REGION 8 Lower Brazos Regional Flood Planning Group

**MEMORANDUM**

**DATE:** August 13th, 2025 **Data Code:** _____

**TO:** Lower Brazos Regional Flood Planning Group

**FROM:** Evan Adrian, PE, CFM, ENV SP; Jacob Torres, PhD, PE, CFM, BC.WRE

(Torres & Associates, LLC)

**PROJECT:** 2028 Lower Brazos Regional Flood Plan

**SUBJECT:** Preliminary Recommendations on Floodplain Management Practices (Task 3A)

This memorandum provides a cursory listing of *Standards for Recommendation* for the Lower Brazos Region, in partial fulfillment of *Task 3A - Evaluation and Recommendations on Floodplain Management Practices*. The purpose of Task 3A is to evaluate existing floodplain management practices within the Lower Brazos Planning Region and recommend floodplain management standards that minimize existing flood risks and prevent creating new flood risks. It is essential to note the RFPG does not have the authority to enact or enforce floodplain management, land use, or other infrastructure design standards. Any standards considered, recommended, and accepted by the Lower Brazos RFPG are intended to encourage implementation by local entities in the Lower Brazos Planning Region with flood-related authority. Any standards considered, recommended, and adopted by the Lower Brazos RFPG in this task would be aimed at encouraging implementation by local entities in the region with flood-related authority.

Floodplain management standards fall into two main categories, *adoption* and *recommendation*. Recommended standards are general guidelines for consideration by the floodplain regulating entities in the region. Adopted standards are specific minimum standards that should be adopted by the entities within the region. Standards determined to be for adoption must be implemented by entities prior to the RFPG including any flood management evaluations, flood management strategies, or flood mitigation projects for the entity in the Regional Flood Plan. **Based on feedback from the RFPG during the meeting on May 15th, 2025, standards proposed for the Lower Brazos Flood Planning Region are recommended standards to be used as general guidelines for consideration by the entities within the region.**

The recommended standards for consideration are divided into two distinct categories: standards for region-wide recommendation and standards recommended for smaller "zones" within the Lower Brazos Planning Region delineated along county boundaries. These categories allow for a broad application of standards and a tailored formulation for capturing flood risk variability, natural hydrography, topography, climatological effects, and demographics throughout the region. The different categories of standards are described further in subsequent sections, along with the definitions of each standard. **Table 1** provides a summary of the *recommended* standards for the Lower Brazos Region.

**Table 1. Summary of Lower Brazos Recommended Standards**

| Recommended Standard | Region Wide | Zone 1 "Coastal" | Zone 2 "Upper Coastal" | Zone 3 "Brazos Valley" | Zone 4 "Middle Brazos" |
|---|---|---|---|---|---|
| National Flood Insurance Program Participation | X | | | | |
| Compensatory Storage Requirement in 1% Floodplain | X | | | | |
| No Adverse Impacts for the 1% Storm Event | X | | | | |
| Improved Flood Response | X | | | | |
| Improved Flood Risk Awareness/Education | X | | | | |
| Use of Best Available Rainfall Data* | X | | | | |
| No Adverse Impacts for the 1% and 10% Storm Event | | X | X | X | |
| Formation of a Voluntary Buyout Program | | X | | | |
| Long-term Operation and Maintenance Planning of Drainage Infrastructure | | X | | | |
| Drainage Corridor Preservation | | | X | X | |
| Compensatory Storage Requirement in 0.2% Floodplain | | | | X | X |
| Requirements for Culvert and Bridge Crossings | | | | X | X |
| Roadway Requirements within the Floodplain | | | | X | X |
| Culvert and Bridge Hydrologic and Hydraulic Analysis Requirement | | | | X | X |

*Based on feedback from entities in the Lower Brazos Region, the Use of Best Available Rainfall Data Recommended Standard was revised to be applied Region Wide rather than only to Zones 1-3 in the 2023 Regional Flood Plan.

# Data Collection and Analysis

Several data sources were utilized to inform the determination of floodplain management standards. These sources include survey feedback, existing criteria, standards, programs, regulations, reports, and available Texas Water Development Board (TWDB) data sources. Survey feedback was gathered to better understand the existing floodplain management practices throughout the region and identify standards that entities within the Lower Brazos region would like to see included in the regional flood plan. Existing criteria and standards were looked at to provide information on existing floodplain management practices for entities that did not provide survey feedback. This information supplemented the data gathered from the survey and provided a better understanding of the entire region on floodplain management practices. Spatial data provided by TWDB helped determine characteristics for areas within the region that assisted in refining recommended standards to be tailored to each area.

Existing criteria and standards were analyzed for many of the entities within the region. The existing criteria included drainage criteria manuals, engineering standards, master plans, stormwater management programs, subdivision regulations, and ordinances. Cities had a greater variation in existing criteria with many having drainage criteria manuals, master plans, and stormwater management programs. Counties primarily had subdivision regulations and stormwater management programs. The criteria varies over the region, however many of the entities have more stringent floodplain management standards than the minimum standards set by the National Flood Insurance Program (NFIP). Even though there are many entities that have higher standards, only 12 entities participate in the Community Rating System (CRS). The CRS is a program within the NFIP that recognizes communities that implement standards higher than minimum floodplain management standards. NFIP participating communities and CRS communities are shown in **Exhibit 3**.

TWDB technical guidance provided an outline for developing region-specific floodplain management standards. This included example standards, resources for higher standards including reports by Texas Floodplain Managers Association (TFMA) and FEMA CRS standards, and considerations to make when developing the standards. TWDB provided a rich assortment of spatial data that included FEMA flood claims, low water crossings, critical infrastructure, flood control infrastructure, and floodplain quilt. Low water crossings consist of roadway creek crossings that are subject to frequent inundation during storm events. Critical infrastructure includes hospitals, schools, fire stations, police stations, emergency shelters, assisted living facilities, and nursing homes. The data was analyzed through GIS to highlight specific watershed characteristics for each HUC 8 within the region. The metrics calculated were used to help tailor standards to each regional zone.

Entities within the Lower Brazos Region provided feedback through a basin wide survey initiated in January 2025. The survey included questions regarding existing floodplain management practices and considerations for minimum standards across the region. The responses provided insight into the existing standards being practiced by entities in the basin and suggested minimum standards that the communities

would prefer to see implemented. **Figure 1** provides the survey responses regarding minimum standards that entities within the Lower Brazos Region wants to see considered. All items from the survey are addressed by the recommended standards in the Regional Flood Plan.

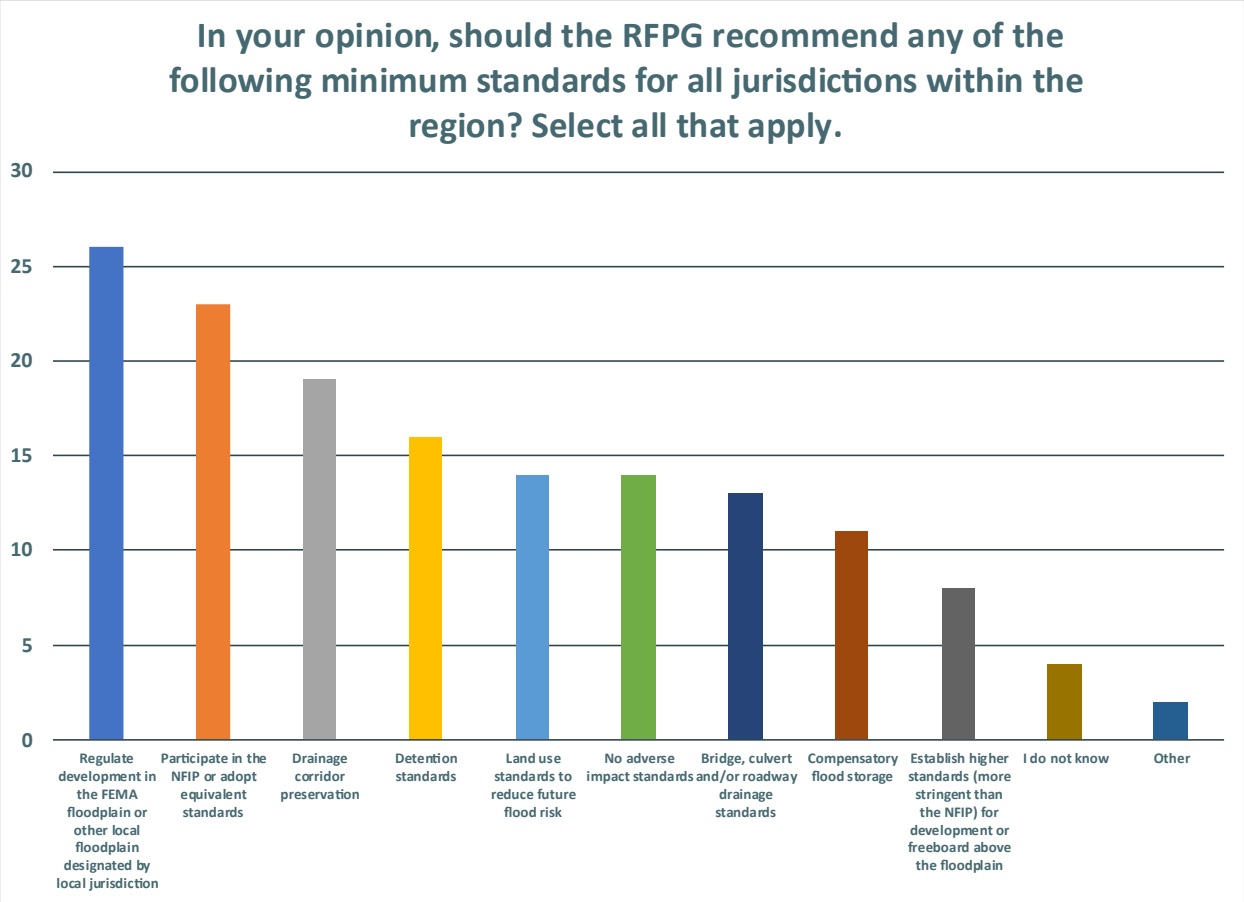



*Figure 1. Responses to Question from the 2025 Lower Brazos Data Collection Survey*

# Region-Wide Standards for *Recommendation*

Standards presented in this section are *recommendations* for all entities within the Lower Brazos Region. Red text is used to indicate adjustments made to the recommendations included in the 2023 Region Flood Plan. Recommended standards are general guidelines for consideration by the floodplain regulating entities.

***National Flood Insurance Program (NFIP) Participation.***

All floodplain regulating entities should enact ordinances that meet minimum requirements for NFIP Participation and be active NFIP participants in good standing. This standard would only apply to communities not already NFIP participants in good standing. NFIP participation is voluntary, however it allows for discounted insurance premiums, eligibility for federal grants and loans, and federal disaster assistance. For communities to participate in the NFIP program, they must do the following.

- Adopt and enforce a flood damage prevention ordinance.
- Require permits for all types of development in the floodplain.
- Ensure that building sites are reasonably safe from flooding.
- Estimate flood elevations that were not determined by FEMA.
- Require new or substantially improved homes and manufactured homes to be elevated above the Base Flood Elevation (BFE).
- Require other buildings to be elevated or floodproofed.
- Conduct field inspections and cite violations.
- Require Elevation Certificates to document compliance.
- Carefully consider requests for variances.
- Resolve non-compliance and violations.
- Advise FEMA when updates to flood maps are needed.

***Compensatory Storage Requirement in 1 Percent ACE Floodplain.***

Any reduction in floodplain storage or conveyance capacity within the 1 percent ACE regulatory floodplain must be offset with a hydraulically equivalent (one-to-one) volume of mitigation sufficient to offset the reduction. Floodplains provide critical and beneficial functions for flood storage, natural habitat, and water quality. Fill placed within the floodplain impairs the benefits provided by the floodplain and should be avoided. This standard may be exercised for planned development or fill placement located within the 1 percent ACE regulatory floodplain. Such mitigation shall be within the same watershed or at an alternative site that is approved by that community's Floodplain Administrator. A complete hydrological and hydraulic (H&H) analysis must be submitted to support a request for mitigation outside the developed property boundaries. This requirement does not apply to FEMA classified flood zones with velocity hazards (FEMA Flood Zone V and VE).

***No Adverse Impacts for the 1 Percent ACE Storm Event.***

The 1 percent ACE is considered the primary storm for basing no adverse impacts. Incorporating no adverse impacts can help minimize flood damages caused by activities that could adversely impact flood damage to another property or community. This practice is cited in the Texas Floodplain Managers Association's (TFMA) Higher Standards (TFMA, 2018). This standard will require a complete H&H analysis to be submitted to support the no adverse impact requirement. Considerations should be made by each entity on the best practice for determining no adverse impacts, including the extent of impact consideration, no rise in water surface elevation versus no increase in peak flow, and regional mitigation versus local development mitigation. For reference, examples of no adverse impact determinations are:

- A rise of 0.01 feet on another property is non-permissible and is considered an adverse impact. In addition, any loss in floodplain volume on the property is also an adverse impact.
- An increase in peak flow in the receiving waterway downstream of development is non-permissible and is considered an adverse impact.

***Improved Flood Response.***

This measure includes appropriate efforts for enhancing flood notification and communication, both with emergency response personnel and the public. Efforts to improve flood response can include development of an Emergency Action Plan (EAP) for significant storm events, communication plans to contact residents of emergency situations during storm events, implementation of an emergency response system, and execution of emergency response tabletop exercises. This can improve flood risk communication and mobility (response and evacuation) at large geographic scales.

***Improved Flood Risk Awareness/Education.*** This standard recommends implementation of flood risk awareness and education within the region. Flood risk awareness and education can include a website, webinars, public meetings, or other engagement efforts to increase public flood risk awareness.

***Use of Best Available Rainfall Data.*** Utilize the latest rainfall data as the more conservative rainfall estimates as part of new analysis and design standards and flood prevention regulations.

Based on feedback from some communities in the region, it was recommended that the Use of Best Available Rainfall Data be revised to a Region-wide Standard due to Statewide Agencies updating their criteria to use Best Available Rainfall Data as it is available. For example, the Texas Department of Transportation (TXDOT) has adopted Atlas 14 rainfall as the best available rainfall data on a statewide basis which provides much of the groundwork for entities to use the best available rainfall data in their areas.

# Lower Brazos "Zone" Standards for *Recommendation*

Standards presented in this section are suggested as *recommendations* for entities within each defined zone within the Lower Brazos Region. Recommended standards are general guidelines for consideration by the floodplain regulating entities. Each zone has defining characteristics that were used to tailor recommended standards to help local entities establish preventative measures for reducing flood damage. **Table 2** summarizes the characteristics of each zone. The recommended standards for all zones were developed to increase CRS participation by recommending higher standards be implemented by entities and increase coastal resiliency for Zone 1. The zones are based on the county boundaries with the region. A map of the zones is provided as **Exhibit 2**.

**Table 2. Lower Brazos "Zone" Characteristics**

| Zone | Flood Claims* | CRS Communities | NFIP Participation (% of Entities) | Critical Infrastructure in Floodplain* | Low Water Crossings |
|---|---|---|---|---|---|
| Zone 1 "Coastal" | 10,346 | 3 | 100% | 303 | 18 |
| Zone 2 "Upper Coastal" | 631 | 0 | 79% | 22 | 47 |
| Zone 3 "Brazos Valley" | 2,344 | 6 | 86% | 256 | 1,121 |
| Zone 4 "Middle Brazos" | 1,026 | 4 | 83% | 166 | 534 |

*Base datasets gathered during the 2023 Regional Flood Plan

## *Zone 1 – "Coastal"*

Zone 1 is defined as the coastal region nearest the Gulf of Mexico. The zone is comprised of Brazoria County and Fort Bend County. There are three CRS rated communities within the zone, Missouri City, the city of Sugar Land, and a small portion of the City of Houston. The defining characteristics of this zone are a high number of FEMA flood claims, high NFIP participation, high number of critical infrastructure within the floodplain, and only a few low water crossings. Over half of the zone is within the 0.2 percent ACE FEMA floodplain. Precipitation estimates for this zone have increased with Atlas 14 revised rainfall data.

## *Zone 2 – "Upper Coastal"*

Zone 2 is defined as the upper coastal region and is comprised of Austin and Waller Counties. The defining characteristics of this zone are a low number of FEMA flood claims, above 75% NFIP participation, low number of critical infrastructure within the floodplain, and few low water crossings. Precipitation estimates for this zone have increased with Atlas 14 revised rainfall data.

## Zone 3 – "Brazos Valley"

Zone 3 is defined as the Brazos Valley region and is comprised of the central counties within the region. The upstream and downstream boundaries were defined based on the proximity of the county boundaries to existing HUC-8 boundaries. McLennan County and Bell County were included in Zone 3 based on similarities to the other counties within Zone 3. The defining characteristics of this zone are a moderate amount of FEMA flood claims, medium to high NFIP participation, high number of critical infrastructure within the floodplain, and a significant number of low water crossings. Precipitation estimates for this zone have increased with Atlas 14 revised rainfall data.

## Zone 4 – "Middle Brazos"

Zone 4 is the Middle Brazos region and is comprised of the northwestern counties within the Lower Brazos Region. The defining characteristics of this zone are a moderate amount of FEMA flood claims, medium to high NFIP participation, moderate number of critical infrastructure within the floodplain, and a significant number of low water crossings.

## Recommended Standards for Zones

***No Adverse Impacts for the 1 Percent ACE and 10 Percent ACE Storm Events. (Zone 1, 2, 3)***

The 1 percent and 10 percent ACE storm events are considered the primary storm for basing no adverse impacts. Incorporating no adverse impacts can help minimize flood damages caused by activities that could adversely impact flood damage to another property or community. This practice is cited in TFMA's Higher Standards (TFMA, 2018). This standard will require a complete H&H analysis be submitted to support the no adverse impact requirement. Considerations should be made by each entity on the best practice for determining no adverse impacts including the extent of impact consideration, no rise in water surface elevation versus no increase in peak flow, and regional mitigation versus local development mitigation. Examples of no adverse impact determinations are provided below for reference.

- A rise of 0.01 feet on another property is non-permissible and is considered an adverse impact. In addition, any loss in floodplain volume on the property is also an adverse impact.
- An increase in peak flow in the receiving waterway downstream of development is non-permissible and is considered an adverse impact.

***Formation of a Voluntary Buyout Program. (Zone 1)***

This practice recommends forming a voluntary buyout program by local entities to assist in reducing flood damage within certain areas of the floodplain. Implementing the program would help improve coastal resiliency and reduce repetitive flood damage.

***Long-Term Operation and Maintenance Planning of Drainage Infrastructure. (Zone 1)***

Developing a plan for long-term operation and maintenance of critical drainage infrastructure within each entity is recommended to improve coastal resiliency and reduce flood risk. This plan should include a defined sustainable funding mechanism to support long-term operation and maintenance. Critical drainage infrastructure can include dams, levees, floodwalls, and any other infrastructure identified as critical by the entity.

***Drainage Corridor Preservation. (Zone 2, 3)***

Infrastructure construction should avoid high-risk and sensitive areas such as floodways, floodplains, coastal dunes, and areas downstream of dams, levees, and floodwalls. New buildings or other new infrastructure should be prohibited within the regulatory floodplain and in other high risk or sensitive areas identified by the entity.

***Compensatory Storage Requirement in 0.2 Percent ACE Floodplain. (Zone 3, 4)***

Any reduction in floodplain storage or conveyance capacity within the 0.2 percent ACE floodplain must be offset with a hydraulically equivalent (one-to-one) volume of mitigation sufficient to offset the reduction. This standard may be exercised for planned development or fill placement located within the 0.2 percent ACE regulatory floodplain. Such mitigation shall be within the same watershed or at an alternative site that that community's Floodplain Administrator approves. A complete H&H analysis must be submitted to support a request for mitigation outside the developed property boundaries. This requirement does not apply to flood zones with velocity hazards (Zone V and VE).

***Requirements for Culvert and Bridge Crossings. (Zone 3, 4)***

Culverts and bridges at arterial roadways, access roads to critical facilities, emergency routes, and evacuation routes should pass the 1 percent ACE with a minimum of one (1) foot of freeboard. This standard assists in reducing the number of new low water crossings within the zone.

***Roadway requirements within the Floodplain.* (Zone 3, 4)**

New arterial roadways, access roads to critical facilities, emergency routes, and evacuation routes within the regulatory floodplain should be at or above the base flood elevation to provide access for emergency vehicles during a flood.

***Culvert and Bridge Hydrologic and Hydraulic Analysis Requirement. (Zone 3, 4)***

New culverts or bridges constructed in the floodway should require a complete H&H analysis.

# References

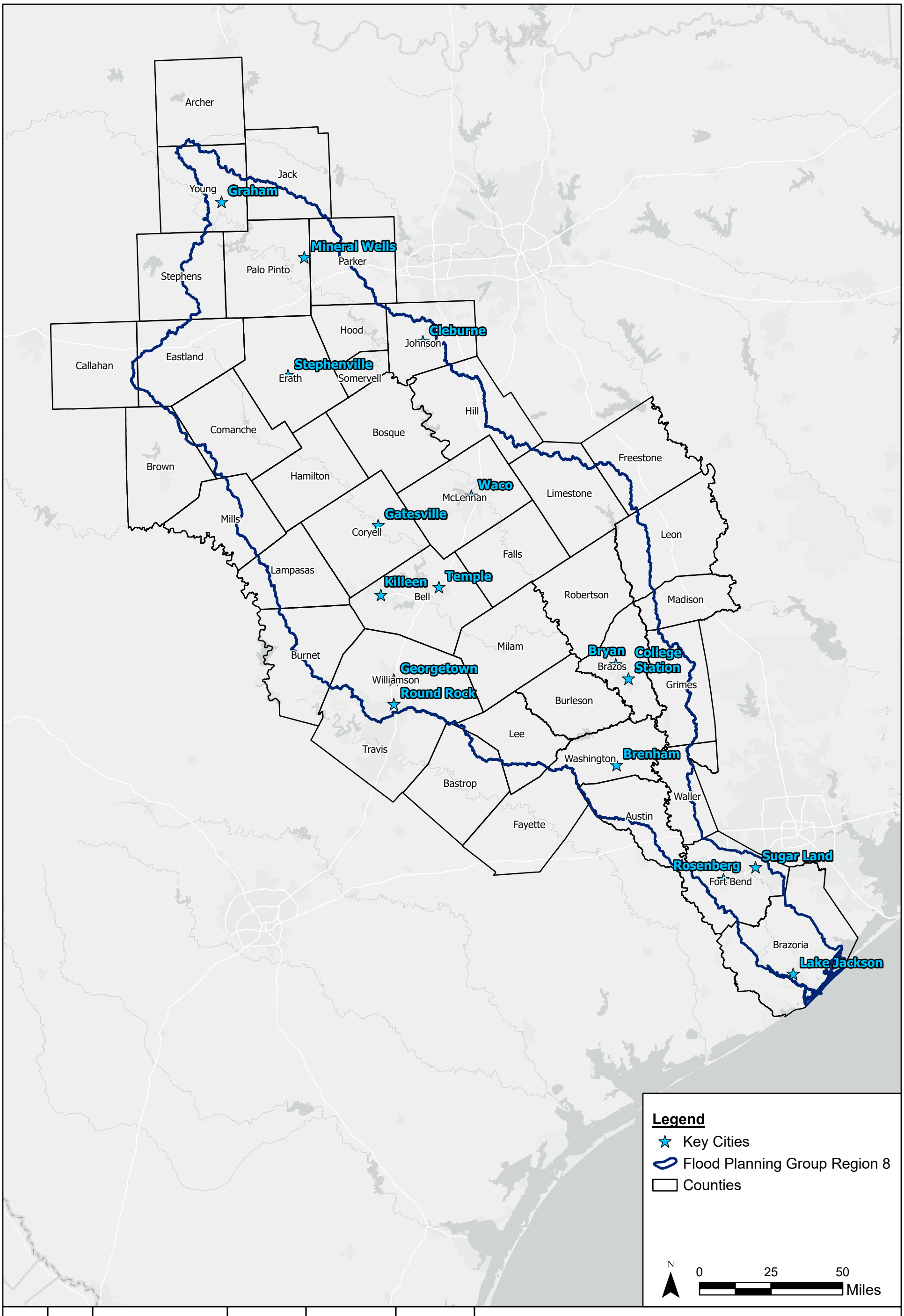
Federal Emergency Management Agency (FEMA). (2017). "National Flood Insurance Program Community Rating System, Coordinator's Manual."

National Oceanic and Atmospheric Administration (NOAA). (2018). "NOAA Atlas 14 Precipitation-Frequency Atlas of the United States, Volume 11 Version 2.0: Texas."

Texas Floodplain Management Association (TFMA), (2018). "A Guide for Higher Standards in Floodplain Management," May 2018.

Texas Water Development Board (TWDB). (2025). "Technical Guidelines for Regional Flood Planning," revised February 2025.

# List of Exhibits

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|---|---|---|---|---|---|---|
| Exhibit 01 | Date: Jul 2025<br>Scale: As Noted | halff<br>9303 NEW TRAILS DRIVE<br>SUITE 400<br>THE WOODLANDS, TX 77381 | Prepared: SCG | Checked: ESA | Approved: ESA | 2028 REGION 8 (LOWER BRAZOS) REGIONAL FLOOD PLAN |
| | | | TORRES & ASSOCIATES<br>Engineers \| Scientists \| Professionals | | | LOWER BRAZOS COUNTIES AND KEY CITIES |

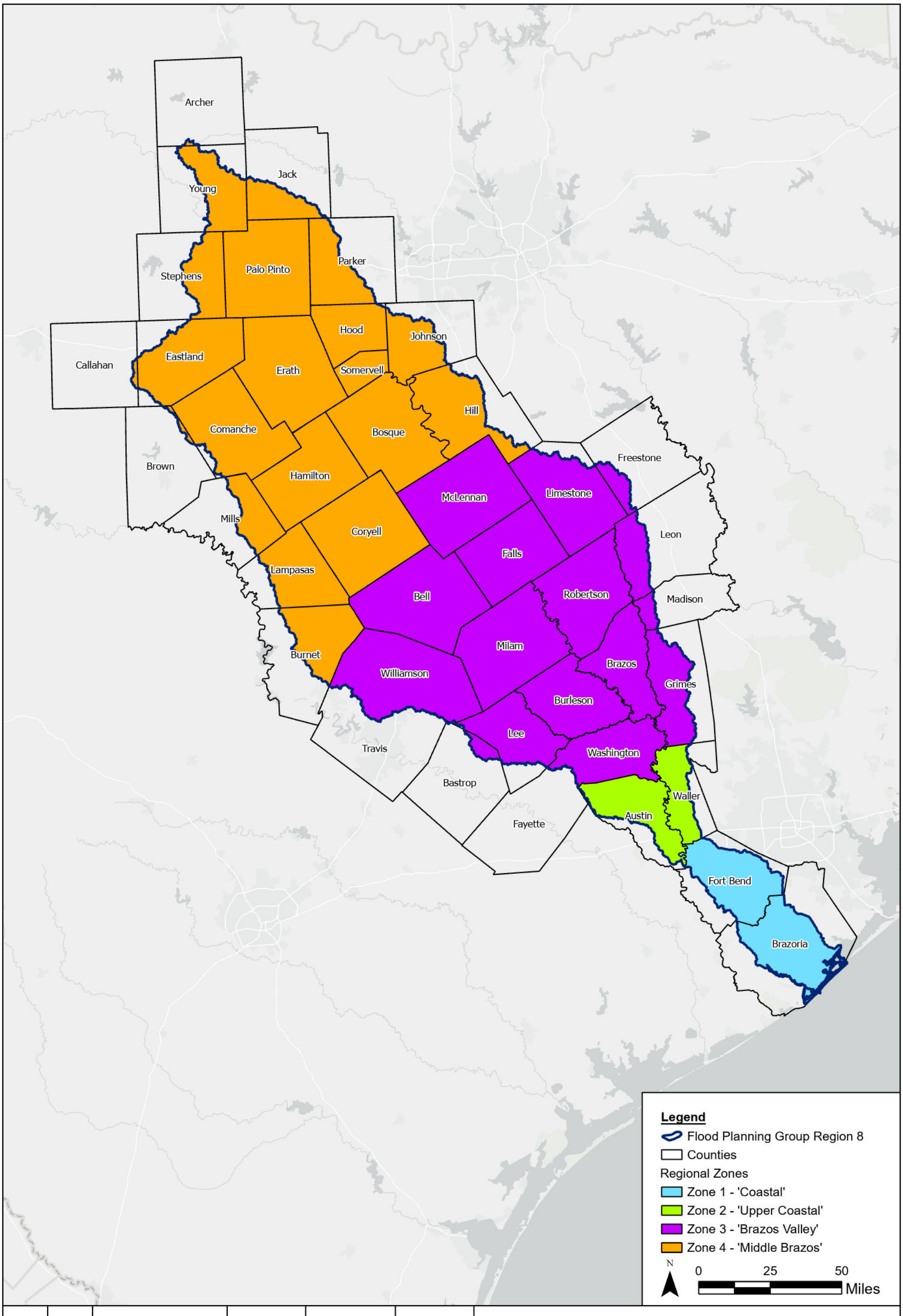


Exhibit 02

Date: Aug 2025
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9303 NEW TRAILS DRIVE
SUITE 400
THE WOODLANDS, TX 77381

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| SDH | ESA | ESA |

TORRES & ASSOCIATES
ENGINEERS | SCIENTISTS | PROFESSIONALS

# 2028 REGION 8 (LOWER BRAZOS) REGIONAL FLOOD PLAN

## LOWER BRAZOS REGIONAL ZONES BY COUNTY

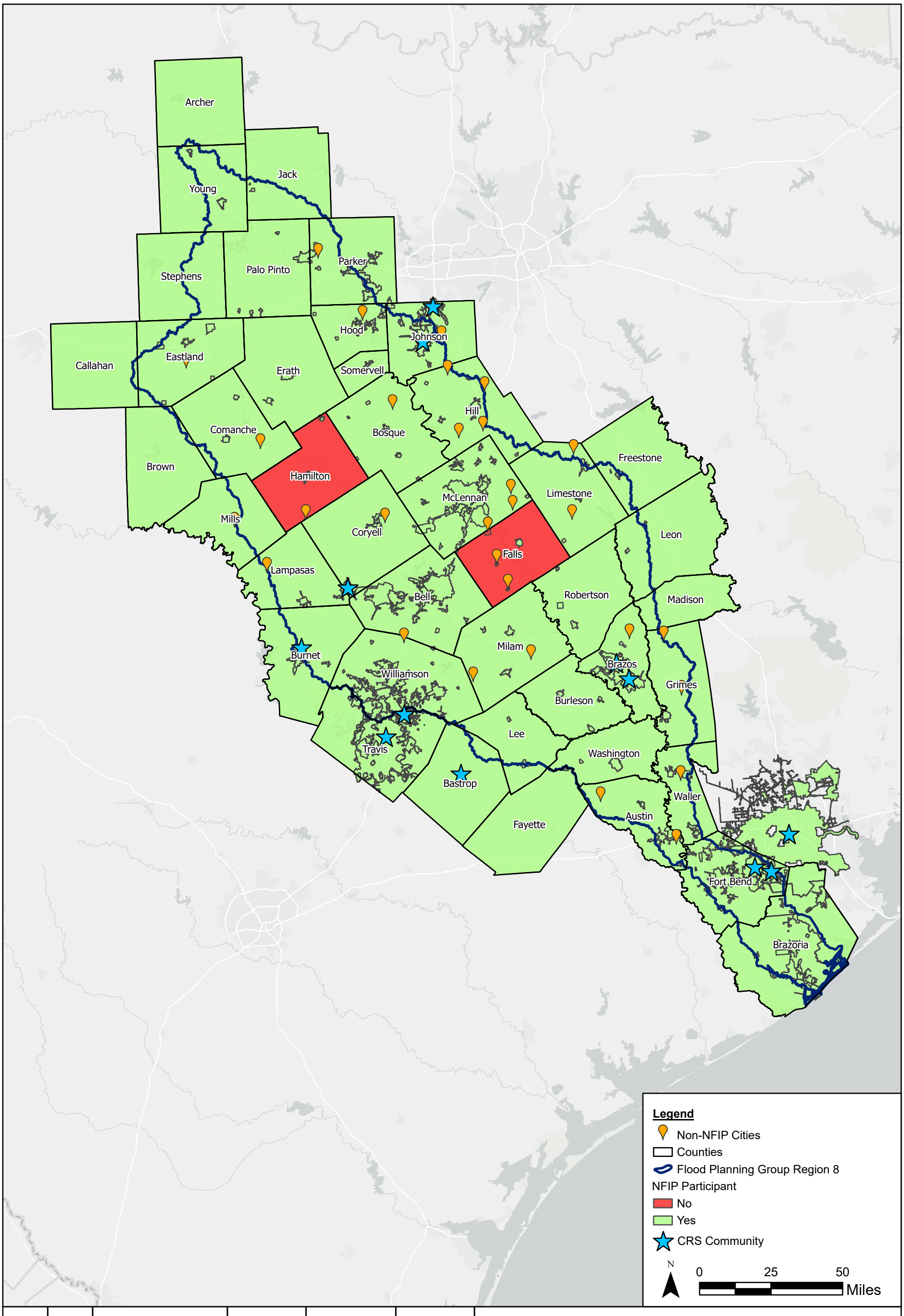


Exhibit 03

Date: Jun 2025
Scale: As Noted

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| SCG | ESA | ESA |

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# 2028 REGION 8 (LOWER BRAZOS) REGIONAL FLOOD PLAN

## NFIP AND CRS PARTICIPATING ENTITIES

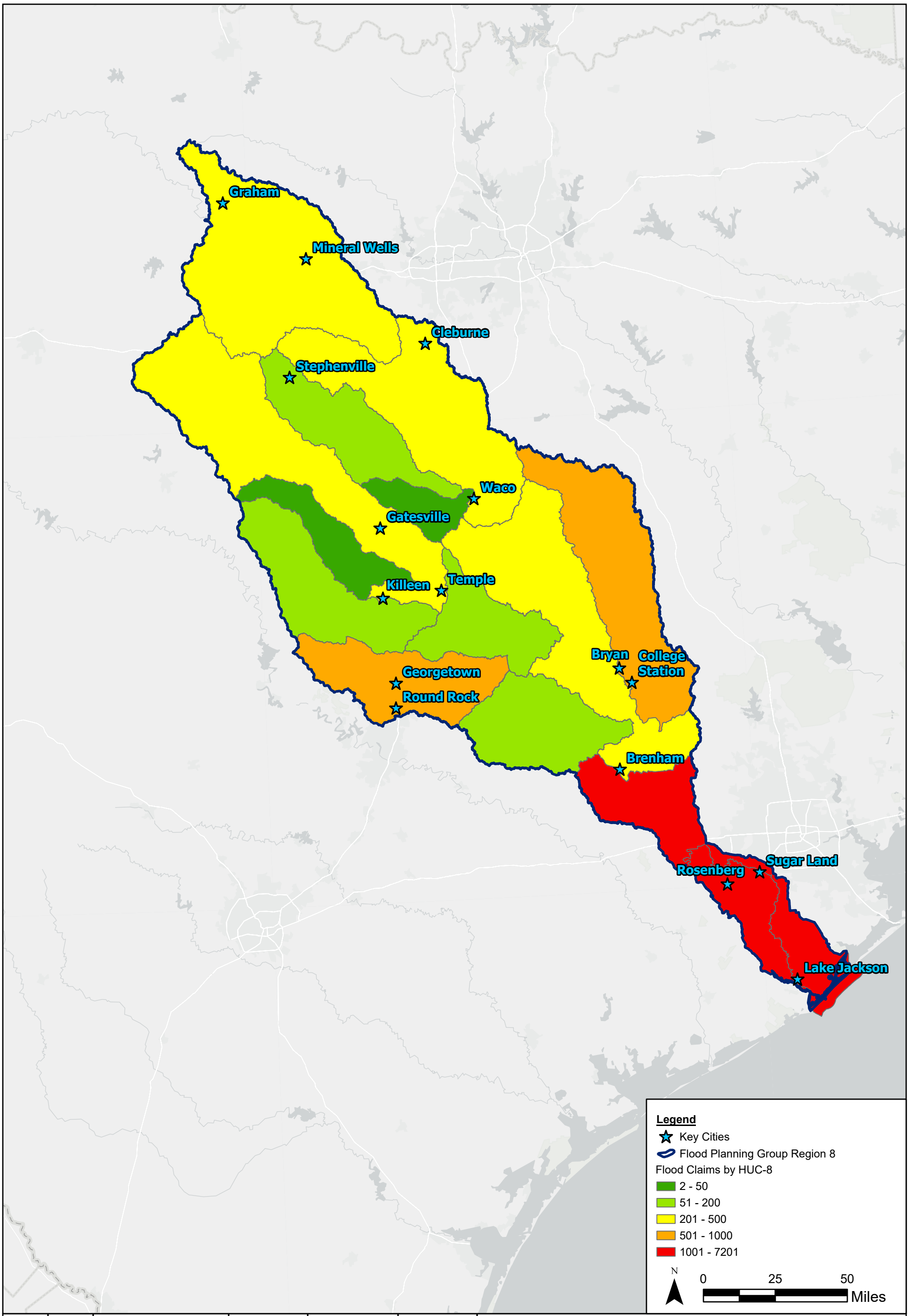


Exhibit 04

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| SCG | ESA | ESA |

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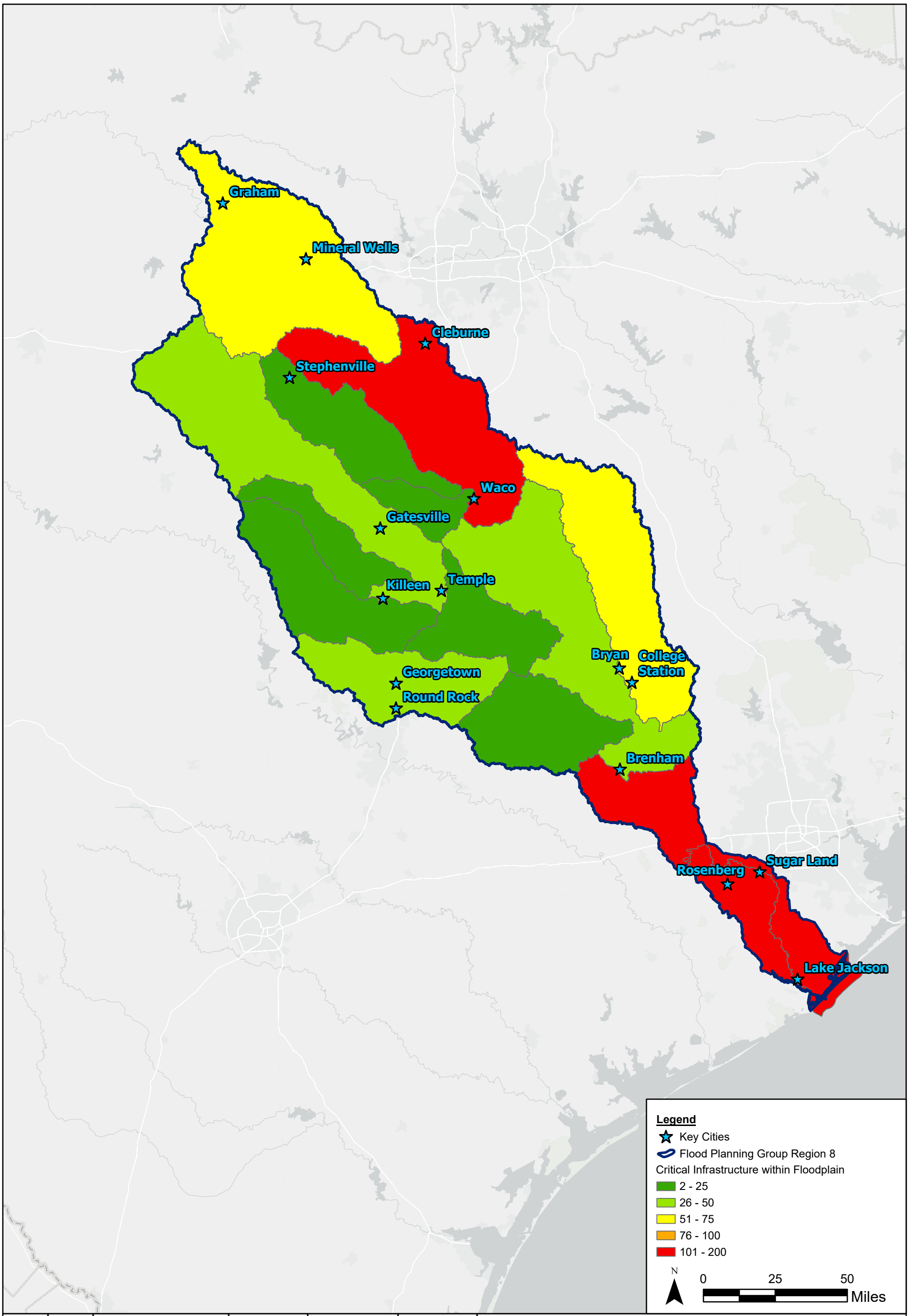
# 2028 REGION 8 (LOWER BRAZOS) REGIONAL FLOOD PLAN

## FLOOD CLAIMS BY HUC-8

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| Exhibit 05 | Date: Jun 2025<br>Scale: As Noted | halff<br>9303 NEW TRAILS DRIVE<br>SUITE 400<br>THE WOODLANDS, TX 77381 | Prepared: SCG | Checked: ESA | Approved: ESA | 2028 REGION 8 (LOWER BRAZOS) REGIONAL FLOOD PLAN |
| | | | TORRES & ASSOCIATES<br>Engineers \| Scientists \| Professionals | | | **CRITICAL INFRASTRUCTURE WITHIN THE FLOODPLAIN** |

Graham
Mineral Wells
Cleburne
Stephenville
Waco
Gatesville
Killeen
Temple
Georgetown
Round Rock
Bryan
College Station
Brenham
Rosenberg
Sugar Land
Lake Jackson

**Legend**

- Key Cities
- Flood Planning Group Region 8

Low Water Crossings

- 1 - 25
- 26 - 50
- 51 - 100
- 101 - 200
- 201 - 237

N

0 25 50 Miles

**Exhibit 06**

Date: Jun 2025
Scale: As Noted

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9303 NEW TRAILS DRIVE
SUITE 400
THE WOODLANDS, TX 77381

| Prepared: SCG | Checked: ESA | Approved: ESA |
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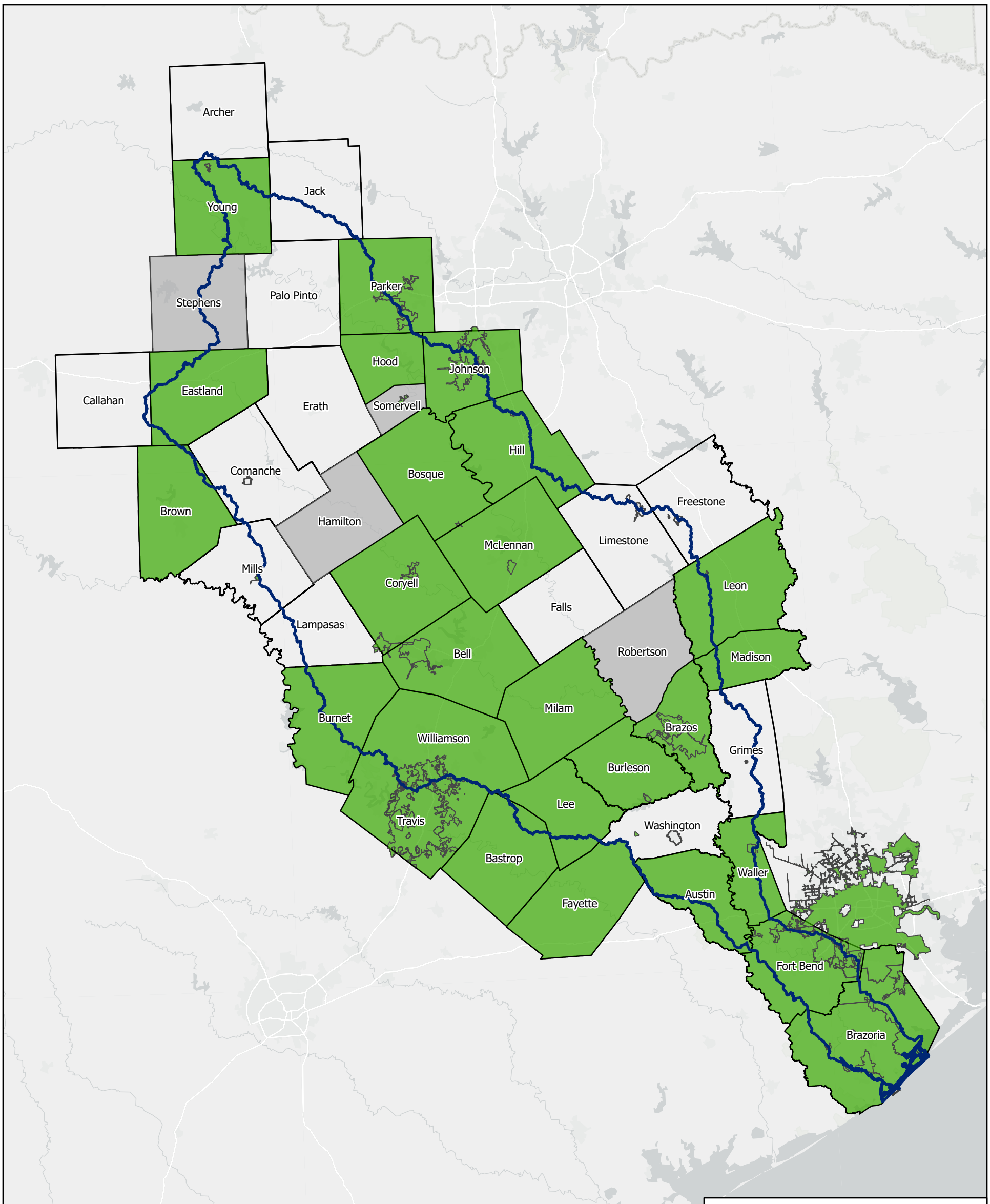
# 2028 REGION 8 (LOWER BRAZOS) REGIONAL FLOOD PLAN

## LOW WATER CROSSINGS

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| Exhibit 07 | Date: Jun 2025<br>Scale: As Noted | halff<br>9303 NEW TRAILS DRIVE<br>SUITE 400<br>THE WOODLANDS, TX 77381 | Prepared: SCG | Checked: ESA | Approved: ESA | 2028 REGION 8 (LOWER BRAZOS) REGIONAL FLOOD PLAN |
| | | | TORRES & ASSOCIATES<br>Engineers \| Scientists \| Professionals | | | **ENTITIES WITH HIGHER STANDARDS IDENTIFIED** |