given flood mitigation action types
- potential FMEs and potentially feasible FMSs and FMPs identified and evaluated under Task 4B, and whether these actions are recommended by the Lower Rio Grande Planning Region

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

5.1 Lower Rio Grande Region Evaluation and Recommendation Process

The technical consultants applied the screening process based on the technical data developed under Task 4B and the RFPG guidance. An initial recommendation for each flood mitigation action was presented to the RFPG on December 15, 2021. At that time, the only criteria the flood mitigation actions were screened for were the flood mitigation and floodplain management goals that the Lower Rio Grande RFPG had adopted. On July 21, 2022, the Lower Rio Grande Planning Region voted to recommend FMEs and FMSs, as the technical consultant advised. The Lower Rio Grande Planning Region approved these FMEs and FMSs, understanding that they could revisit them at a future meeting if new information warranted additional discussion and possible action.

All meetings were held in accordance with the requirements of the Lower Rio Grande Planning Region bylaws, the Texas Open Meetings Act, the general requirements of the Texas Water Code, and the

TWDB's flood planning process requirements. Additional details regarding the flood mitigation actions evaluation process and final recommendations are provided in subsequent sections.

Figure 5.1 Proposed Process to identify and Evaluate FMEs, FMSs, and FMPs

STEP 1	**INITIAL SCREENING OF *FMEs (EVALUATIONS), FMPs (PROJECTS) & FMSs (STRATEGIES)* RECEIVED** Screen for minimum TWDB rules and guidance requirements 1. Does it address a flood mitigation or floodplain management goal (Task 3B)? 2. Does it address an emergency need? 3. Does it address a flood problem with a drainage area of 1 square mile or greater? *Except in instances of flooding of critical facilities or transportation routes or for other reasons, including levels of risk or project size, determined by the RFPG* 4. Does it reduce flood risk for 100-year (1% annual chance) flood?
STEP 2	**SCREENING OF *FMPs (PROJECTS)*** Screen per TWDB flowchart on page 61 of Exhibit C- Technical Guidelines for Regional Flood Planning (April 2021)

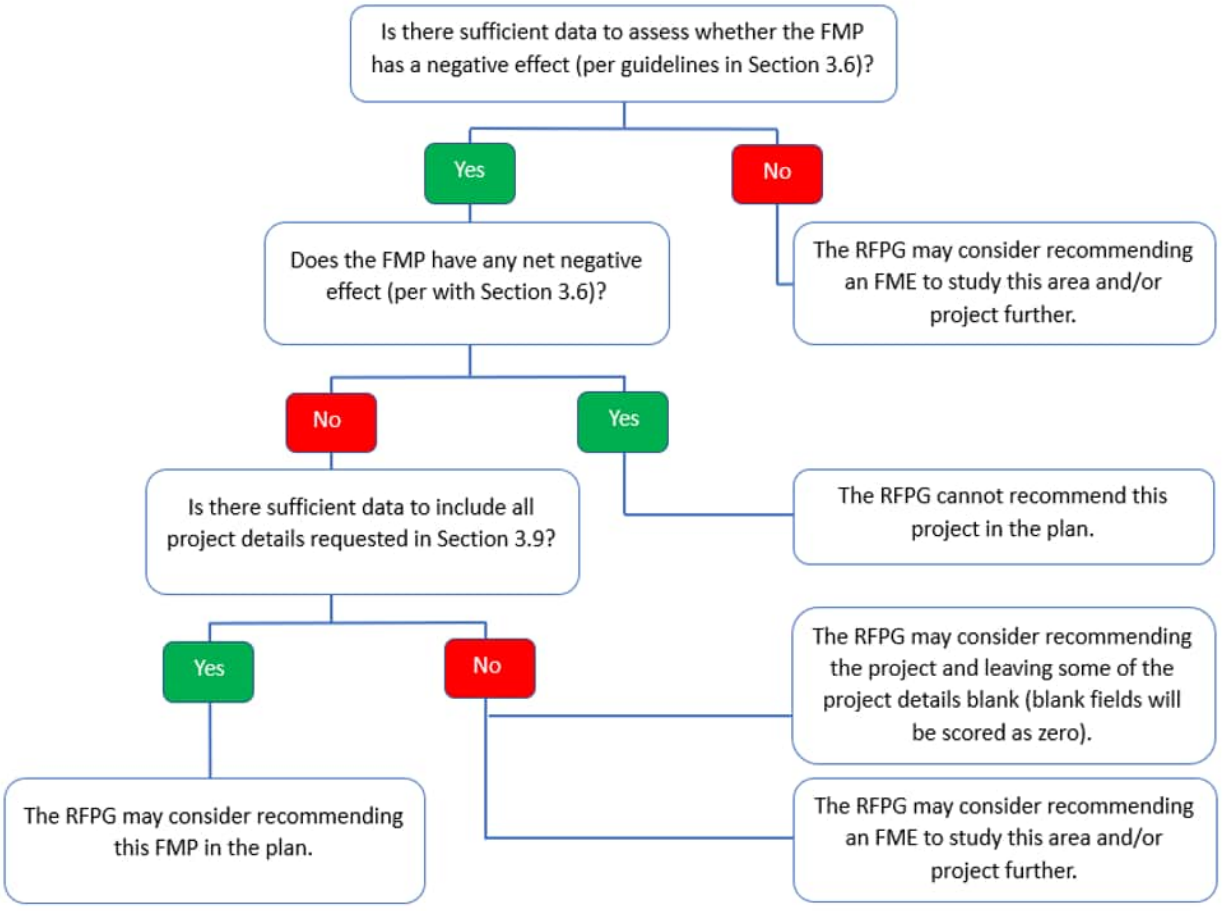


Figure 5.1 continued Proposed Process to identify and Evaluate FMEs, FMSs, and FMPs

STEP 3	**SCREENING OF *FMEs (EVALUATIONS)*** Screen for minimum TWDB guidance requirements 1. Was it a Project that did not meet the requirements of an FMP in Step 2? 2. Is it a planned flood study or flood risk reduction analysis provided by an entity? 3. Was it a flood study or flood risk reduction alternatives analysis that was identified in Task 4A? 4. Other criteria: a. Is it a detailed H&H and mitigation alternatives analysis? → *Project* or *Strategy* b. Is the study sensible? c. Does it have a reasonable planning-level cost estimate? d. Has a sponsor(s) been identified? e. Will it identify structures, population and critical facilities at risk? f. Will it address roadways at risk? g. Will it mitigate area of farm and ranch land at risk?
STEP 4	**SCREENING OF *FMSs (STRATEGIES)*** Screen for minimum TWDB guidance requirements. 1. Is there a planning-level cost estimate? 2. Has a sponsor(s) been identified? 3. Have the flood risk and flood risk reduction been estimated?
STEP 5	**DETAILED EVALUATIONS OF SELECTED *FMEs (EVALUATIONS), FMPs (PROJECTS) & FMSs (STRATEGIES)*** 1. Does it have a project benefit-cost ratio > 1.0? 2. Has a *willing* sponsor(s) been identified? 3. Are there no known challenging implementation constraints or hurdles (ROW, utility conflicts, permitting, etc.)? 4. Has it meet RFPG specific requirements to incorporate a project or strategy into the RFP?
STEP 6	**FINAL RECOMMENDATIONS OF *FMEs (EVALUATIONS), FMPs (PROJECTS) & FMSs (STRATEGIES)*** 1. Have the recommended FMEs, FMSs and FMPs been made available for public comment? 2. Has the RFPG adopted it?

5.2 FMEs

5.2.1 Summary of Approach in Recommending FMEs

The Lower Rio Grande Planning Region evaluated the identified potential FMEs and based on the significant needs in the region, recommended all FMEs that met the TWDB requirements, with the understanding that not all FMEs may be performed during the same planning cycle as they are identified. Recommended FMEs were also required to demonstrate alignment with at least one regional floodplain management and flood mitigation goal developed in *Chapter 3*. Finally, each recommended FME should identify and investigate at least one solution to mitigate the 1 percent ACF. It is the intent that all FMEs with a hydrologic and hydraulic (H&H) modeling component will evaluate multiple storm

events, including the 1 percent ACF. The exact solutions identified through performing these FMEs cannot be defined at this time. However, it is anticipated that an impact analysis will be performed for all alternatives. Project benefits will be tabulated for the 1 percent ACF to inform any recommended alternatives and define feasible FMPs under this planning framework. Based on these TWDB requirements, the Lower Rio Grande Planning Region identified and recommended three main types of FMEs:

1. **Flood Risk Modeling and Mapping**. Recommended FMEs in this category include detailed hydrologic and hydraulic (H&H) studies that will result in increased flood risk modeling and mapping coverage across the region as they are implemented. As our assessment of the existing flood hazards in the region showed, the Lower Rio Grande Region has large gaps of inundation boundary mapping. Many of the proposed FMEs in this category are a direct result of that assessment. These types of FMEs have two major implications for the identification of potentially feasible FMSs and FMPs in the future. First, a current and comprehensive understanding of flood risk across the basin is necessary to identify high-risk areas for evaluating and developing flood risk reduction alternatives. Second, FMPs, and in some cases, FMSs, require a demonstrated potential reduction in flood risk to be recommended in the RFP. For this metric to be assessed, H&H modeling must be available to compare existing and post-project floodplain boundaries to determine a given project's flood risk reduction potential.

2. **Flood Mitigation Alternative Analysis/Feasibility Study.** Recommended FMEs that are classified as Flood Mitigation Alternative Analysis/Feasibility Studies are hydrologic and hydraulic studies an entity would conduct to understand the flood risk of a specific watershed or area to develop flood mitigation solution alternatives for developing FMPs and FMSs. Many of these types of FMEs were identified as projects in Hazard Mitigation Action Plans. Because the metrics to be classified as an FMP are so stringent, projects listed in these plans may not be based on an actual H&H analysis. H&H analysis is needed to prove that a project meets the evaluation criteria for an FMP.

3. **Preliminary Engineering**. Recommended FMEs classified as Preliminary Engineering types were also included. These FMEs are generally studies or preliminary designs to address a specific, known flood need. However, these flood mitigation actions currently lack some or all of the detailed technical data necessary for evaluation and recommendation as an FMP. An example would be an existing study that identifies potential drainage construction projects but does not provide a full impacts analysis. Completing these components as part of an FME will result in a potentially feasible FMP for consideration during future flood planning efforts.

The primary reason for not recommending an FME was based on sponsor input. An FME was not recommended if a sponsor indicated that the proposed study is currently in progress, has been completed, or was no longer a priority they intended to pursue. In some cases, it is conceivable that multiple FMEs can be combined into a single FME for recommendation due to the proximity of the study areas. Further coordination with the Sponsor is needed to understand their strategy.

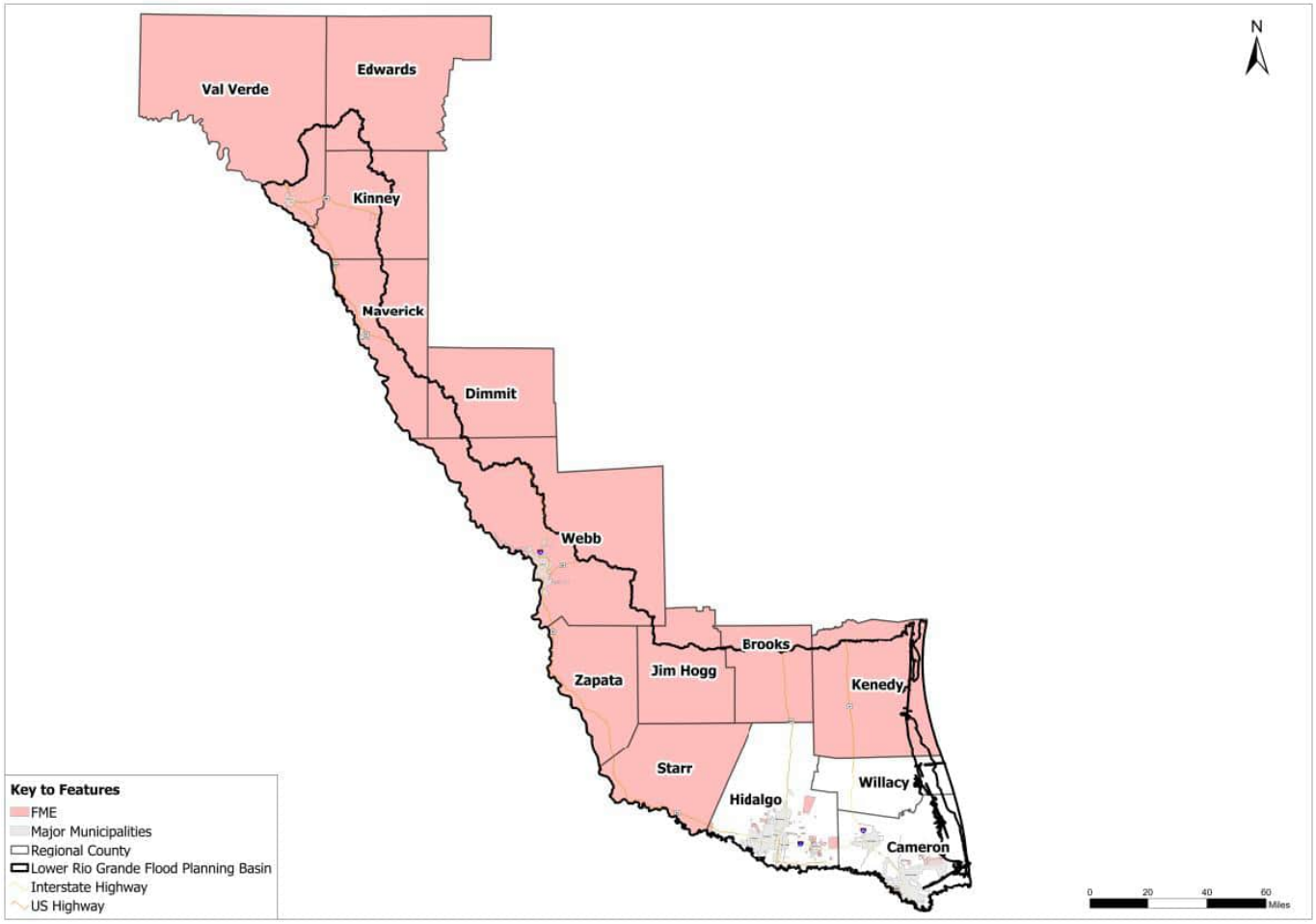
5.2.2 Description and Summary of Recommended FMEs

A total of 133 potential FMEs were identified and evaluated by the Lower Rio Grande Planning Region. Of these projects, 95 were recommended, representing a total of approximately $57 million of FME needs across the region. The number and types of projects recommended by the Lower Rio Grande Planning Region are summarized in **Table 5.1**. The full list of FMEs and supporting technical data is in **Table 15** in **Appendix B**. A map of recommended FMEs is presented in **Figure 5.2** below. A one-page report summary for each recommended FME is included in **Appendix C**.

Table 5.1 Summary of Recommended FMEs

FME Type	FME Description	# of Potential FMEs Identified	# of FMEs Recommended	Total Cost of Recommended FMEs
Watershed Planning	Flood Risk Modeling/ Mapping	24	22	$7,500,000
Preparedness	Flood Mitigation Alternative Analysis/ Feasibility Study	85	51	$22,195,000
Other	Preliminary Engineering	24	22	$27,330,000
	Total	**133**	**95**	**$57,025,000**

Figure 5.2 Map of Recommended FMEs



5.3 FMPs

5.3.1 Summary of Approach in Recommending FMPs

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

1. supports at least one regional floodplain management and flood mitigation goal
2. primary purpose is mitigation (response and recovery projects are not eligible for inclusion in the Regional Flood Plan)
3. FMP is a discrete project (not an entire capital program or drainage master plan)
4. implementation of the FMP results in:
   a. quantifiable flood risk reduction benefits

b. no negative impacts to adjacent or downstream properties (a No Negative Impact Certification is required)
c. no negative impacts to an entity's water supply
d. no overallocation of a water source based on the water availability allocations in the most recently adopted State Water Plan.

In addition, the TWDB recommends that, at a minimum, FMPs should mitigate flood events associated with the 1 percent ACF (100-year annual chance flood event). However, if a 100-year level of service is not feasible, the Lower Rio Grande RFPG can document the reasons for its infeasibility and may recommend an FMP with a lower capacity.

Updated construction cost estimates and estimates of project benefits must also be available to define a BCR for each recommended FMP. The TWDB recommends that proposed projects have a BCR greater than one, but the Lower Rio Grande Planning Region may recommend FMPs with a BCR lower than one with proper justification.

All potentially feasible FMPs with the necessary data and detailed H&H modeling results available to populate these technical requirements were considered for recommendation by the Lower Rio Grande Planning Region. Pertinent details about the FMP evaluation are provided in the following section.

5.4.2 FMP Evaluation

Initial Evaluation

Each FMP was evaluated to verify that it would support at least one of the regional floodplain management and flood mitigation goals established in *Chapter 3*. The goal(s) associated with each FMP are included in **Table 16** in **Appendix B**. Based on a review of the supporting studies and H&H models, the region determined that the primary purpose for each FMP is mitigation (rather than a response or recovery project), is a discrete project, and does not have any anticipated impacts to water supply or water availability allocations as established in the most recently adopted State Water Plan.

No Negative Impacts Determination

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

For the purposes of the flood planning effort, no negative impact can be determined if stormwater does not increase the inundation of infrastructure such as residential and commercial buildings and

structures. Additionally, the following requirements, per TWDB *Technical Guidelines*, should be met to establish no negative impact, as applicable:

- stormwater does not increase inundation in areas beyond the public right of way, project property, or easement
- stormwater does not increase inundation of storm drainage networks, channels, and roadways beyond design capacity
- maximum increase of one-dimensional (1D) Water Surface Elevation (WSEL) must round to 0.0 feet (<0.05 feet) measured along the hydraulic cross-section
- maximum increase of two-dimensional (2D) Water Surface Elevations (WSEL) must round to 0.3 feet (<0.35 feet) measured at each computation cell
- maximum increase in hydrologic peak discharge must be less than 0.5 percent measured at computation nodes (sub-basins, junctions, reaches, reservoirs, etc.). This discharge restriction does not apply to a 2D overland analysis.

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

Furthermore, the Lower Rio Grande Planning Region has the flexibility to consider and accept additional "negative impact" for requirements one through five based on the engineer's professional judgment and analysis, given any affected stakeholders are informed and accept the impacts. This should be well-documented and consistent across the entire region. Flexibility regarding negative impact remains subject to the Lower Rio Grande RFPG review.

A comparative assessment of pre- and post-project conditions for the 1 percent ACE (100-year flood) was performed for each potentially feasible FMP based on their associated H&H models. The floodplain boundary extents, resulting WSEL, and peak discharge values were compared at pertinent locations to determine if the FMP conforms to the no negative impacts requirements. This comparative assessment was performed for the entire zone of influence of the FMP.

A general description of the scope of work for each potentially feasible FMP is provided in **Appendix C**. Based on this evaluation, it was determined that two potentially feasible FMPs conform to the no negative impact requirements. The remaining 36 potential FMPs did not have sufficient data available to perform the no negative impacts assessment at the time of this draft report or they did not provide evidence that the project provided beneficial protection for a 1% annual chance event. These FMPs may still be considered for recommendation as part of the Draft RFP when better data becomes available.

Benefit-Cost Analysis (BCA)

BCA is the method by which the future benefits of a hazard mitigation project are determined and compared to its costs. The end result is a BCR, which is calculated by dividing the project's total benefits, quantified as a dollar amount, by its total costs. The BCR is a numerical expression of the relative "cost-effectiveness" of a project. A project is generally considered cost-effective when the BCR is one or

greater, indicating the benefits of a prospective hazard mitigation project are sufficient to justify the costs (*FEMA, 2009*). However, a BCR greater than one is not a requirement for inclusion in the Regional Flood Plan. The Lower Rio Grande Planning Region can decide to recommend a project with a lower BCR with appropriate justification.

When a BCR had been previously calculated in an engineering report or study that was used to create an FMP, the previously calculated BCR value was utilized for the FMP analysis. For any FMP that did not already have a calculated BCR value, no further analysis was performed. More time and better information is needed to be able to calculate the BCR for the proposed FMPs.

5.4.3 Description and Summary of Recommended FMPs

Due to the level of detail required for consideration as an FMP, only two out of 38 potentially feasible FMPs were determined to have enough details available for evaluation and potential recommendation for inclusion in the Regional Flood Plan. Based on the FMP evaluation described in *Section 5.4.2*, the Lower Rio Grande Planning Region has determined that two FMPs comply with all the TWDB requirements and recommended them for inclusion in the Regional Flood Plan representing a combined total project cost of $13,782,000. A map of project areas for the recommended FMPs is provided in **Figure 5.3** on the next page.

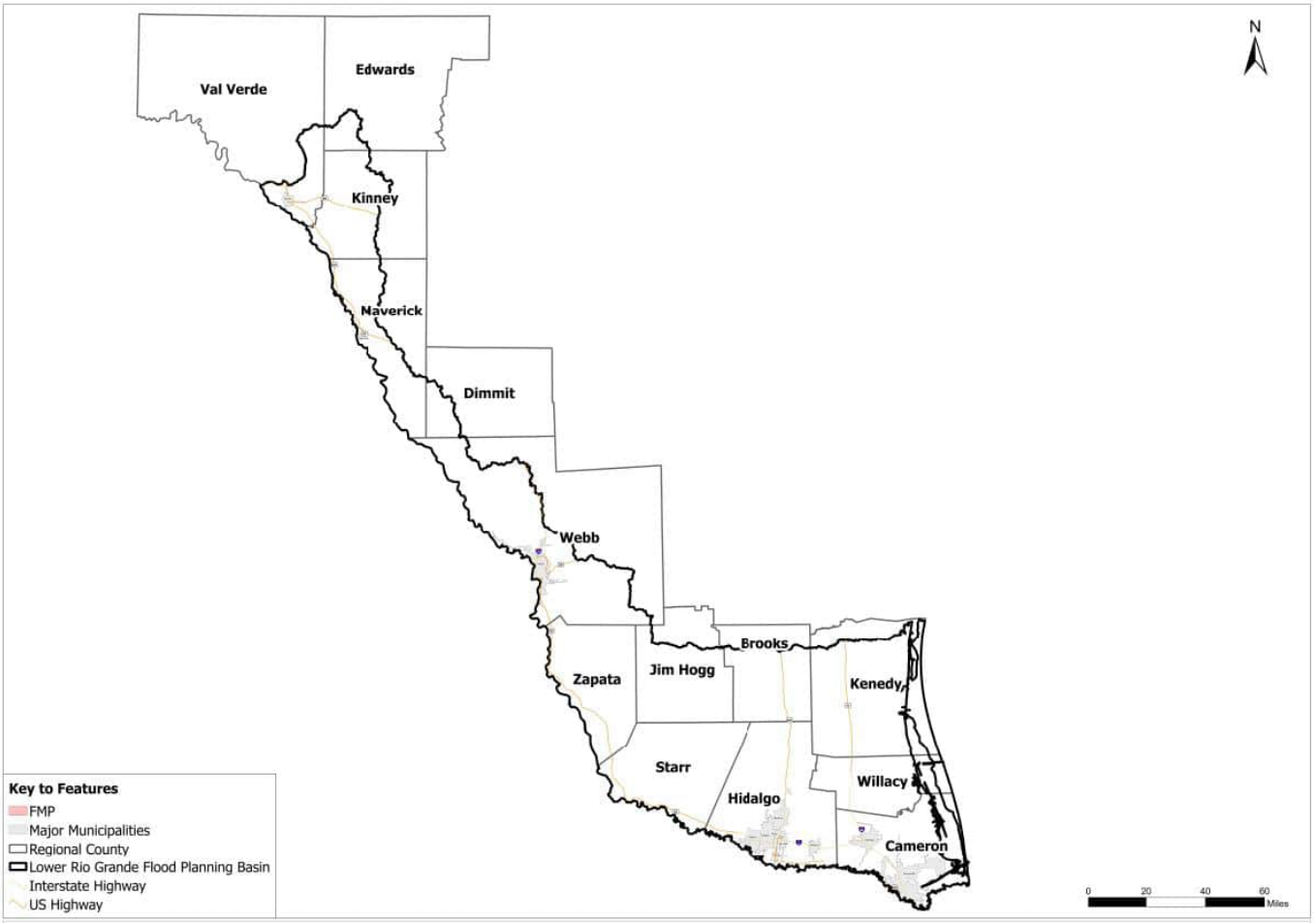
A summary of the recommended FMPs for inclusion in the Regional Flood Plan is presented in ***Table 5.2***. These two projects are located within the City of Pharr and represent a combined total construction cost of $13.8 million. Supporting technical data for each FMP, including their flood risk reduction benefits, is included in **Table 16** in **Appendix B**. A one-page report summary for each recommended FMP is included in **Appendix C.** Additionally, **Appendix C** provides a detailed breakdown of the estimated planning-level costs for each FMP following the TWDB Technical Guidelines.

Table 5.2 Summary of Recommended FMPs

FMP ID	FMP Name	FMP Description	Cost
153000011	North Pharr Mitigation Project	Construct 3400 linear feet of channel improvements on the ditch running south to north along North Fir Street and 2800 linear feet of channel improvements on the Pharr-McAllen Lateral Ditch up to North I road. Install culvert improvements, 2 – 8' X 4' RCB, alongside the ditch running parallel to Fir Street at crossings of W. Sioux Road and a connection to the outfall of a maintained ditch to the Pharr-McAllen Lateral System. Construct an inline Regional Detention Facility (RDF) along the Pharr-McAllen drain within the City Limits of San Juan. The pond will require a footprint of 35 acres.	$8,195,000
153000012	Southwest Pharr Drainage	Construct four regional detention facilities (RDF). RDF 1 has a footprint of 19.75-acres and is a lateral detention facility between Dicker and Thomas Road	$5,587,000

	Mitigation Project	west of Highway 281 and near Carmen Anaya Elementary. RDF 2 has a footprint of 7.4 acres and is located in the western section of Jones Box Park. RDF 3 has a footprint of 5.5-acres and is located in the central section of Jones Box Park. Redirect flow from the Los Ranchitos Subdivisions via a reconfigured 36'' RCP into a pilot channel located in the deepest section of the pond. Install 36''RCP and flap gate at the outfall to prevent backflow from the South Floodwater Channel into the subdivisions north of Jones Box Park. RDF 4 is located between Dicker and Las Milpas Road east of Highway 281, south of the South Floodwater Channel, and will require a footprint of 13.8-acres.	
		Total	**$13,782,000**

Figure 5.3 Map of Recommended FMPs



5.4 FMSs

5.4.1 Summary of Approach in Recommending FMSs

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

1. supports at least one regional floodplain management and flood mitigation goal
2. primary purpose is mitigation
3. implementation of the FMS results in:
    a. quantifiable flood risk reduction benefits
    b. no negative impacts to adjacent or downstream properties (a No Negative Impact Certification is required)
    c. no negative impacts to an entity's water supply
    d. no overallocation of a water source based on the water availability allocations in the most recently adopted State Water Plan

In addition, the TWDB recommends that, at a minimum, FMSs should mitigate flood events associated with the 1 percent ACF (100-year level of service). However, if a 100-year level of service is not feasible, the Lower Rio Grande RFPG may document the reasons for its infeasibility and still recommend an FMS with a lower level of service.

Although each potentially feasible FMS must demonstrate that there would be no negative flood impacts on a neighboring area due to its implementation, there were no structural FMSs identified for this region. Therefore, no adverse impacts from flooding or to the water supply are anticipated.

In addition to the above requirements, some FMSs were not recommended if they were redundant with another recommended FMS or if their purpose was primarily related to stormwater quality. In some cases, multiple FMSs were combined into a single FMS for recommendation. These merged FMSs included the development of county-wide educational programs and updating land use planning and zoning regulations.

5.4.2 Description and Summary of Recommended FMSs

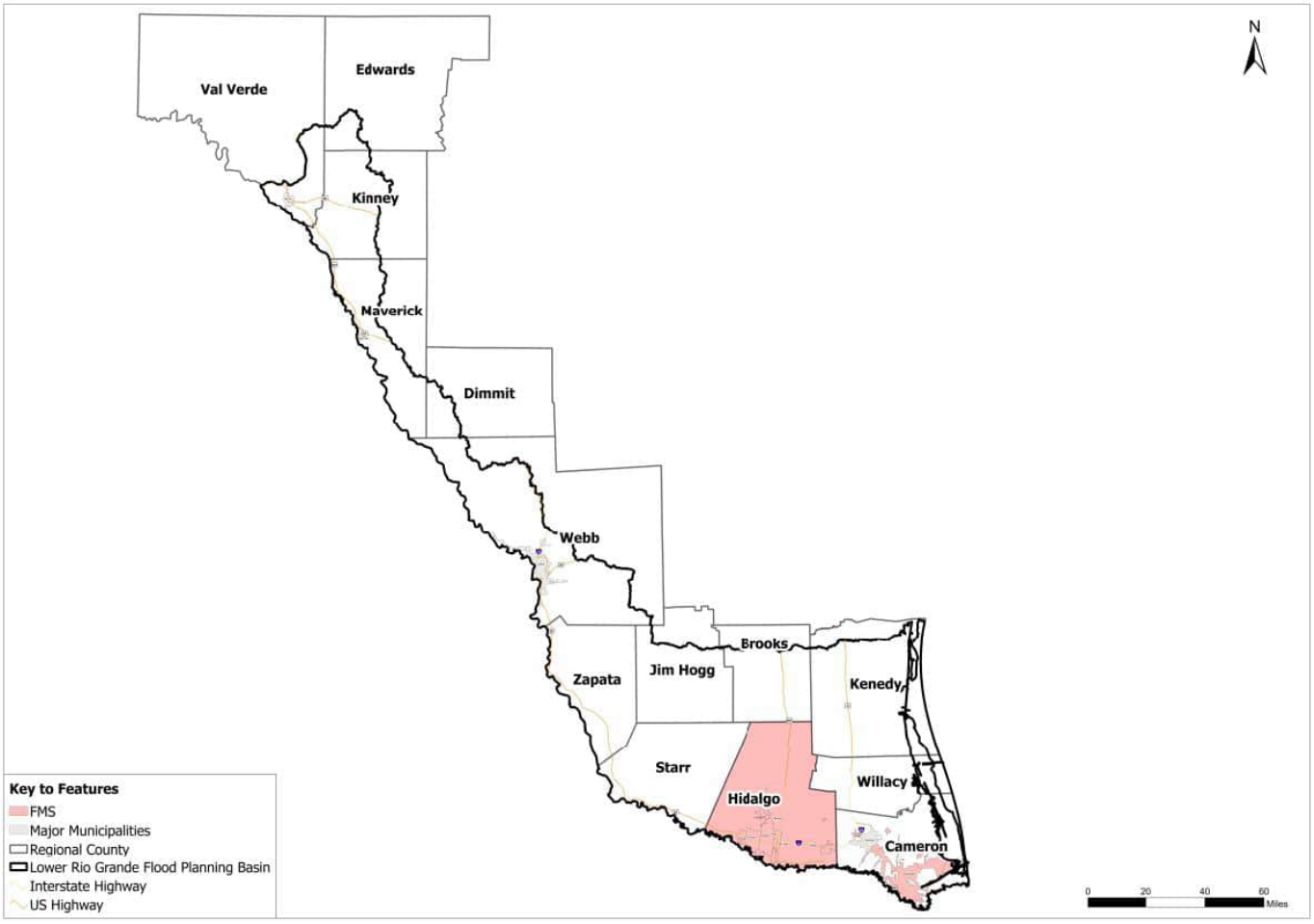
A wide variety of FMS types were identified and evaluated for the Lower Rio Grande Planning Region. The Lower Rio Grande Region considered a total of 51 potentially feasible FMSs and all 51 were recommended for inclusion in the Regional Flood Plan. Generally, these FMSs recommend city-wide and county-wide strategies and initiatives that represent a combined total cost of approximately $4 million. A map of project areas for the recommended FMSs is provided in **4** on the next page.

The number and types of strategies recommended by the Lower Rio Grande Region are summarized in **Table 5.3** . The full list of FMSs and supporting technical data, including their flood risk reduction benefits as applicable, is included in **Table 17** in **Appendix B**. A one-page report summary for each recommended FMS is included in **Appendix C.**

Table 5.3 Summary of Recommended FMSs

FMS Type	FMS Description	# of Potential FMSs Identified	# of FMSs Recommended	Total Cost of Recommended FMSs
Education and Outreach	NFIP Education; Flood Education; Floodplain Regulatory Awareness; Emergency Contact Awareness	8	8	$66,000
Flood Measurement and Warning	Flood Warning Systems; Mass Notifications during Natural Hazard Incident; Dam Inundation Studies	25	25	$1,867,000
Regulatory and Guidance	City Floodplain Ordinance Creation/Updates; Zoning Regulations; Land Use Programs;	18	18	$2,177,000
	Total	**51**	**51**	**$4,109,000**

Figure 5.4 Map of Recommended FMSs



Chapter 6

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Chapter 6: Impact and Contribution of the Regional Flood Plan

The objective of this task is to assess and summarize the impacts and contributions, in the aggregate, associated with the implementation of this Regional Flood Plan. Previous chapters assessed existing flood hazards and exposure conditions based on the 1 percent and 0.2 percent annual chance flood events. In addition, an inventory of existing infrastructure and natural features was compiled for use as a baseline. Flood risk reduction or mitigation needs were identified, leading to the Region Flood Planning Group (RFPG) adoption of recommendations presented in the previous chapter of flood management evaluations, strategies, and mitigation projects. This chapter compares those identified risks with the potential estimated positive and negative benefits of implementing the Regional Flood Plan. Additionally, in the second part of this chapter, potential contributions to and impacts on water supply development and the State Water Plan are assessed.

6.1. Impacts of Regional Flood Plan

Implementation of the Regional Flood Plan is expected to mitigate future flood risk. The requirement that all evaluations, projects and strategies mitigate to a 1% annual chance flood event is higher than what entities within the region currently design to. Furthermore, the lack of local ordinances and policies requiring that a no negative impact be checked is another higher standard that entities will start enforcing if they want to include their project in the State Flood Plan. Implementation of the two recommended flood mitigation projects (FMPs) included in this RFP is expected to benefit an estimated 9,247 people living in a flood-prone areas. As more FMEs, FMPs, and FMS get implemented, the flood risk will be reduced, at least for the area of impact for the action. Benefits will vary across the region due to the highly variable and local nature of most flood hazard areas, as well as with the types of studies, strategies, and projects implemented, however, the risks should at the minimum not worsen. Further discussion of the potential benefits of implementing this Regional Flood Plan is provided below.

1.1.a. Summary of Relative Reduction of the Flood Risk

Floodplain Management and Modeling

The existing condition exposure analysis revealed that approximately 4,079 square miles or 33 percent of the Lower Rio Grande Planning Region, including an estimated population of 276,662, are currently at risk of flooding during the 1% annual chance flood event. Information was compiled during the baseline development of the Regional Flood Plan. The lack of current flood risk hazard data in the Lower Rio Grande Region makes analysis of any improvements difficult. Quantitative measures of how successful a mitigation effort is, is not possible until the entire region is mapped, and the hydraulic capacity and operation of the watershed and drainage system are understood. The wide range of floodplain management practices and enforcement practices limit how much a community can do unless they work cooperatively with the other stakeholders within the same watershed. Detailed hydrologic and hydraulic modeling of a watershed is needed to understand the risk and the effectiveness of strategies, objectively.

A total of 95 FMEs are recommended in this RFP. Twenty-two (22) of the recommended FMEs are flood risk mapping studies that were identified during the needs assessment. These 22 floodplain mapping will better define the flood risk for 67% of the floodplain. Implementation of the FMEs will ultimately give entities a tool to address the flood hazard aggressively and effectively in their community. Once the flood hazard is better understood, effect floodplain management and land use strategies can be implemented. Another 85 proposed FMEs will conduct and alternative analysis to determine the source and extent of a flood prone area and will identify the most beneficial solution that not only mitigates the flood problem, but also considers the project's impact on their neighbors and water supply. The last 24 FMEs are refinement projects that take the analysis to a deeper or higher level to define its level of service, consider the environmental and financial benefits of the project and evaluate the impacts of the project within the watershed.

Reduction in Flood Impacted Areas

Existing and future flood hazard areas were identified and quantified for both 1 percent and 0.2 percent annual chance flood events; however, flood risk is generally defined for the existing condition 1 percent annual chance (100-year) flood event. The tables below show the flood-impacted areas in square miles for both existing and future scenarios based on both annual chance flood events and the reduction of impacted areas. Implementing the Regional Flood Plan will reduce areas previously impacted by approximately 0.2 percent, or a reduction of approximately 4.7 square miles.

Table 6.1 Reduction in Existing Flood Impacted Areas

Annual Chance Event Flood Event	Area in Floodplain (sq. mi.)	Reduction of Floodplain after Implementation (sq. mi.)	Decrease in floodplain impacted, (%)
1% (100-Year Event)	4,078	2.9	0.07%
0.2% (500-Year Event)	1,209	1.8	0.15%
Total	**5,287**	**4.7**	**0.09%**

Table 6.2 Reduction in Future Flood Impacted Areas

Annual Chance Event Flood Event	Area in Floodplain (sq. mi.)	Reduction of Floodplain after Implementation (sq. mi.)	Decrease in floodplain impacted, (%)
1% (100-Year Event)	5,287	2.9	0.05%
0.2% (500-Year Event)	1,269	1.8	0.14%
Total	**6,556**	**4.7**	**0.07%**

Benefits to Population and Structures at Risk

The direct beneficiaries of this Regional Flood Plan implementation are the populations that reside in areas with reduced flood risk and public and private assets (e.g., structures, roads, utilities). The estimated population removed from the flood risk area is shown in **Table 6.3**. While the number of potentially avoidable injuries and deaths associated with implementing this plan is not quantifiable, the expected benefits could be significant. Public safety benefits will be a result of changing flood characteristics to reduce flood risk to structures, roads, and property (structural flood mitigation projects) and by changing the way people interact with flood risk (non-structural flood mitigation projects and strategies) through regulatory improvements, educating people about flood risks, and by implementing flood early warning and evacuation measures.

Table 6.3 shows the estimated populations for the 14 counties, or parts thereof, located within the Lower Rio Grande Planning Region for the year 2020 and projected populations for the year 2050. These populations are based on Water User Group and HUC (Hydrologic Unit Codes)-8 population projections provided by the Texas Water Development Board from the 2022 State Water Plan.

Table 6.3 Population Removed from the Floodplain

Annual Chance Event Flood Event	Existing At-Risk Population	Reduction of At-Risk Population after Implementation	Decrease in Population Impacted
1% (100-Year Event)	276,662	7,217	2.6%
0.2% (500-Year Event)	689,125	42,064	6.1%
Total	**965,787**	**49,281**	**5.1%**

Implementation of this plan provides benefits by removing existing structures within flood hazard areas. These include inundated structures for short periods and those inundated for extended periods within areas with relatively flat topography, such as the coastal areas. **Table 6.4** shows the estimated number of structures that will be removed after implementing the Regional Flood Plan.

Table 6.4 Structures Removed from the Floodplain

Annual Chance Event Flood Event	Existing At-Risk Structures	Reduction of At-Risk Structures after Implementation	Decrease in Structures Impacted
1% (100-Year Event)	114,282	4,530	4%
0.2% (500-Year Event)	174,084	7,204	4.1%
Total	**288,366**	**11,734**	**4%**

Critical facilities are generally identified as municipal and other public utilities, governmental facilities, hospitals and care facilities, and schools. **Table 6.5** shows the estimated number of exposed critical facilities and those that will be removed from the floodplain through this plan's implementation.

Table 6.5 Critical Facilities Removed from the Floodplain

Annual Chance Event Flood Event	Existing At-Risk Critical Facilities	Reduction of At-Risk Critical Facilities after Implementation	Decrease in Critical Facilities Impacted
1% (100-Year Event)	138	0	0%
0.2% (500-Year Event)	428	20	4.7%
Total	**566**	**20**	**3.5%**

Low Water Crossings and Impacted Roadways

The direct beneficiaries of this Regional Flood Plan implementation are the populations that reside in areas with reduced flood risk and public and private assets (e.g., structures, roads, utilities). The estimated low water crossings removed from the flood risk area are shown in **Table 6.6**. The benefits of the FMPs implemented, unfortunately, do not impact low water crossings.

Table 6.6 Low Water Crossings Removed

Annual Chance Event Flood Event	Existing At-Risk Low Water Crossings	Reduction of At-Risk Low Water Crossings after Implementation	Decrease in Low Water Crossings Impacted
1% (100-Year Event)	124	0	0%
0.2% (500-Year Event)	2	0	0%
Total	**126**	**0**	**0%**

In addition to the number of low water crossings being removed, flooded roadways also benefit from implementing the Regional Flood Plan. Information in

Table 6.7 shows transportation infrastructure benefits by reducing the time a roadway is closed or removing it from flooding altogether.

Table 6.7 At-Risk Roadways Removed

Annual Chance Event Flood Event	Existing At-Risk Roadways (miles)	Reduction of At-Risk Roadways after Implementation	Decrease in Roadways Impacted
1% (100-Year Event)	3,793	45.6	1.2%
0.2% (500-Year Event)	2,583	21.6	0.8%
Total	**6,376**	**67.2**	**1.1%**

Socioeconomic and Recreational Impacts

Socioeconomic

Implementing the Regional Flood Plan, as shown in the previous sections, benefits the entire region. As part of this effort, socioeconomic impacts were considered to evenly distribute flood risk reduction benefits among all regional groups as much as practical. The region has a diverse population with wide-ranging economic levels requiring extra attention to improve conditions for everyone. Disadvantaged socioeconomic populations have limited access to resources hindering response and recovery from flood events. Processes in developing the appropriate Flood Mitigation Strategies (FMSs), Flood Mitigation Projects (FMPs), and Flood Mitigation Evaluations (FMEs) included reducing the impacts of flood events and improving the lives of all socioeconomic groups ensuring the most disadvantaged were well represented. This can be shown in the locations of FMSs, FMPs, and FMEs identified in the region.

Recreation Impacts

There can be many opportunities to benefit recreation through implementing the Regional Flood Plan. Many parks located along waterfronts are designed to be flooded periodically with infrastructure minimally impacted. Floodplains and wetlands can support recreation and tourism. Although not specifically identified in this plan, as FMSs and FMPs are implemented that remove structures from floodplains and reduce existing floodplains, new opportunities become available for local sponsors. These areas are often utilized in cities throughout the state for hiking and biking trails. The RFPG will encourage secondary benefits such as recreational opportunities. While the Regional Flood Plan will provide opportunities, it will not negatively impact existing recreation activities throughout the region.

Overall Impacts

Implementing the Regional Flood Plan provides numerous benefits associated with the primary purposes of FMEs, FMSs, and FMPs. Although not readily quantifiable, the benefits will provide greater protection of public health and safety throughout the region. This is accomplished by reducing the frequency and severity of flooding in flood-prone areas, removing populations, structures, and roadways from flooding with expanded improved warning systems, and providing officials with the tools to effectively manage flood-prone areas.

6.2. Contributions to and impacts on water supply development and the State Water Plan

Regional Flood Plans must include a region-wide assessment of the potential contributions and impacts that implementation can be expected to have on water supplies and the State Water Plan. As part of this analysis, each FMS and FMP was reviewed to determine whether there are potential impacts on existing water supplies or the availability of water supplies. Impacts include potential contributions to, as well as reductions in water supply and availability. These impacts, as determined, would be placed in one of the following categories:

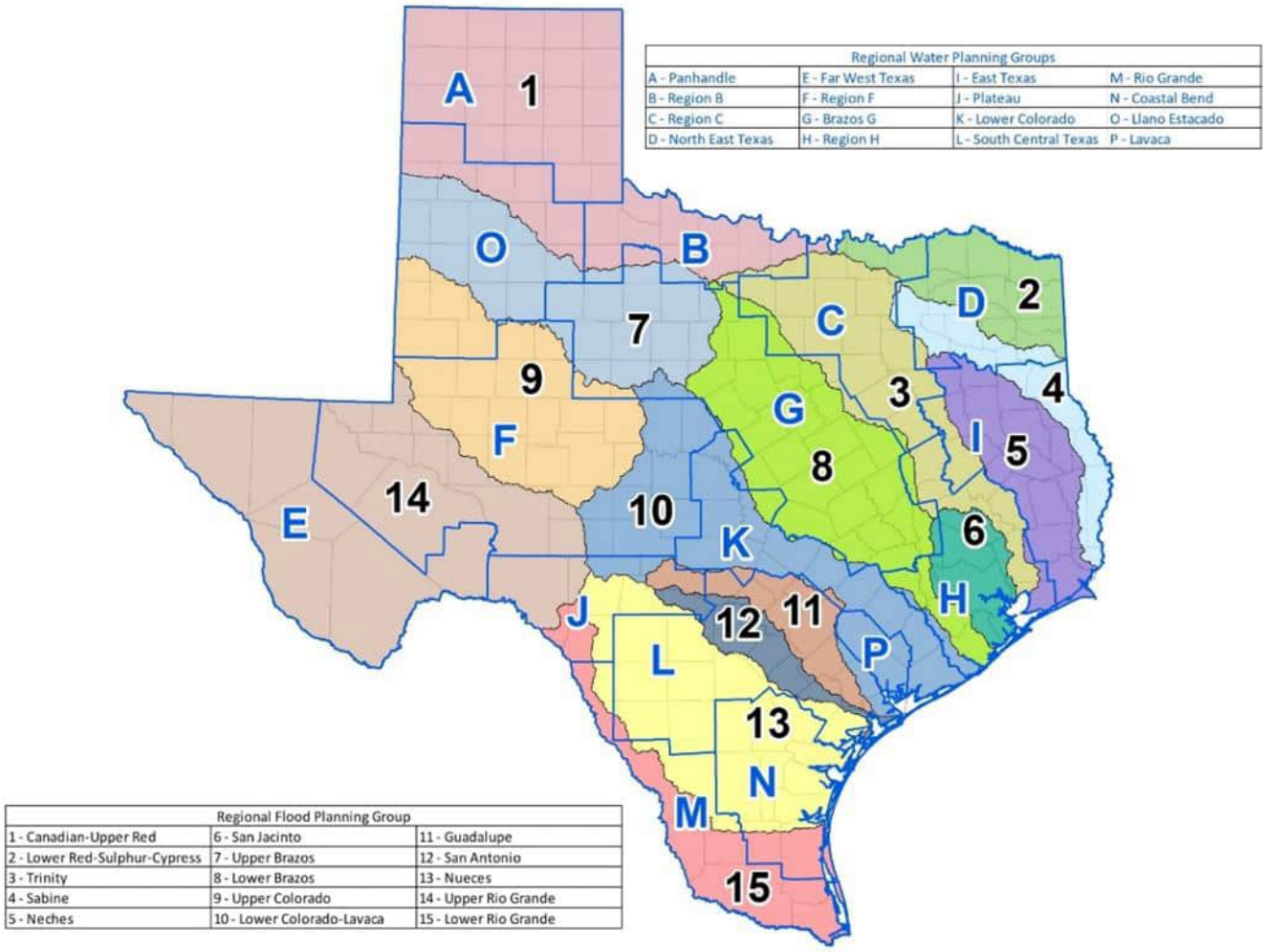
- involves direct impacts on available water supply yield during a drought-of-record, which requires both availability and directly connecting supply to a specific water user group(s)

- direct benefits (i.e., increases) water availability
- indirectly benefits water availability
- has no anticipated impact on the water supply

It was determined that there were no anticipated impacts from the recommended FMSs and FMPs on water supply, water availability, or projects in the State Water Plan based on no anticipated measurable impacts.

Figure 6.1 below shows the overlap of the various Regional Flood Planning Regions and the Regional Water Planning Regions. Region 15 Regional Flood Planning basin overlaps the Region J, L and M Regional Water Planning Area.

Figure 6.1 Flood Planning Regions versus Regional Water Plan Boundaries



Chapter 7

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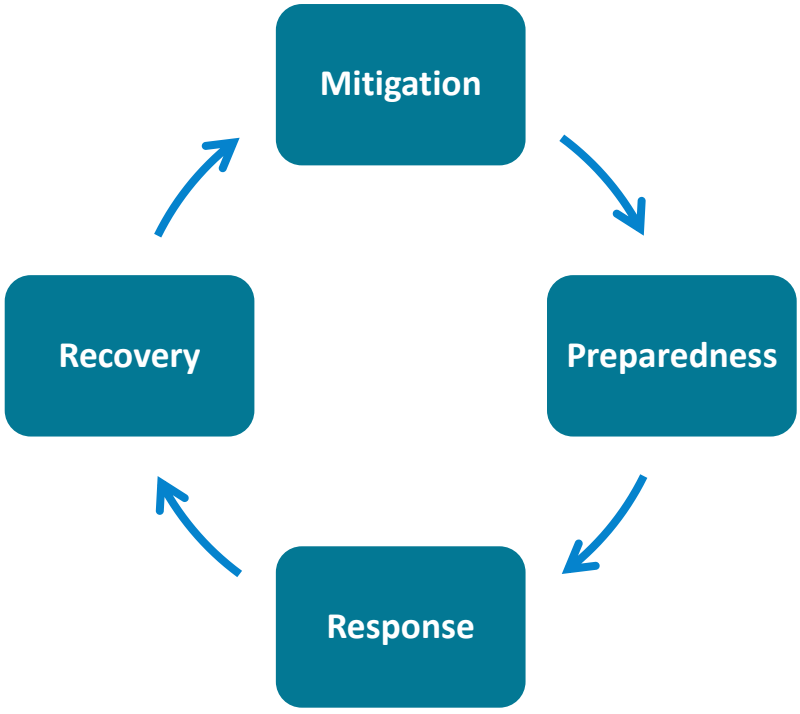
Chapter 7: Flood Response Information and Activities

This chapter summarizes the existing flood response and recovery activities provided by communities within the Lower Rio Grande Planning Region.

In 2011, a Presidential Policy Directive[1] was issued establishing a national preparedness goal "…aimed at strengthening the security and resilience of the United States through systematic preparation for the threats that pose the greatest risk to the security of the Nation, including … catastrophic natural disasters." The directive also established the National Preparedness System, which includes a series of "integrated national planning frameworks" that address prevention, protection, mitigation, response, and recovery. Together these establish an overall institutional framework through which flood response preparedness is planned and implemented at the federal, state, and local levels of government. As depicted in **Figure 7.1**, this national framework for emergency management is organized around four phases: mitigation, preparedness, response, and recovery.

Figure 7.1 The Four Phases of Emergency Management



Source: Texas Water Development Board (TWDB)

[1] Presidential Policy Directive/PPD-8. National Preparedness. The White House, March 30, 2011. Available at: https://www.dhs.gov/xlibrary/assets/presidential-policy-directive-8-national-preparedness.pdf

As shown in **Figure 7.1**, emergency management involves four phases (*FEMA, 1998*):

- **Flood Preparedness:** Actions, aside from mitigation, are taken before flood events to prepare for flood response activities.
- **Flood Mitigation:** The implementation of actions, including both structural and non-structural solutions, to reduce flood risk to protect against the loss of life and property.
- **Flood Response:** Actions taken during and in the immediate aftermath of a flood event.
- **Flood Recovery:** Actions taken after a flood event involving repairs or other actions necessary to return to pre-event conditions.

This chapter is focused on the preparedness, response, and recovery phases of Emergency Management, as the rest of the Regional Flood Plan addresses the Mitigation Phase. The chapter is organized into three sections: roles and responsibilities for flood emergency preparedness, response, and recovery; flood preparedness and response; and recovery actions for the Lower Rio Grande Planning Region.

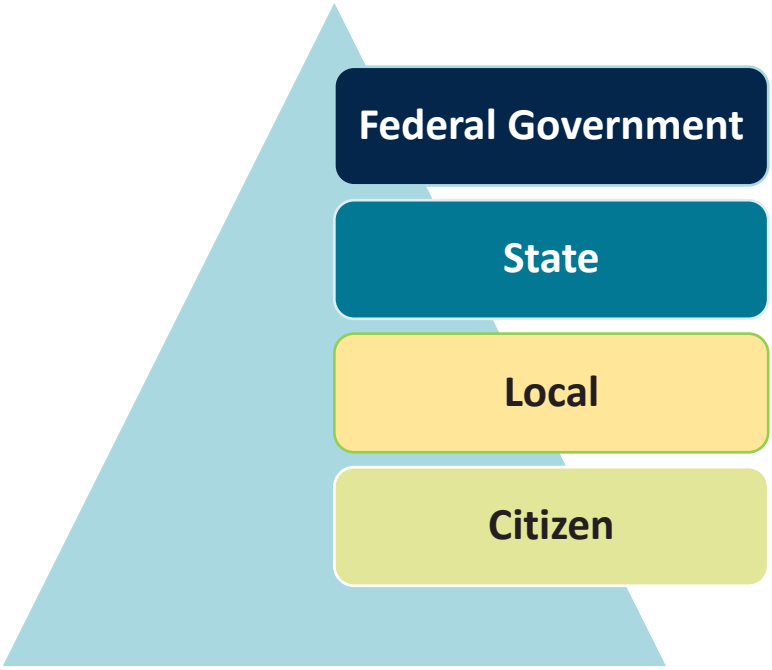
7.1 Roles and Responsibilities for Flood Emergency Preparedness, Response, and Recovery

Responsibility for flood emergency preparedness, response, and recovery is a shared responsibility between multiple federal agencies, the states (and tribes and territories), and communities (i.e., individuals, businesses, and local government) operating within the national emergency management framework. Additionally, the United States Department of Homeland Security has established the National Incident Management System, which "…provides a consistent nationwide template to enable partners across the Nation to work together to prevent, protect against, respond to, recover from, and mitigate the effects of incidents, regardless of cause, size, location, or complexity."[2]

In many respects, the institutional framework for flood emergency preparedness, response, and recovery are "bottom-up." Much of the responsibility and authority for emergency management rests with local government and the communities they serve. This allows emergency management processes and activities to be tailored to only those areas affected by a natural disaster, such as a flood emergency. That said, federal and state agencies play a critical and central role in coordinating emergency management activities and providing support and assistance to local entities in emergency preparedness planning, emergency response, and post-disaster recovery. Starting with the federal role, the following presents a discussion of the emergency management roles and responsibilities at each level of government.

[2] Federal Emergency Management Agency, National Incident Management System, Third Edition, October 2017.

Figure 7.2 Emergency Management Support



Source: Emergency Management Institute, Are You Ready?

7.1.A Federal Emergency Management Responsibilities

Nationally, the Federal Emergency Management Agency (FEMA) and their federal agency partners have legal authorities, technical and financial resources, and programs to assist state and local governments with flood preparedness and emergency response and with flood risk reduction through prevention and mitigation. Below is a brief description of the lead role played by FEMA at the federal level in flood emergency preparedness, response, and recovery.

Federal Emergency Management Agency (FEMA)

FEMA is an agency of the United States Department of Homeland Security (DHS). FEMA's primary focus is to coordinate the response to all types of disasters in the United States and its territories, particularly those of a magnitude that may overwhelm the capabilities and resources of state and local authorities. At the federal level, FEMA plays the central role in helping people before, during, and after disasters.

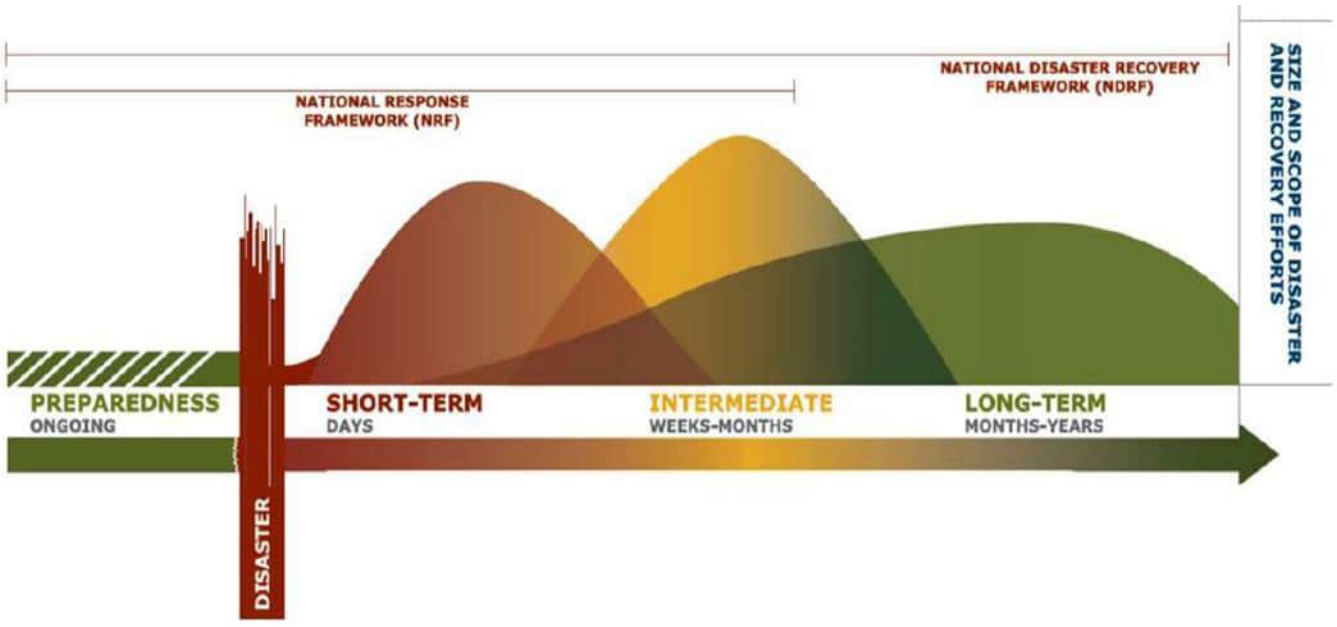
Specifically, FEMA assists with:

- public outreach and education, through raising flood risk awareness, informing the public and interest groups about flood risk reduction options, and providing technical and financial assistance with flood emergency planning and preparedness
- coordination of the federal response to flood disasters and mobilization and management of the federal resources during disasters
- coordination of the federal disaster recovery efforts and provision of resources.

By law, FEMA is tasked with a lead role in disaster prevention, protection, mitigation, response, and recovery, consistent with the agency's statutory authorities. FEMA has incorporated the Presidential Policy Directive into their established emergency management program, which focuses on the four-phase *all-hazards* approach to emergency management that is implemented in partnership with state and local government, private sector entities, and non-governmental organizations (e.g., the American Red Cross). As discussed in some detail in *Chapter 3*, FEMA also plays a key role nationally in flood risk prevention and reduction as the administering agency for the National Flood Insurance Program (NFIP). As noted in *Chapter 3*, nearly all eligible local entities in the Lower Rio Grande Planning Region are current participants in the NFIP. They, therefore, have adopted and enforced at least the minimum required standards for floodplain management.

FEMA also oversees the National Disaster Recovery Framework to promote disaster effectiveness. A core component of the National Disaster Recovery Framework advances the concept that recovery extends beyond simply repairing damaged structures. It also includes "the continuation or restoration of services critical to supporting the physical, emotional, and financial well-being of impacted community members."[3] In other words, it includes restoring and strengthening key systems and assets critical to the community's long-term vitality. One of the key concepts of the National Disaster Recovery Framework is the Recovery Continuum—an acknowledgment that the foundation for a strong recovery starts with effective pre-incident preparedness planning (**Figure 7.3**).

Figure 7.3 National Disaster Recovery Framework (NDRF) Recovery Continuum



[3] NRDF. Available at: https://www.fema.gov/sites/default/files/2020-06/national_disaster_recovery_framework_2nd.pdf

FEMA also has the lead role in initiating federal emergency response actions and mobilizing and coordinating federal resources in "real-time" immediately before and during flood disasters. This involves coordinating with the Governors of affected states, state emergency management agencies, and the Texas Division of Emergency Management (TDEM). State Emergency Managers coordinate with local officials in impacted areas, primarily at the county level, and county officials coordinate and collaborate with the local officials. During the pre-event preparedness and response phases, FEMA's authority and resources may be bolstered by an "Emergency Declaration" by the President, which is one of two types of federal disaster declarations provided for in the federal Stafford Act (42 U.S.C. §§ 5121-5207). For Emergency Declarations, the President can declare an emergency for any occasion or instance where there is a need for federal assistance. Emergency Declarations are generally issued in response to a direct request from the Governor of the affected state and/or upon recommendation of FEMA.

An Emergency Declaration intends to enable the federal government to mobilize resources in real-time to support and supplement state and local efforts to "…provide emergency services, such as the protection of lives, property, public health, and safety, or to lessen or avert the threat of a catastrophe in any part of the United States."[4] Once the President issues an Emergency Declaration, FEMA can assist state and local entities with debris removal and implementation of emergency protective measures. Before an imminent natural disaster and often in advance of an Emergency Declaration, FEMA may also place federal resources on standby or even pre-position federal personnel and other resources; for example, to have personnel and equipment at the ready to aid in rescue operations and/or to prepare for the recovery phase, such as by pre-positioning of drinking water and food to expedite delivery to impacted areas. In some circumstances, the Governor of an affected state may request and receive a Pre-Disaster Emergency Declaration, which enables FEMA to assist with emergency protective measures.

The second type of federal disaster declaration is a "Major Disaster Declaration," issued only by the President and considered in the aftermath of a major natural disaster. Major disasters are any natural event (e.g., hurricanes, severe storms, floods, water, tidal waves, etc.) where it has been determined that the damage is of such severity that it is beyond the combined capabilities of state and local government. A major disaster declaration provides for a wide range of federal assistance programs for both impacted individuals, businesses, public infrastructure, and for continuity of local governmental operations. All requests for a presidential declaration of a major disaster are made by the Governor of the affected state or territory.

FEMA plays a central role in the process for issuance of Major Disaster Declarations, which are required for full mobilization of federal disaster recovery resources. The process begins with a preliminary damage assessment, often conducted jointly by FEMA and state officials and agencies, such as TDEM, and with the participation of affected local entities. In this step, the extent of the disaster is assessed along with impacts on the public and public facilities. From the assessment, a preliminary determination

[4] FEMA Declarations. Available at: https://www.fema.gov/disaster/how-declared.

is made as to the types of federal assistance that may be needed. Typically, the preliminary damage assessment provides the basis for a Governor's request for a Major Disaster Declaration. However, in some cases where the magnitude of the disaster is such that the level of damage and the need for federal assistance is overwhelming and apparent, a Major Disaster Declaration may be requested before the completion of the preliminary assessment.

Other Federal Agency Partners

Several federal agencies partner with FEMA to provide support and assistance before, during, and after flood emergencies and disasters. For example, the United States Army Corps of Engineers often has a lead role as the federal contracting agency for acquiring, pre-positioning, and distributing drinking water, food supplies, equipment, and other goods and services. FEMA may also call upon them and other federal agencies to provide personnel and available equipment for debris removal or other recovery activities. Another example is the Small Business Administration, an agency of the United States Department of Commerce, which is often mobilized to assist impacted businesses with recovery by providing loans or other assistance.

7.1.B State Emergency Management Responsibilities

As indicated in the above discussion, at the state level, the Governor and the Texas Division of Emergency Management (TDEM) also have central roles in emergency management before, during, and after flood emergencies and disasters. The Governor, for example, has the authority to issue State Disaster Declarations and, in doing so, mobilize and deploy state resources to prepare for and respond to natural disasters. This may include the deployment of state personnel or the National Guard to support public safety activities, such as a large-scale evacuation, as well as provision of material support, such as the deployment of equipment for clean-up in the immediate aftermath of a disaster and during the recovery phase. Most importantly, as noted, it is the Governor that can make requests for presidential Emergency Declarations and Major Disaster Declarations.

TDEM is an administrative unit of the Texas A&M University System and is the state agency charged with implementing the state's all-hazard emergency management program. A key TDEM responsibility is supporting the Governor with the state and federal emergency declaration and response processes. With this role, TDEM serves as the primary point of contact with FEMA, counties, and other local entities before and during flood emergencies. During the recovery phase, TDEM plays a central role in coordinating the participation of affected state and local entities in conducting preliminary damage assessments. Specifically, TDEM has a lead role in collecting, compiling, and analyzing data and information provided by local authorities regarding the extent of damages to public infrastructure and facilities, impacts on individuals and businesses, and costs for local response and recovery activities. Other responsibilities include disaster preparedness activities, including state and local emergency management planning, hazard mitigation planning, and training of local officials and emergency management personnel.

7.1.C Local Emergency Management Responsibilities

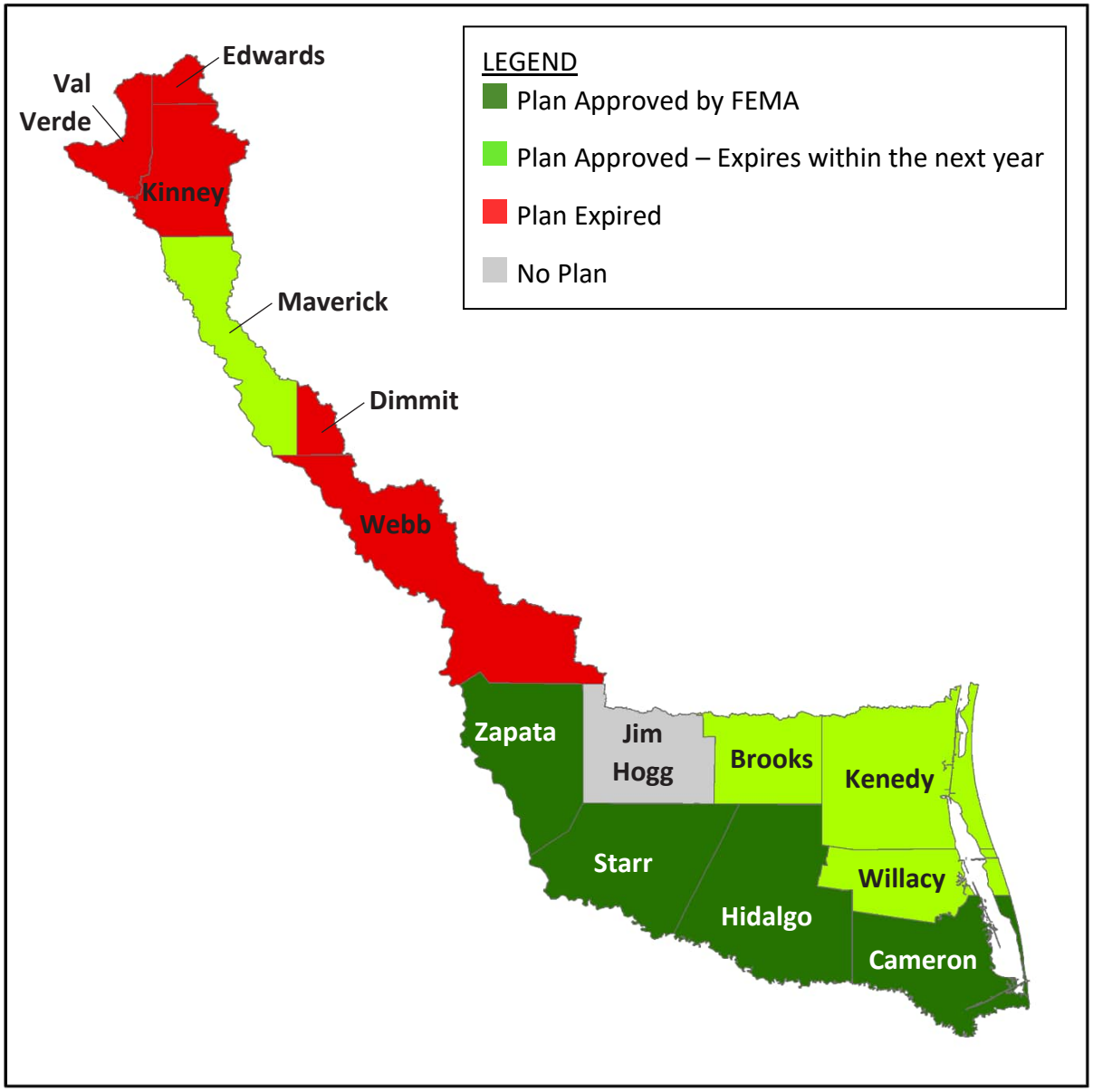
As noted previously, in many respects, emergency management is a bottom-up process with a large portion of the responsibility related to flood emergency preparedness, response, and recovery residing at the local level. In Texas, counties and municipalities are at the frontline of emergency management. The chief executives of these local governmental entities – county judges and mayors – have the authority under state law to declare local disasters and oversee local and/or inter-jurisdictional emergency management functions. As stated in Chapter 418 of the Texas Government Code and Title 37, Part 1, Chapter 7 of the Texas Administrative Code, these officials are authorized to declare local disasters.[5] A local disaster declaration allows public officials to exercise emergency powers to preserve life, property, and public health. For example, county or city officials can order evacuations from and control access to threatened or impacted areas under a local disaster declaration and temporarily suspend certain rules and regulations. Local disaster declarations are very often the first step in the process of requesting state and federal assistance.

7.2 Lower Rio Grande Planning Region's Flood Preparedness and Response

Many of the Lower Rio Grande Planning Region's entities with Flood control-related authority have or recently had Hazard Mitigation Plans (HMPs) that support the preparedness, response, recovery, and mitigation phases. Currently, only 57 percent of the counties within the Lower Rio Grande Planning Region have Hazard Mitigation Action Plans approved by FEMA, according to TDEM County Hazard Mitigation Plans Status Webmap as of 11/1/2020 (County Hazard Mitigation Plans Status (*arcgis.com*)). It should be noted that this status report is nearly two years old, and some counties may have had their status change. As shown in **Figure 7.4**, 13 counties have previously engaged in Hazard Mitigation Planning, including Flood Hazard Mitigation Planning.

[5] TWCA Emergency Management Guidebook. Available at: https://www.twcarmf.org/wp-content/uploads/2018/07/TWCARMF-Emergency_Management_Guide.pdf.

Figure 7.4 County Hazard Mitigation Plans Status for Lower Rio Grande Planning Region



*Source: TDEM County Hazard Mitigation Plans Status Webmap as of 11/1/2020 (*County Hazard Mitigation Plans Status (arcgis.com)*)*

It is noted that although some plans are expired according to the TDEM database, it is understood by the Regional Flood Planning Group that the Flood Hazard activities related to preparedness, response, and recovery are still being conducted when the entity is faced with a Flood Hazard emergency. Due to the nature of preparedness, response, and recovery activities and the widespread flood planning region, each entity is individually responsible for orchestrating their individual activities related to this task.

In addition to the counties, 34 of the 54 municipalities and two of the 17 special districts have done additional Hazard Mitigation planning to address needs specific to their unique circumstances. The available HMP within the Lower Rio Grande Planning Region is summarized below.

Table 7.1 Hazard Mitigation Action Plans available in the Lower Rio Grande Planning Region

Hazard Mitigation Plans	Entities Included in HMP	Date
Cameron County Hazard Mitigation Action Plan Update 2021	Cameron County City of Harlingen City of Palm Valley	February 2, 2021
Council of Cities Hazard Mitigation Plan	Town of Bayview Town of Indian Lake Town of Laguna Vista City of Los Fresnos Town of Primera City of Port Isabel Town of Rancho Viejo City of Rio Hondo City of San Benito City of South Padre Island	June 14, 2017
City of La Feria Hazard Mitigation Plan	City of La Feria	December 2016

Hazard Mitigation Plans	Entities Included in HMP	Date
Hidalgo County Hazard Mitigation Action Plan	Hidalgo County City of Alton City of Donna City of Edcouch City of Edinburg City of Elsa City of Granjeno City of Hidalgo City of La Joya City of La Villa City of McAllen City of Mercedes City of Mission City of Palmhurst City of Palmview City of Penitas City of Pharr City of Progreso City of San Juan City of Sullivan City Santa Cruz Irrigation District #15 Hidalgo County Drainage District No. 1	Update 2021
Starr County Multi-Jurisdiction Hazard Mitigation Plan	Starr County Escobares Rio Grande City Roma Roma ISD	2019-2024

Upon review of the various Hazard Mitigation Action Plans currently or formerly in place by the various municipalities within the Lower Rio Grande Planning Region, each entity generally shares the same ideas for how best to prepare for and respond to a flood hazard emergency. These activities are summarized

in the individual sections below and elaborated in the entities' respective Hazard Mitigation Action Plans.

7.2.A Regional Flood Hazard Preparedness Activities

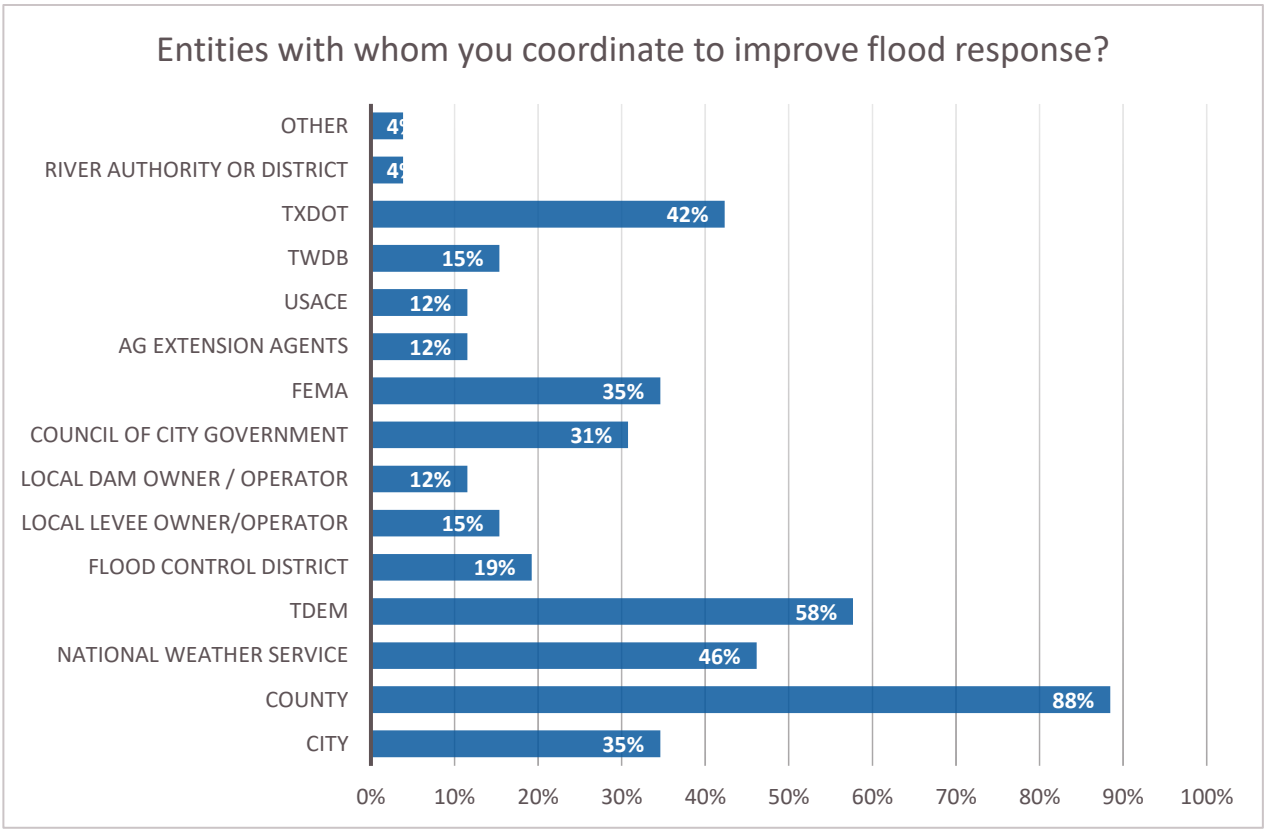
FEMA defines flood preparedness as actions, aside from mitigation, taken before flood events to prepare for flood response activities. These activities generally include measures to more efficiently "Respond To" or "Recovery From" flood hazards, as well as means to preserve the lives of the residents. In contrast, mitigation actions tended to focus on reducing the risk to the lives and properties of those residing within the flood planning region. They are taken by various subdivisions of the entities, such as emergency responders, drainage districts, and others, to prepare for their individual tasks.

Multiple entities identified the following preparation activities currently in place to prepare their respective jurisdictions for flood response activities:

- identify and educate the community about existing flood evacuation routes
- utilize early warning weather alert programs through the National Weather Service and National Oceanic and Atmospheric Administration via the radio and other public broadcasts
- educating the community on the dangers posed by flooding and proper actions to take during flood emergencies
- procurement of flood disaster supplies and equipment, such as pumping equipment
- construction of community storm shelters

Stakeholders within the Lower Rio Grande Planning Region were asked who they coordinated with to improve flood response to their community in preparation for a flood event. Responses for this question from 25 entities are summarized in **Figure 7.5**.

Figure 7.5 Survey question to Lower Rio Grande Entities asking who they coordinated with to improve flood response to their community in preparation for a flood event.



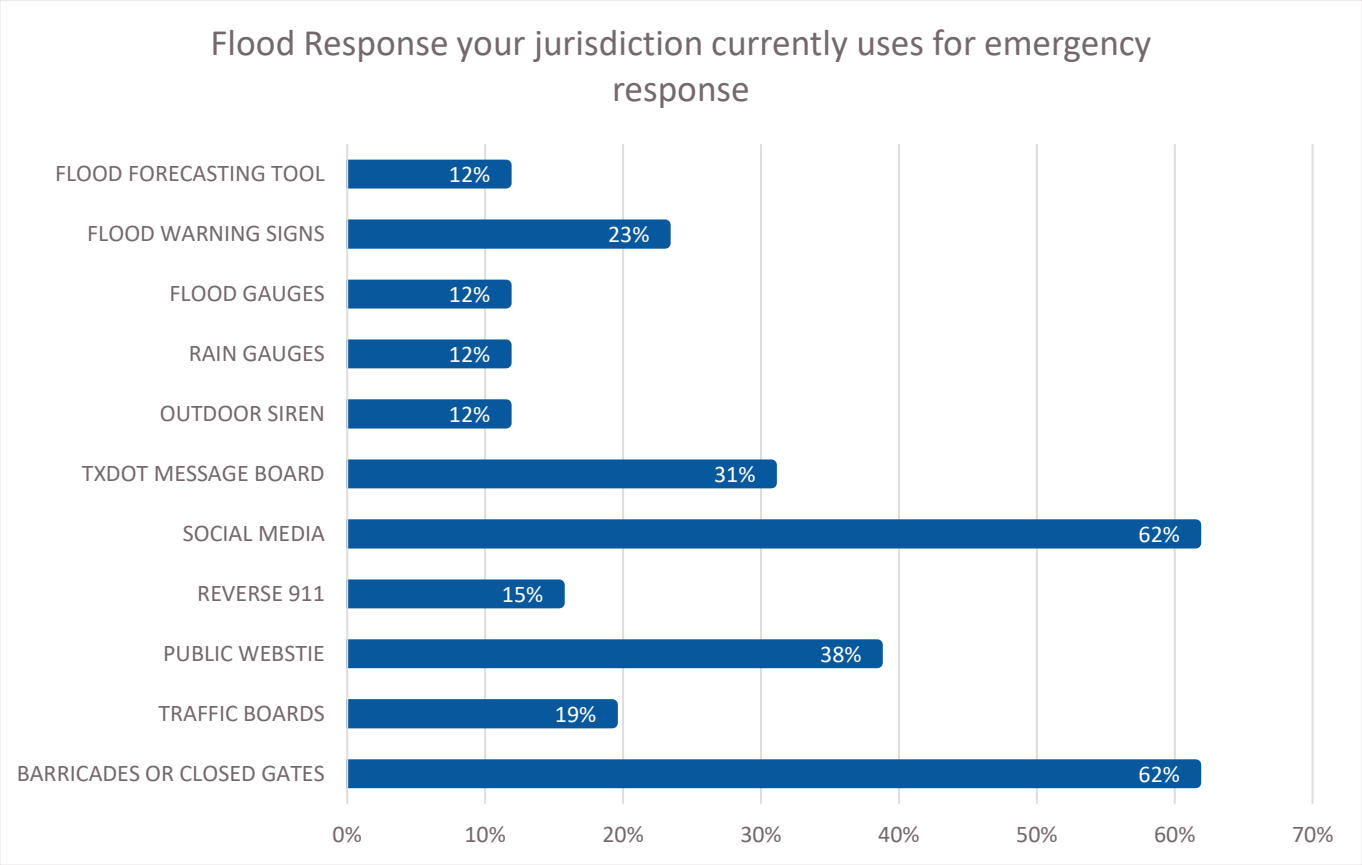
7.2.B Regional Flood Hazard Response Activities

FEMA defines flood response as actions taken during and in the immediate aftermath of a flood event. These activities are typically time sensitive and are the most visible during flood emergencies and are generally taken by each respective entity's emergency and first responders, as well as various other departments such as a city's public works department. The main flood hazard response activities identified by the various counties, municipalities, and other entities in their Hazard Mitigation Plans for flood risk include the following:

- development and implementation of an outreach/notification system to warn and instruct the residents of flood-impacted or soon-to-be-impacted areas
- distribution of sandbags to community members
- development and implementation of rescue programs for those stranded during floods
- mobilization of mobile pump platforms to alleviate flooding in affected areas by accelerating the drainage process
- debris management programs to clear roadways, drainage inlets, and other infrastructure impacted during flood events.

Stakeholders within the Lower Rio Grande Planning Region were asked what measure their jurisdiction uses for emergency response. Responses for this question from 25 entities are summarized in **Figure 7.6**.

Figure 7.6 Survey question to Lower Rio Grande Planning Region's Entities asking what flood response measures their jurisdiction currently uses for Emergency Response.



When asked what measures the entities plan on implementing as changes or additions to their emergency response system over the next five years, the following responses were received:

- install flood gauges
- develop a public-facing website
- acquire a flood forecasting tool
- install flood warning signs (with and without flashing lights)
- coordinate with TxDOT for message board announcements
- setting up crews to barricade closed streets and close gates
- implement a social media platform
- install an outdoor siren

7.3 Lower Rio Grande Planning Region's Flood Hazard Recovery Activities

FEMA defines flood recovery as actions taken after a flood event involving repairs or other actions necessary to return to pre-event conditions. The various jurisdictions in the Lower Rio Grande Planning Region handle flood recovery with a wide range of activities. Many of these can be seen as a continuation of some activities completed during the flood response. For example, the First Responders may brush away from critical infrastructure to reduce flooding during flood response and then return during flood recovery to remove the debris entirely. The activities taken by the various counties, municipalities, and other entities include the following:

- debris removal programs to remove stockpiled and remaining debris in the community and dispose of collected material properly
- flood damage assessment to identify and repair any public utility or facility, such as downed electrical or communication lines, or damaged roadways
- continued use of mobile pump platforms to continue pumping water out of storage facilities to restore drainage system capacity
- documentation of Flood Response and Flood Recovery Activities based on location and damage severity to feed into future Flood Hazard Mitigation Efforts

Chapter 8

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Chapter 8: Administrative, Regulatory, and Legislative Recommendations

8.1. Recommendation Planning Process

This chapter describes the administrative, regulatory, and legislative recommendations developed and implemented by the Region 15 Lower Rio Grande Regional Flood Planning Group (RFPG) to facilitate floodplain management and flood mitigation planning and implementation. Recommendations must also be provided regarding potential new revenue-raising opportunities, which would be used for the development, operation, and maintenance of activities related to floodplain management or flood mitigation activities within the region. The task was introduced during a planning meeting to brief stakeholders and planning group members on the recommendation task, requirements, and what they believe is a higher priority. Below the group split up the recommendations into three categories: legislative, regulatory, and administrative. These recommendations are believed to be necessary to meet the flood planning goals.

8.2. Legislative Recommendations

The RFPG has been able to communicate and interact with several entities on what the priorities are for each area of the region. The RFPGs have identified trends and occurrences throughout most of the state, which helps improve the recommendations proposed by each region. Some practices are encouraged, while others may hinder the floodplain and stormwater management of the entity, region, and/or state. Throughout the flood planning process, the different people involved have provided input on the overall functionality and effectiveness of the existing legislature recommendations concerning floodplain and stormwater management. **Table 8.1** identified the Lower Rio Grande RFPG's legislative recommendations for consideration in relation to floodplain and stormwater management.

Table 8.1 Legislative Recommendations for the Lower Rio Grande Planning Region

ID	Recommendation Statements	Reason for Recommendation
8.1.1	Add legislative ability to allow counties the opportunity to establish and assess drainage (stormwater) utility fees. Legislation is needed to allow counties and others with flood control responsibilities to establish drainage (stormwater) utilities and collect fees for these services. Extend Local Government Code, Title 13, Subtitle A, Chapter 552 to allow counties the opportunity to establish and collect drainage utilities/fees.	Counties are often the entity that bridges area between and around cities. They often are called on to handle excessive runoff from development. Allowing a County another vehicle to use to finance the much needed and shared flood-risk would help ease the burden for some.
8.1.2	Provide alternative revenue-generating sources of funding. Expand eligibility for and use of funding for stormwater and flood mitigation solutions (Local, State, Federal, Public/Private Partnerships, etc.)	An entity's general fund can only go so far. Every public entity is having to do more with less. Occurrences like the global health pandemic can happen and public entities rely heavily on local leaders for assistance. Unlike enterprise funds that can repay a loan, stormwater utilities will never be able to be self-sustaining due to the large capital cost of the improvements and the relatively little use the infrastructure gets once it is installed. Competition for all flood mitigation grants is fierce because the needs are great, and the available funding is in short supply.
8.1.3	Requirements for future planning studies	To keep up with development, a community needs to understand their flood risk, especially since it is often shared with other entities. State and federal governments should prioritize flood risk mapping for all areas and establish criteria to plan as a region easier.

8.3. Regulatory or Administrative Recommendations

Some of the proposed recommendations are not directly controlled by the state legislature. They fall under either the regulatory or administrative recommendations concerning existing procedures, state entities, or state/regional regulations. Some confusion occurs when it comes to current floodplain management regulations and responsibilities that fall under the jurisdiction of different counties. The clarification and guidance of the flood-related authorities in place would greatly benefit the outcome in all counties. **Table 8.2** shows the regulatory and administrative recommendations for the Lower Rio Grande Planning Region.

Table 8.2 Regulatory and Administrative Recommendations for the Lower Rio Grande Planning Region

ID	Recommendation Statements	Reason for Recommendation
8.2.1	Flooding does not recognize jurisdictional boundaries. Remove barriers that prevent jurisdictions from working together to provide regional flood mitigation solutions and regional detention across jurisdictional boundaries.	Different laws and regulations apply to counties, cities, and special districts. Regulations need to promote collaboration instead of creating obstacles.
8.2.2	Funding for projects that benefit agricultural activities should not be scored or awarded based on a traditional benefit-cost ratio.	The damages for agriculture and personal property are different. Different criteria should be used.
8.2.3	Funding for projects in Historically Disadvantaged Communities or Areas of Persistent Poverty should be allocated a minimum amount of future funding, so they are not competing against more fortunate communities.	Disadvantaged communities are less resilient to stressors. Equitable solutions are needed to give communities that suffer more profound losses due hazards.

ID	Recommendation Statements	Reason for Recommendation
8.2.4	Separate funding should be made available for each of the different aspects of floodplain management, such as developing floodplain maps, flood planning studies, advance project planning and development for floodplain management projects, and implementation of floodplain management projects.	Again, the need for all types of improvements is broad, but also large.
8.3.3	Require that future regional flood planning studies develop and maintain a 100-year timeline.	Construction is costly and disruptive. Designing the infrastructure to accommodate future growth would help future generations.

8.4. Other Recommendations

These recommendations are proposed to improve the flood planning process for future planning cycles. **Table 8.3** identifies the state flood planning recommendations for the Lower Rio Grande Planning Region.

Table 8.3 State Flood Planning Recommendations for the Lower Rio Grande Planning Region

ID	Recommendation Statements	Reason for Recommendation
8.3.1	Flood planning alternatives should include options that do not cause irreparable damage to coastal habitats.	Laguna Madres is a unique ecosystem that should be protected. Adverse impacts should value other habitats as well as private property.
8.3.2	The Regional Flood Plan should include tools and resources to continuously include all significant impacts on the watersheds and floodplain management.	A regional entity should have tools to taking the lead on coordination efforts.

8.5. Funding Recommendations

The RFPG is responsible for providing funding recommendations from the separate entities to the TWDB. Comments regarding funding recommendations included the following:

- Add legislative ability to allow counties the opportunity to establish and assess drainage (stormwater) utility fees.
- Provide alternative revenue-generating funding sources for flood mitigation projects
- Expand eligibility for and use of funding for stormwater and flood mitigation solutions (Local, State, Federal, Public/Private Partnerships, etc.).

Chapter 9

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Chapter 9: Flood Infrastructure Financing Analysis (361.44)

The Texas Water Development Board (TWDB) requires that each regional flood planning group (RFPG) assess and report on how sponsors propose to finance recommended Flood Management Evaluations (FMEs), Flood Management Strategies (FMSs), and Flood Mitigation Projects (FMPs). This chapter will focus on understanding the funding needs of the Lower Rio Grande RFPG's sponsors and recommend the state's role in financing the recommended FMEs, FMSs, and FMPs.

This chapter presents an overview of common funding sources for flood mitigation planning, projects, and other flood management efforts. It then describes the methodology and results of the financing survey.

9.1. Potential Funding Sources for Flood Management and Mitigation Activities

Communities, counties, and special districts with flood-related authority utilize local, state, and federal sources to fund their flood management efforts. Historically, because the local governments (county and municipal entities) have the flood-related authority, they have borne the greatest share of the financial burden for flood-related activities and drainage and flood infrastructure. The federal government financed larger, regional projects, like Amistad Dam and the Lower Rio Grande Flood Control Project (IBWC Floodway), in response to large disasters that caused widespread flooding and millions in damage. A combination of these funding sources is needed to implement all the identified flood management and mitigation activities of the Lower Rio Grande Regional Flood Plan. A discussion of the potential funding sources that entities within the Lower Rio Grande Planning Region typically use to implement their flood management and flood mitigation projects is discussed in the following sections.

1.1.a. Local Funding

Through the Lower Rio Grande RFPG's initial stakeholder outreach efforts, stakeholders from the Lower Rio Grande Planning Region were asked what their local funding sources were for their flood management activities. We received responses from 25 entities for this question. Those communities who reported having local funding indicated the following primary sources:

- general fund
- ad valorem tax
- bond program
- permitting fees
- stormwater utility fee
- special tax districts

A summary of their responses is included below in **Figure 9.1**.

Figure 9.1: Local funding sources that Entities in the Lower Rio Grande Region used for their flood management activities

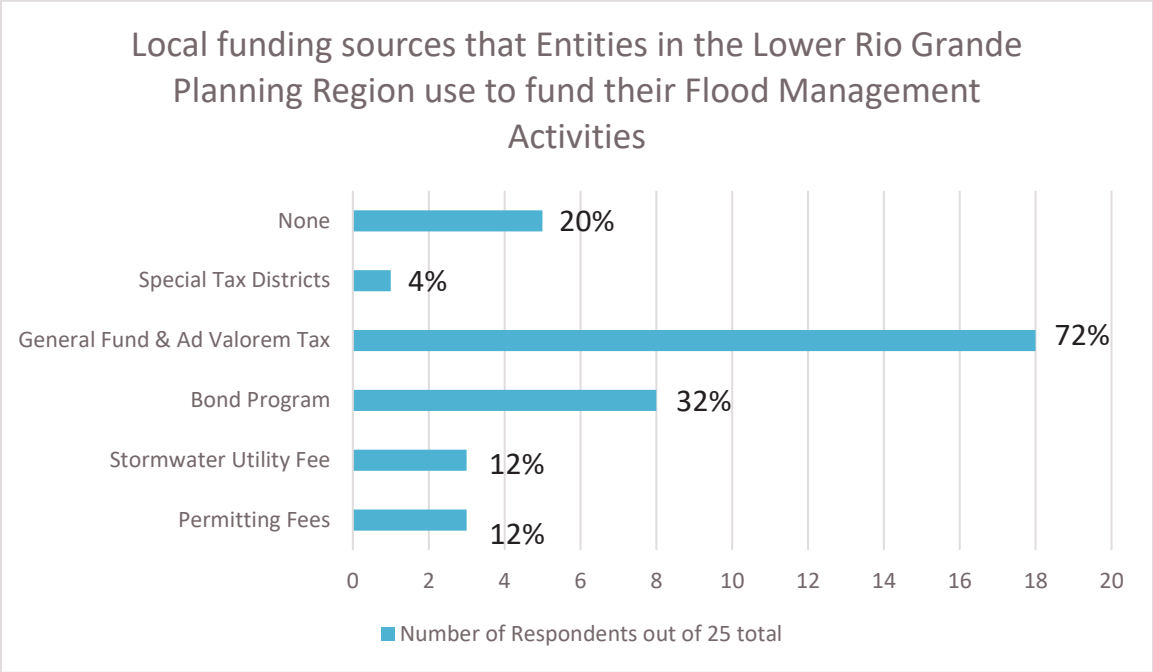

Figure 9.1 shows that 20 percent of the communities that responded did not have any local funds to perform their flood management activities. The remaining 72 percent of the respondent entities indicated that they rely on their General Fund and Ad Valorem Taxes to fund flood management activities. The General Fund is the primary fund entity that provides services such as police, fire, parks, public infrastructure, and local government administration and generally comes from Ad Valorem Taxes (sales, property, and other taxes). Thirty-two percent of respondents indicated that they funded their flood management activities through Bond Programs that the voters approved. Twelve percent of the entities that responded indicated that they used funds collected through their Stormwater Utility Fee or through Permitting Fees. Lastly, 4 percent of respondents responded that they utilized funds from a special tax district to provide these activities.

Figure 9.1 shows that most entities rely on the community's general fund to fund all their required services. The competition for these funds is high in all communities, and often what an entity can fund is only enough for maintenance. Communities rely on outside funding to stretch their local funding and allow them to take on flood mitigation studies and a project that is limited in scope. Often, communities only take on large flood mitigation projects through a special bond election or with funds from a special fund such as a stormwater utility fee fund. The adoption of stormwater utility fees exists in only four of the 130 communities in the region that have flood-related authority. Implementing a stormwater utility fee may be a tool that some entities use to fund their flood management evaluations, flood management strategies, or flood mitigation projects, but that would be a very small percentage of the overall need.

Another source for local funding to support flood management efforts includes special districts. A special district is a political subdivision established to provide a single public service (such as water supply, drainage, or sanitation) within a specific geographic area. Examples of these special districts include Water Control and Improvement Districts (WCID), Municipal Utility Districts (MUD), Drainage Districts (DD), and Flood Control Districts (FCD). Each of these different types of districts is governed by different state laws, which specify the authorities and process for creating a district. Districts can be created by various entities, including the Texas Legislature, the Texas Commission on Environmental Quality (TCEQ), county commissioners' courts, or city councils. Some types of districts may be able to raise revenue through taxes, fees, or bonds to fund flood and drainage-related improvements within their jurisdiction.

Lastly, municipalities and counties have the option to issue debt through general obligation bonds, revenue bonds, or certificates of obligation, which are typically paid back using any of the previously mentioned local revenue mechanisms.

Overall, local governments have various options for raising revenue to support local flood-related efforts; however, each avenue presents its own unique challenges and considerations. It is important to note that municipalities have more authority to establish various revenue-raising options compared to counties. Of the communities with access to local funding, the amount available is generally much lower than the total need, leading local communities to seek out state and federal financial assistance programs.

9.1.b. State Funding

Today, communities have a broader range of state and federal funding sources and programs available due to new grant and loan programs that did not exist even five years ago. Two primary state agencies currently provide state funding for flood mitigation projects: the TWDB and the Texas State Soil and Water Conservation Board (TSSWCB). **Figure 9.2** depicts how local communities responded when asked what state and federal funding sources they have obtained to implement flood management activities.

Figure 9.2: State and Federal Funding Sources Utilized by Local Communities in the Lower Rio Grande Region for Implementation of Flood Management Activities

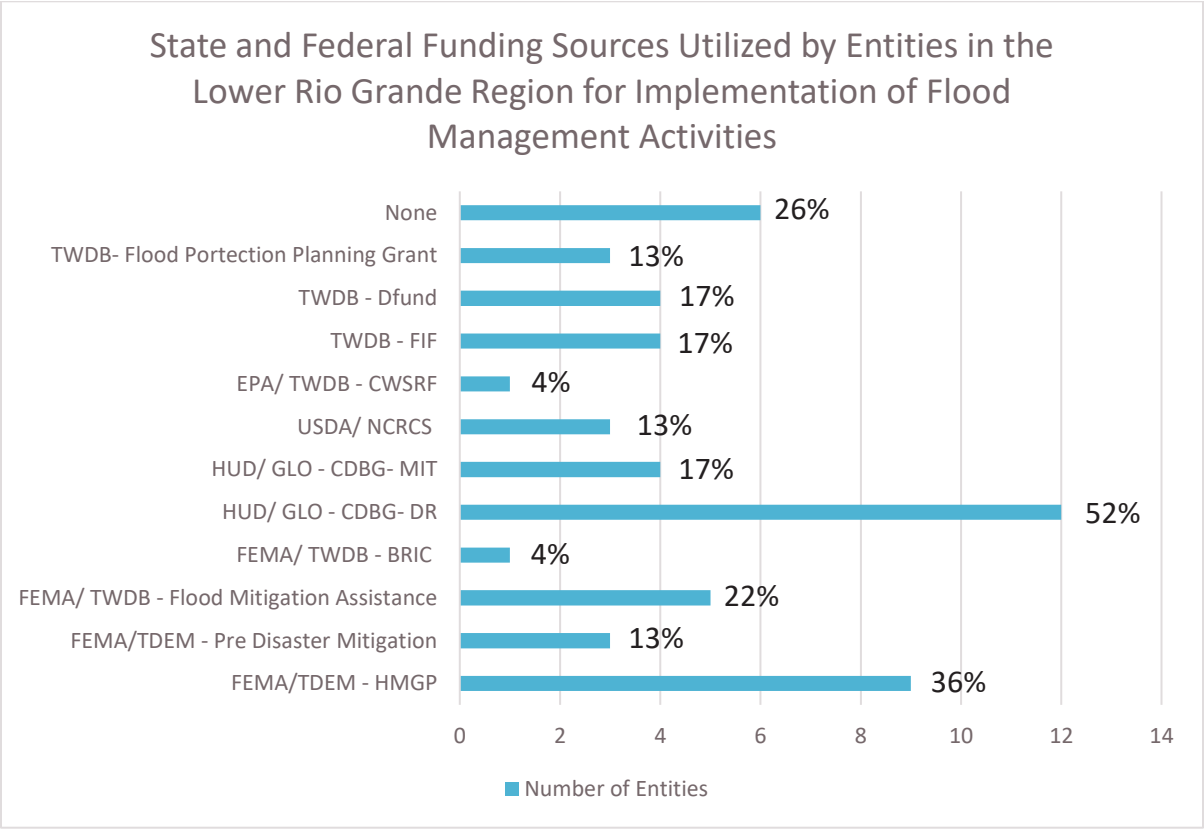

Figure 9.2 shows a total of 11 state and federal programs that entities with flood-related authority have obtained to implement their flood management activities. The majority of the identified funding sources came through a state agency, with their primary funding source originating from the federal government. This section will focus on three funding that is completely state-funded, while the next section will discuss the federally funded programs.

Texas Water Development Board (TWDB) Programs

The TWDB's Flood Infrastructure Fund (FIF) is a new funding program established by the Texas Legislature and approved by Texas voters through a constitutional amendment in 2019. The program provides financial assistance through low-interest or zero-interest loans and/or grants (cost match varies) to eligible political subdivisions for flood control, flood mitigation, and drainage projects. FIF rules allow for a wide range of flood projects and related activities, including structural and non-structural flood risk reduction projects, planning studies, and preparedness efforts such as flood early warning systems. After the first State Flood Plan is adopted, only projects included in the most recently adopted state flood plan will be eligible for funding from the FIF. FMEs, FMSs, and FMPs recommended in this Regional Flood Plan will be included in the overall State Flood Plan and thus be eligible to access this funding source. Note that the Flood Protection Planning Grant referenced in **Figure 9.2** has been replaced by Flood Infrastructure Fund Category 1 planning grants.

The TWDB also administers the Texas Water Development Fund (Dfund) program, a state-funded streamlined loan program that provides financing to eligible political subdivisions for several types of water-related infrastructure projects. This program enables the TWDB to fund projects with multiple eligible components (water supply, wastewater, or flood control) in one loan at low market rates. Financial assistance for flood control may include structural and non-structural projects, planning efforts, and flood warning systems.

Texas State Soil & Water Conservation Board (TSSWC) Programs

The Texas State Soil & Water (TSSWCB) has three state-funded programs specifically for flood control dams: the Operation and Maintenance (O&M) Grant Program; the Flood Control Dam Infrastructure Projects - Supplemental Funding Program; and the Structural Repair Grant Program. The O&M Grant Program is for local soil and water conservation districts (SWCD) and certain co-owners of small flood control dams. This program reimburses SWCDs 90 percent of the cost of an eligible O&M activity as defined by the program rules; the remaining 10 percent must be paid with non-state funding. The Flood Control Dam Infrastructure Projects - Supplemental Funding program was newly created and funded in 2019 by the Texas Legislature. Grants are provided to local sponsors of flood control dams, including SWCDs, to fund the repair and rehabilitation of the flood control structures to ensure dams meet safety criteria to adequately protect lives downstream. The Structural Repair Grant Program provides state grant funds to provide 95 percent of the cost of allowable repair activities on dams constructed by the United States Department of Agriculture Natural Resources Conservation Service (NRCS), including match funding for federal projects through the NRCS Dam Rehabilitation Program and the NRCS Emergency Watershed Protection (EWP) Program.

9.1.c. Federal Funding

Funding for flood-related activities and projects is available from programs administered by seven different federal agencies and discussed in this section. The funding for these programs originates from the federal government, but for many programs, a state agency partner plays a key role in the management of the program. Each funding program has its own eligibility requirements, applicant and project types, application processes, award timelines, etc. A few examples of eligibility requirements for some of the federal grant programs are: requiring applicants to be participants in the National Flood Insurance Program (NFIP), requiring recipients to have an approved Hazard Mitigation Plan, or requiring a project to have a benefit/cost ratio of 1.0 or greater. More information regarding each program and its unique eligibility requirements and award processes can be found at the Internet web links in this section.

Federal Emergency Management Agency

Common FEMA-administered federal flood-related funding programs include Flood Mitigation Assistance (FMA), Building Resilient Infrastructure and Communities (BRIC), Safeguarding Tomorrow through Ongoing Risk Mitigation (STORM), Rehabilitation of High Hazard Potential Dam (HHPD) Grant Program, Hazard Mitigation Grant Program (HMGP), the Public Assistance (PA) program, and the Cooperating Technical Partners (CTP) Program.

Flood Mitigation Assistance (FMA) is a nationally competitive annual grant program that provides funding to states, local communities, federally recognized tribes, and territories. FMA is administered in Texas by the TWDB. Funds can be used for projects that reduce or eliminate the risk of repetitive flood damage to buildings insured by the National Flood Insurance Program (NFIP). Funding is typically a 75 percent federal grant with a 25 percent local match. Projects mitigating repetitive loss and severe repetitive loss properties may be funded through a 90 percent federal grant and 100 percent federal grant, respectively. FEMA's FMA program now includes a disaster initiative called Swift Current. The program was released as a pilot initiative in 2022 and explored ways to make flood mitigation assistance more readily available during disaster recovery. Similar to traditional FMA, the program mitigates repetitive losses and substantially damaged buildings insured under the NFIP.

The Building Resilient Infrastructure and Communities (BRIC) is a new nationally competitive non-disaster annual grant program implemented in 2020. The program supports states, local communities, tribes, and territories as they undertake hazard mitigation projects, reducing the risks they face from disasters and natural hazards. BRIC is administered in Texas by the Texas Division of Emergency Management (TDEM). Funding is typically a 75 percent federal grant with a 25 percent local match. Small, impoverished communities may be funded through a 90 percent federal grant and 100 percent federal grant, respectively.

Safeguarding Tomorrow through Ongoing Risk Mitigation (STORM) is a new revolving loan program enacted through federal legislation in 2021 to provide needed and sustainable funding for hazard mitigation projects. The program is designed to provide capitalization grants to states to establish revolving loan funds for projects to reduce risks from disaster, natural hazards, and other related environmental harm. At the time of the publication of this plan, the program does not yet appear to be operational and has not yet been implemented in Texas.

FEMA's Rehabilitation of High Hazard Potential Dam (HHPD) Grant Program, administered in Texas by the TCEQ, provides technical, planning, design, and construction assistance in the form of grants for the rehabilitation of eligible high hazard potential dams. The cost-share requirement is typically no less than 35 percent state or local share.

Under the Hazard Mitigation Grant Program (HMGP), FEMA provides funding to state, local, tribal, and territorial governments to rebuild from a recent disaster in a way that reduces, or mitigates, future disaster losses in their communities. The program is administered in Texas by TDEM. Funding is typically a 75 percent federal grant with a 25 percent local match. While the program is associated with Presidential Disaster Declarations, the HMGP is not a disaster relief program for individual disaster victims or a recovery program that funds repairs to public property damaged during a disaster. The key purpose of HMGP is to ensure that the opportunity to take critical mitigation measures to reduce the risk of loss of life and property from future disasters is not lost during the reconstruction process following a disaster.

FEMA's Public Assistance (PA) program provides supplemental grants to state, tribal, territorial, and local governments and certain types of private non-profits following a declared disaster so communities can

quickly respond to and recover from major disasters or emergencies through actions such as debris removal, life-saving emergency protective measures, and restoring public infrastructure. Funding cost-share levels are determined for each disaster and are typically not less than 75 percent federal grant (25 percent local match) and typically not more than 90 percent federal grant (10 percent local match). In Texas, FEMA PA is administered by TDEM. In some situations, FEMA may fund mitigation measures as part of the repair of damaged infrastructure. Generally, mitigation measures are eligible if they directly reduce future hazard impacts on damaged infrastructure and are cost-effective. Funding is limited to eligible damaged facilities located within PA-declared counties.

The Cooperating Technical Partners (CTP) program is an effort launched by FEMA in 1999 to increase local involvement in developing and updating Flood Insurance Rate Maps (FIRMs), Flood Insurance Study reports, and associated geospatial data in support of FEMA's Risk Mapping, Assessment, and Planning (Risk MAP) Program. To participate in the program, interested NFIP-participating communities, state or regional agencies, universities, territories, tribes, or non-profits must complete training and execute a partnership agreement. Working with the FEMA regions, a program participant can develop business plans and apply for grants to perform eligible activities.

United States Department of Housing and Urban Development

HUD administers the following three federal funding programs: Community Development Block Grant – Disaster Recovery (CDBG-DR), Community Development Block Grant – Mitigation (CDBG-MIT), and Community Development Block Grant (TxCDBG) for Rural Texas.

Following a major disaster, Congress may appropriate funds to the Department of Housing and Urban Development (HUD) under the Community Development Block Grant – Disaster Recovery (CDBG-DR) program when there are significant unmet needs for long-term recovery. Appropriations for CDBG-DR are frequently very large, and the program provides 100 percent grants in most cases. The CDBG-DR is administered in Texas by the Texas General Land Office (GLO). The special appropriation provides funds to the most impacted and distressed areas for disaster relief, long term-recovery, restoration of infrastructure, housing, and economic revitalization.

The Community Development Block Grant – Mitigation (CDBG-MIT) is administered in Texas by the GLO. Eligible grantees can use CDBG Mitigation (CDBG-MIT) assistance in areas impacted by recent disasters to carry out strategic and high-impact activities to mitigate disaster risks with typically 100% grants. The primary feature differentiating CDBG-MIT from CDBG-DR is that, unlike CDBG-DR, which funds recovery from a recent disaster to retore damaged services, systems, and infrastructure, CDBG-MIT funds are intended to support mitigation efforts to rebuild in a way that will lessen the impact of future disasters.

The Community Development Block Grant (CDBG) program also provides annual grants on a formula basis to small, rural cities and counties to develop viable communities by providing decent housing and suitable living environments and expanding economic opportunities principally for persons of low- to moderate-income. Funds can be used for public facilities such as water and wastewater infrastructure, street and drainage improvements, and housing. In Texas, the CDBG program is administered by the Texas Department of Agriculture (TDA).

United States Army Corps of Engineers

The United States Army Corps of Engineers works with non-federal partners (states, tribes, counties, or local governments) throughout the country to investigate water resources-related needs and opportunities and develops civil works projects that would otherwise be beyond the sole capability of the non-federal partner(s). Partnerships are typically initiated or requested by the local community to their local USACE District office. Before any project or study can begin, USACE determines whether there is an existing authority under which the project could be considered, such as the US Army Corps of Engineers Continuing Authorities Program (CAP), or whether Congress must establish study or project authority and appropriate specific funding for the activity. New study or project authorizations are typically provided through periodic Water Resource Development Acts (WRDA) or another legislative vehicle. Congress will not authorize a project until required studies are completed and a recommendation to Congress is made via a Report of the Chief of Engineers (Chief's Report) or Report of the Director of Civil Works (Director's Report). Opportunities to partner with USACE are not considered grant or loan opportunities but shared participation projects where USACE performs planning work and shares in the construction cost. USACE also provides technical assistance to state and local governments through their Floodplain Management Services and the Planning Assistance to States programs.

Environmental Protection Agency

The Clean Water State Revolving Fund (CWSRF), administered by the TWDB, provides financial assistance in the form of loans with subsidized interest rates and sometimes partial principal forgiveness for planning, acquisition, design, and construction of wastewater, reuse, and stormwater infrastructure projects. Projects can be structural or non-structural, and loans for Low Impact Development (LID) projects are also eligible.

United States Department of Agriculture

The USDA Natural Resources Conservation Service (NRCS) provides technical and financial assistance to local government agencies through the following programs: Emergency Watershed Protection Program, Watershed Protection and Flood Prevention Program, Watershed Surveys and Planning, and Watershed Rehabilitation. The Emergency Watershed Protection (EWP) program, a federal emergency recovery program, helps local communities recover after a natural disaster by offering technical and financial assistance to relieve imminent threats to life and property caused by floods and other natural disasters that impair a watershed. The Watershed Protection and Flood Prevention Program helps units of federal, state, local, and tribal government protect and restore watersheds; prevent erosion, floodwater, and sediment damage; further the conservation development, use and disposal of water; and further the conservation and proper use of land in authorized watersheds. The Watershed Surveys and Planning Program focuses on funding watershed plans, river basin surveys and studies, flood hazard analyses, and floodplain management assistance to identify solutions that use land treatment and non-structural measures to solve resource problems. Lastly, the Watershed Rehabilitation Program helps project sponsors rehabilitate aging dams that are reaching the end of their design lives. This rehabilitation addresses critical public health and safety concerns. The USDA offers various Water and Environmental

grant and loan funding programs for water and waste facilities, including stormwater facilities, in rural communities.

Special Appropriations

Occasionally Congress may appropriate federal funds for special circumstances such as recovery from natural disasters or pandemics (COVID-19). A few examples of recent special appropriations from the federal government that can be used to fund flood-related activities are discussed in this section.

In 2021, the American Rescue Plan Act (ARPA) provided a substantial infusion of resources to eligible state, local, territorial, and tribal governments to support their response to and recovery from the COVID-19 pandemic. Coronavirus State and Local Fiscal Recovery Funds, a part of ARPA, delivers $350 billion directly to the state, local, and tribal governments across the country. Some of the authorized uses include improving stormwater facilities and infrastructure. Although not a direct appropriation to local governments like ARPA, the 2021 Infrastructure Investment and Jobs Act, also referred to as the Bipartisan Infrastructure Law (BIL), authorizes over $1 trillion for infrastructure spending across the United States and provides for a significant infusion of resources over the next several years into existing federal financial assistance programs as well as creating new programs.

9.2. Assessment of State's Role in Financing Recommended Flood Management and Mitigation Actions

During the planning process, stakeholders from the Lower Rio Grande Planning Region were asked why their jurisdiction did not seek funding assistance to implement their flood management activities. We received responses from 25 entities for this question, and a summary of their responses is included in **Figure 9.3**.

Figure 9.3: Reasons an Entity does not seek other funding to pay for implementation of their flood management activities

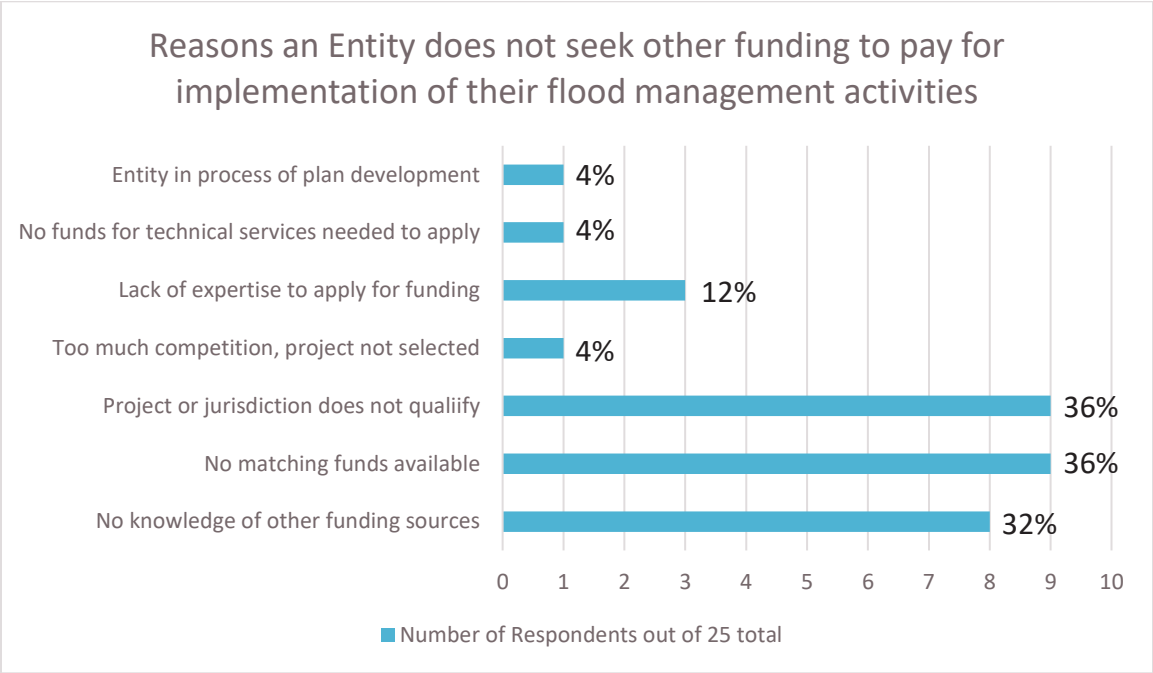

Figure 9.3 shows that one-third of the respondent entities are (1) unaware of available funding sources, (2) do not qualify for funding assistance because either they or the flood management activity they want to implement are not eligible, or (3) they cannot afford the local match that is required as part of the funding program. Twelve percent of respondents indicated that they lacked the expertise to apply for funding, while an additional 4 percent specified that they did not have the funds or resources to perform the professional and technical services needed for funding applications. Four percent of respondent entities indicated that projects not being selected for funding is a reason they don't seek other funding opportunities. Lastly, one of the respondents indicated that they did not seek funding to implement their flood management activities because they were in the process of updating their flood management activities.

These entities would benefit if the State of Texas would provide the following:

- take additional steps to better inform communities of funding opportunities
- expand the eligibility of project and entity types under existing programs
- expand funding opportunities or create new programs for communities and special districts unable to meet local cost-sharing requirements
- resources for communities unable to apply for funding due to a lack of expertise
- technical resources (or funding to acquire technical resources) to provide technical and professional services needed for funding opportunities applications
- prioritization of vulnerable communities when considering financing recommendations
- Lack of expertise to manage funding awards when received

Unlike other types of infrastructure projects, flood-related projects do not typically generate revenue, and many communities do not have steady revenue streams to fund flood projects. Consequently, communities struggle to generate funds for local match requirements or loan repayment. Complex, labor-intensive, and often technical support documentation needed for a funding application to show that the project meets program requirements are real obstacles for some of the smaller and rural communities who want to apply for any financial assistance. Those communities that can overcome these challenges are often not rewarded for their efforts. The high demand for state and federal funding assistance, particularly grant opportunities, makes these opportunities highly competitive. Based on the overwhelming response that any flood-related funding receives, it is obvious that the need exceeds the available funds. For the more impoverished, disadvantaged, and vulnerable communities, this often leaves many local communities without the resources to address their flood risks. Funding opportunities that rely on benefit-cost ratios that solely consider the material value of the flooded structures damaged is hard to achieve a value over one in some areas of the region.

Mitigating flood risk is a watershed problem. Unfortunately, political boundaries do not follow watershed boundaries, making implementing a flood mitigation project sometimes quite challenging, especially when multiple jurisdictions are involved. Based on the list of approved FMEs alone, it is obvious that much of the region do not truly understand their flood risk or any recent floodplain maps. The study of these areas to develop flood risk modeling and mapping is greatly needed so that flood mitigation studies, alternative analysis, and feasibility studies can be performed. Furthermore, current and future conditions flood risk maps are a critical tool that all entities with flood-related authority need to properly guide development and protect the lives and property of the community they serve. Current and future flood risk maps are also needed to inform the public of their flood-risk exposure.

A great majority of the region relies on local funds to pay for any flood-related management and mitigation activities, the budgets they get allocated are very limited, and the problem is that the populations living in these areas do not want to wait on a study to be performed to understand this risk. They want to see a physical project being constructed immediately to address the flooding they see. The study needs are too great for the local community to bear and coordination amongst multiple entities is time-consuming and can be litigious. It is recommended that the State bear the costs for these flood risk mapping studies, so the local communities can apply their local funds to implement construction projects.

It is recommended that the state's role in financing recommended FMSs, FMPs, and FMEs be as follows:

- fully fund all flood risk mapping FMEs
- take additional steps to better inform communities of funding opportunities
- expand the eligibility of project and entity types under existing programs
- expand funding opportunities or create new programs for communities and special districts unable to meet local cost-sharing requirements
- resources for communities unable to apply for funding due to a lack of expertise
- technical resources (or funding to acquire technical resources) to provide technical and professional services needed for funding opportunities applications

- prioritization of vulnerable communities when considering financing recommendations

9.3. Flood Infrastructure Financing Survey

Flood Infrastructure Financing Survey Methodology

The Lower Rio Grande RFPG surveyed the sponsors for the recommended FMEs, FMPs, and FMSs. The Lower Rio Grande RFPG primarily used email to send the surveys to the sponsors. When email addresses were unavailable, additional outreach such as phone calls were used to obtain emails. As a last resort, the Lower Rio Grande RFPG mailed surveys or used other means of collecting the required information. The primary aim of this survey effort is to understand the funding needs of local sponsors and obtain feedback regarding the state's role in financing the recommended FMEs, FMSs, and FMPs.

Flood Infrastructure Financing Survey Results

The flood infrastructure funding survey was sent to the sponsors of recommended FMEs, FMSs, and FMPs, with capital costs identified for each. The primary goal of this survey effort was to understand the funding needs of local sponsors and then propose what role the state should have in financing the recommended FMEs, FMSs, and FMPs. **Appendix C** contains a copy of the survey sent for each FME, FMS, and FMP. We will be reaching out to the sponsors to followup on the response to the survey. With additional time provided in the second cycle of regional flood planning, the Lower Rio Grande RFPG anticipates that a greater response rate may be obtained through additional outreach efforts such as follow-up emails, phone calls, and meetings.

The Lower Rio Grande RFPG assumed that those sponsors who do not respond to the survey would need 90 percent of the total project costs to be funded by state and/or federal sources. This represents an average of 10 percent projected local investment in projects. The initial outreach efforts support a high percentage of outside needs discussed earlier in this chapter, which confirmed that many communities, particularly smaller and more rural communities, do not have any local funding available for flood management activities. Those communities that reported having local funding indicated relatively little local funding available in relation to the overall need.

Overall, a total cost of $75,000,000 is needed to implement the recommended FMEs, FMSs, and FMPs in this regional flood plan. From the total cost, it is projected that $67,000,000 of state and federal funding is needed. This number does not represent the amount of funding needed to mitigate all risks in the region and solve flooding problems in their entirety. This number simply represents the funding needs for the specific, identified studies, strategies, and projects in this cycle of regional flood planning. Future cycles of regional flood planning will continue to identify more projects and studies needed to further flood mitigation efforts in the Lower Rio Grande Planning Region.

CHAPTER 10

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Task 10: Public Outreach and Engagement

The objective of this task is to address public participation, public meetings, and administrative and technical support activities that are required to complete and submit a draft Regional Flood Plan by August 1, 2022, and the final adopted Regional Flood Plan by January 10, 2023. These activities are ongoing from the start to the completion of the planning process.

10.1 Regional Flood Planning Group Meetings (2020 – 2022)

At the start of the regional flood planning process, the Texas Water Development Board (TWDB) established 15 flood planning regions based on river basin boundaries and convened Regional Flood Panning Groups (RFPG) for each region. The RFPG's responsibilities include directing the work of technical consultants, soliciting and considering public input, identifying and assessing flood risks, and identifying, evaluating, and recommending Flood Management Evaluations (FME), Flood Management Strategies (FMS), and Flood Mitigation Projects (FMP). To ensure a diversity of perspectives is represented throughout the planning process, the TWDB appointed RFPG members representing 11 stakeholder groups:

- agriculture
- counties
- electric generation utilities
- environmental interests
- industry
- municipalities
- public
- river authorities
- small businesses
- water districts
- water utilities

The Lower Rio Grande RFPG convened its first meeting in November 2020, at which time it elected a chairperson, a vice-chairperson, a secretary, and two additional RFPG to serve on an Executive Committee. A complete chronology of RFPG meetings is provided in **Table 10.1**.

The Hidalgo County Drainage District #1 (HCDD1), the sponsoring agency for the Lower Rio Grande Regional flood planning process, has been responsible for posting all meetings of the RFPG and its committees on the Texas Secretary of State website and on the Region 15 website. HCDD1 also distributes agendas and meeting materials via email to all voting and non-voting RFPG members, as well as any person or entity who has requested notice of RFPG meetings and activities. The opportunity to subscribe to receive such notifications is clearly provided on the website.

All meetings of the Lower Rio Grande RFPG have been convened either virtually via the Zoom webinar platform or in a hybrid (virtual and in-person) format. All meetings are conducted, as required, following the Texas Open Meetings Act (Chapters 551 and 552, Government Code), Public Information Act, and COVID-related disaster proclamations issued by Governor Abbott. All RFPG meetings must provide at least one opportunity for public comments. Since their first meeting, the Lower Rio Grande RFPG has had an agenda item for public comment at each meeting to allow the public an opportunity to comment.

Table 10.1 RFPG and Technical Committee Meeting Calendar

Year	Date	Meeting	Highlights
2020	November 5	Planning Group Virtual Meeting	RFPG convening hosted by TWDB
2020	December 3	Planning Group Virtual Meeting	Planning Group Sponsor (TWDB) hosts
2021	January 13	Planning Group Virtual Meeting	Pre-planning public comment Nominating members
2021	February 24	Planning Group Virtual Meeting	Pre-planning public comment Technical consultant selected/hired
2021	June 30	Planning Group Virtual Meeting	Award contract to Technical consultant Award contract for public website
2021	July 28	Pre-planning Virtual Meeting	The technical consultant presented and discussed the scope of work, goals, and strategies for public engagement and project completion.
2021	August 18	Planning Group Virtual Meeting & Pre-Planning Meeting	Pre-planning public comment and technical consultant provided updates on Regional Flood Plan Task 1-3
2021	October 13	Planning Group Virtual Meeting	The technical consultant provided tasks 1, 3B,4A, and 4B updates.

Year	Date	Meeting	Highlights
2021	November 17	Planning Group Virtual Meeting	The technical consultant presented the potential adoption of Region 15 overarching flood mitigation and floodplain management goals for the Lower Rio Grande Regional Flood Plan. The Regional Flood Plan approved the process used by the RFPG to identify and evaluate potential FMEs, FMPs, and FMSs. The technical consultant also discussed Floodplain management standards.
2021	December 15	Pre-Planning Virtual Meeting	The technical consultant presents the technical memo for approval to submit to the TWDB by January 7, 2022
2022	January 19	Planning Group Virtual Meeting	The technical consultant provides an update on flood mitigation resolution and reaching out to different entities regarding missing data for the best models to reflect the information given
2022	March 9	Planning Group Hybrid Meeting	The technical consultant provides updates on Tasks 2A, 2B, 3A, and 4B.
2022	April 12	Planning Group Hybrid Meeting	The technical consultant introduces RATES to RFPG and provides updates on Tasks 3A.
2022	May 18	Planning Group Virtual Meeting	The technical consultant introduces RATES to RFPG and provides updates on Tasks 3A.
2022	July 21	Planning Group Virtual Meeting	The Technical consultant presents 3a, 4, 5, 6,7,8,9 and draft Regional Flood Plan for consideration and approval to the TWDB.

10.2 Public Outreach Strategies and Tools

10.2.1 Website: Robust and User-Friendly

The HCDD1 established the required website on behalf of the Lower Rio Grande RFPG in January 2021 under the domain name Region15lrg.org using the Square Space hosting platform. The technical consultant came on board in June 2021 and immediately helped build the website to provide more information about the Lower Rio Grande Regional Flood Planning Area and the regional flood planning process, as well as information and educational materials about flood planning related topics. The website was also enhanced to allow easy access for the public and entities to provide input and to

access draft deliverables (e.g., flood mitigation and floodplain management goals) for review and comment. The enhanced website went live in July 2021. Currently, there are several locations on the website where active links can be found for public engagement on the website:

- submit public comments and feedback on the contact us page or the public comments tab
  - allows for a personal contact option
- documents and meetings for public access under the meetings tab
- resources for public engagement and information specific to their area
- calendar with the next meeting shown.
- board members with the organization and entity they represent.
- useful links to government agencies, counties, and drainage districts

Website Analytics are shown in **Table 10.2**.

Table 10.2 Website Analytics

Date	Total Visits	Unique Visitors	Page Views
July 19, 2021 - July 12, 2022	29	12	29

10.2.c Direct Email Blasts

The technical consultant used email to communicate directly with public and community stakeholders. An email contact list has been developed for a targeted audience with 174 contacts and includes the following tags:

- municipalities
- counties
- county judges
- floodplain administrators
- other districts
- subscribers through website
- RFPG members
- Technical Consultant Team, led by Halff Associates, Inc.

Four email blasts were sent to audiences between June 2021 and June 2022.

10.3 Public Hearing and Outreach for DRAFT Regional Flood

Note – this section of Chapter 10 will be completed at the conclusion of the required public comment period for the draft Regional Flood Plan and before its adoption by the Region 10 RFPG on or before January 10, 2023.

Rule §361.21 Draft Plan Notice Requirements

- For meetings at which the RFPG will take public input related to the RFPG's draft Regional Flood Plan per TWC 16.062(f–g), the following additional public notice provisions must be met:
  - draft Regional Flood Plan must be made available for public inspection online 30 days before the first meeting if more than one meeting is held and 30 days following the first meeting
  - at a minimum, notice must be provided at least 30 days before the first meeting
  - notice must be provided to all adjacent RFPGs
  - notice of the meeting must include a summary of the Regional Flood Plan
  - notice must include information on how the public may submit a comment
  - one hard copy of the draft Regional Flood Plan must be made available for public inspection in at least three publicly accessible locations within the Lower Rio Grande Planning Region for at least 30 days before the first meeting and 30 days following the first meeting
  - written comments must be accepted for consideration for at least 30 days before the first meeting and at least 30 days following the first meeting for consideration and response before the adoption of the final plan under §361.50 of this title, and oral comments must be accepted during the meeting.

10.3.a Public Engagement and Outreach Plan

According to the requirements above, the Lower Rio Grande RFPG will post the Draft Regional Flood Plan (RFP) on August 1, 2022, online at: http://www.region15lrg.org/page/homepage

Hard copies of the Regional Flood Plan will be placed no later than August 1, 2022, at three locations:

- Upper Basin: (South Texas Development Council (1002 Dicky Lane, Laredo TX 78043)
- Mid-Basin: HCCD1 offices in Edinburg, Tx (902 N Doolittle Rd, Edinburg, TX 78542)
- Lower-Basin: (Cameron County Court House, 1100 E. Monroe St. Dancy Building, Brownsville, TX 78520)

The official Public Hearing for the RFPG to meet in person, as a quorum, to present the summary of the Draft Regional Flood and to take public comment is planned for:

September 15, 2022
Time TBD
Address: TBD

In addition to the public hearing, the project sponsor (HCDD1) and the Technical Consultant Team plan to host three in-person "Open Houses" to present the summary of the Regional Flood Plan, answer questions, and take public comments. Exhibits and handouts will be available to the public, including details and directions for posting public comments after the public hearing and open houses. Locations for open house events are planned for the Lower Rio Grande River basin, with exact locations, dates, and times to be determined.

10.3.b Promotional Tactics to Reach the Public for Awareness and Comment Opportunities

At a minimum, the following activities will be utilized to engage the public and make them aware of the Draft Regional Plan, the public hearing and meetings, and the public comment opportunity:

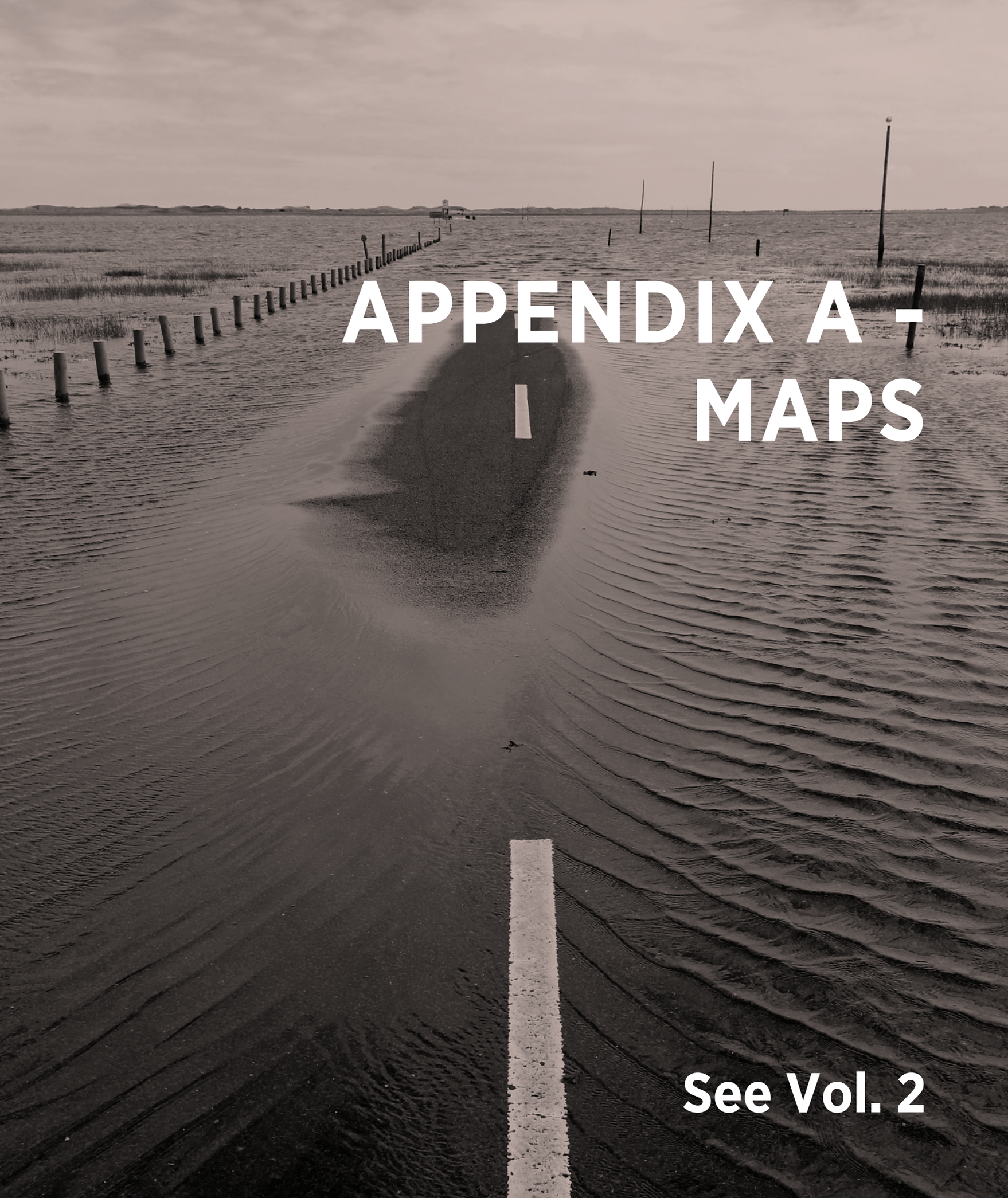
Table 10.3 Promotional Tactics

Tactic	Activity
Media	General media release(s) regarding Draft Regional Flood Plan and public comment period Media alerts to local news outlets where meetings will be held
Email	A series of email blasts to the stakeholder list Direct emails to key stakeholders, including local elected and floodplain administrators
Website	Draft Regional Flood Plan will be posted on the Lower Rio Grande Planning Region's site A public comment link on the website for the Regional Flood Plan
RFPG Members, Project Sponsor, Technical Consultant Team	Content for personal communications will be provided for ease of targeting and sharing

10.3.c Accept Public Comments

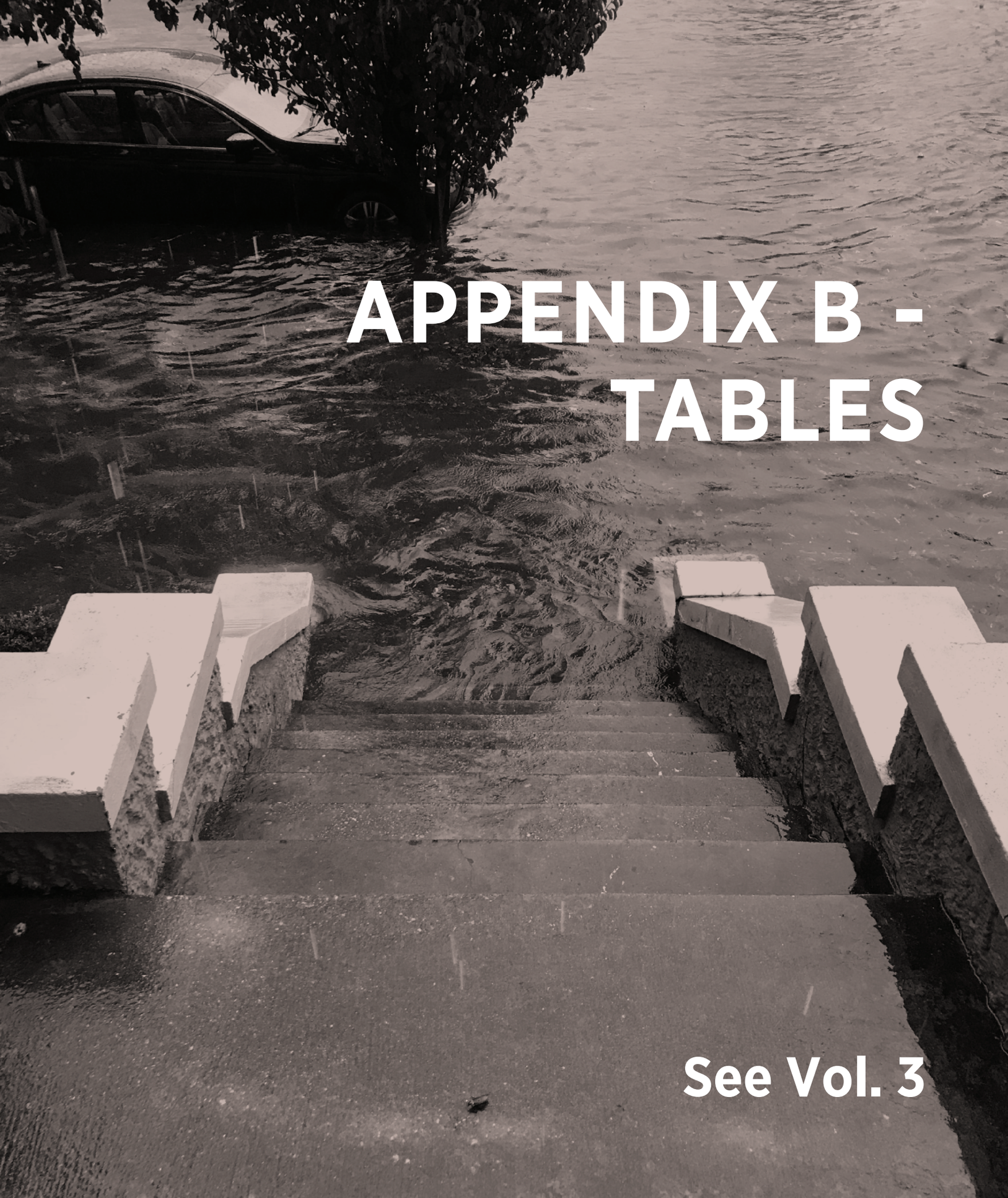
From August 1 through October 15, 2022, public comments will be accepted by:

- oral comments at RFPG meetings and public hearing
- written or verbal comments in person at open house meetings
- written comments sent to (kleal@halff.com)
- written comments received on the Lower Rio Grande Planning Region's website portal



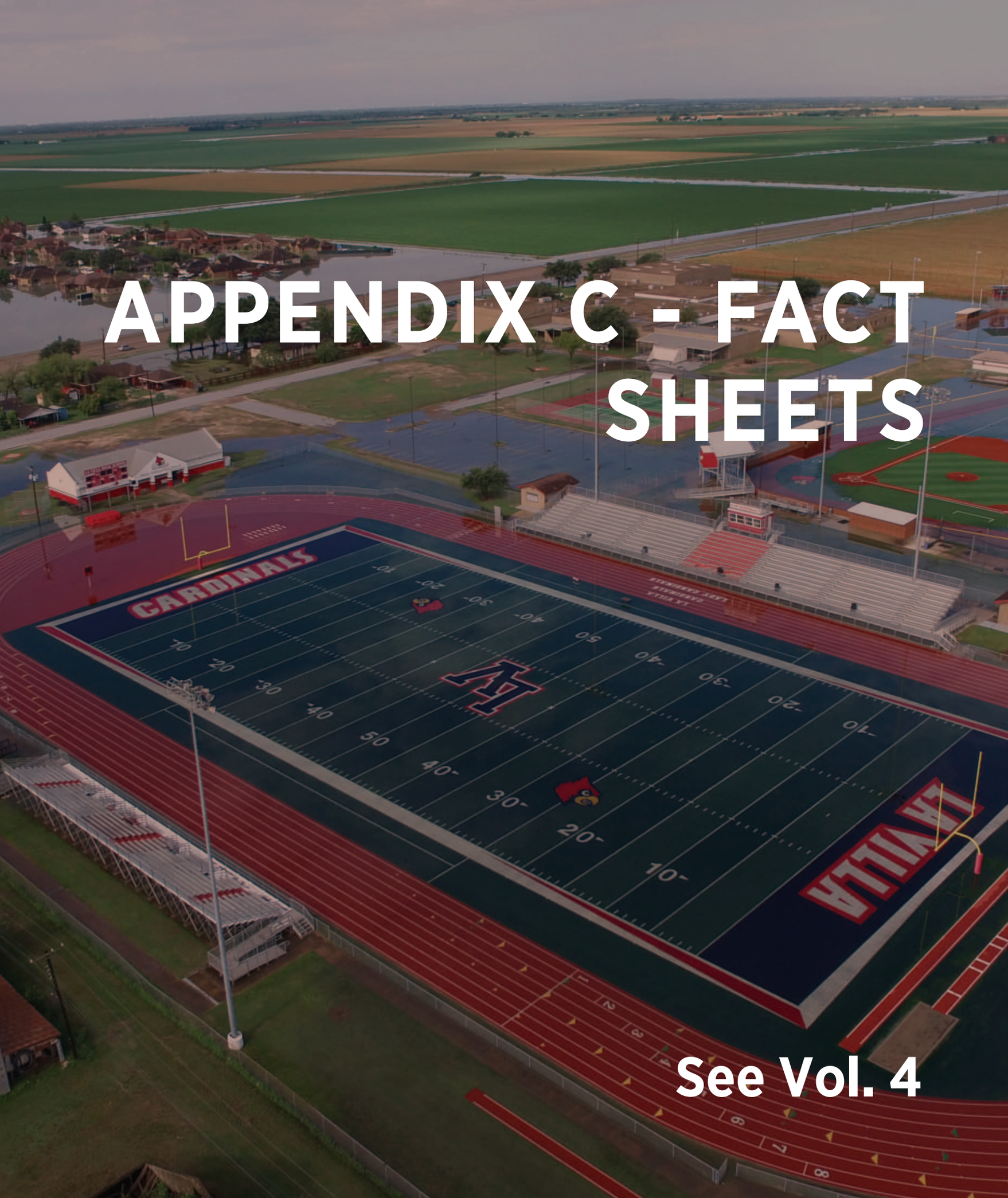
APPENDIX A - MAPS

See Vol. 2



APPENDIX B - TABLES

See Vol. 3



APPENDIX C - FACT SHEETS

See Vol. 4

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