GUADALUPE-BLANCO RIVER AUTHORITY

Hazard Mitigation Action Plan

Mitigating Risk for a Safe, Secure, and Sustainable Future

Adopted: September 19, 2018

H2O PARTNERS
PLAN YOUR RECOVERY

GBRA

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SECTION 1: INTRODUCTION

Background

The Guadalupe-Blanco River Authority (GBRA) was formed in 1933 by the Texas legislature. Its main concerns are water supply and water conservation in the Guadalupe River Basin. The authority extends over ten counties, while their general offices are located in Seguin Texas which is in Guadalupe County.

With ongoing water resources planning, the GBRA remains dedicated to preventing damage before a disaster occurs. In 2005 the GBRA facilitated development of Hazard Mitigation Action Plan (HMAP) approved by the Federal Emergency Management Agency (FEMA) entitled, "Hazard Mitigation in the Guadalupe River Basin – Protecting the Region Against All Hazards." Then in 2011, information about the planning area and hazard events were updated and incorporated into their HMAP Update. These plans were formed with technical assistance provided by GBRA and H2O Partners, Inc. of Austin, Texas. Seven counties and nineteen cities participated in these plans.

The Guadalupe-Blanco River Authority leads as a regional partner managing watershed resources to protect and support the needs of a growing population, economy and healthy environment. The mission of GBRA is to support responsible watershed protection and stewardship, provide quality operational service, and a commitment to promote conservation and educational opportunities in order to enhance quality of life for those it serves. The vision statement of the GBRA is to be a widely recognized leader in managing water resources that benefit both people and the environment.

Consistent with this vision, GBRA took the lead in sponsoring the development of a Hazard Mitigation Plan Update for the facilities and infrastructure of the river authority. The Disaster Mitigation Act requires that hazard mitigation plans be reviewed and revised every five years to maintain eligibility for Hazard Mitigation Assistance (HMA) grant funding. Since FEMA originally approved the GBRA HMAP in 2005, and then approved an update in 2011, the GBRA began the process of developing a HMAP Update in order to maintain eligibility for grant funding. The GBRA selected the consultant team of H2O Partners, Inc. to write and develop the HMAP Update 2018, hereinafter titled: "GBRA Hazard Mitigation Plan Update 2018: Mitigating Risk for a Safe, Secure, and Sustainable Future" (Plan or Plan Update).

Much of the Guadalupe River Basin is in Flash Flood Alley, an area prone to heavy rains and flooding. Even during the hot, dry Texas summer, flooding rains can occur suddenly and without warning, making the Guadalupe River Basin one of the most flash-flood prone areas in North America.[1] While flooding is a well-known risk, the GBRA is susceptible to a wide range of natural hazards, including but not limited

[1] Source: http://floodsafety.com/texas/regional_info/regional_info/sanantonio_zone.htm

to drought, extreme heat, tornadoes, and wildfires. These life-threatening hazards can destroy property, disrupt the economy, and lower the overall quality of life for individuals.

While it is impossible to prevent a hazard event from occurring, the effects from many hazards to people and property can be lessened. This concept is known as hazard mitigation, which is defined by the Federal Emergency Management Agency (FEMA) as *sustained actions taken to reduce or eliminate long-term risk to people and property from hazards and their effects.*[2] Communities participate in hazard mitigation by developing hazard mitigation plans. The Texas Division of Emergency Management (TDEM) and FEMA have the authority to review and approve hazard mitigation plans through the Disaster Mitigation Act of 2000.

Mitigation differs from emergency preparedness and protective measures, which focus on activities designed to make communities more prepared to take appropriate action in a disaster with emergency response and equipment. Mitigation activities involve alteration of physical environments to reduce risks and vulnerabilities to hazards and make it more cost-effective to respond to, and recover from, disasters.

Hazard mitigation activities are an investment in a community's safety and sustainability. It is widely accepted that the most effective hazard mitigation measures are implemented at the local government level, where decisions on the regulation and control of development are ultimately made. A comprehensive hazard mitigation plan addresses hazard vulnerability that exist today and in the foreseeable future. Therefore, it is essential that a plan identify projected patterns of how future development will increase or decrease a community's overall hazard vulnerability.

Scope and Participation

The Guadalupe-Blanco River Authority's Hazard Mitigation Plan Update is a single jurisdictional Plan. Numerous entities and businesses participated as stakeholders in the Plan, including numerous river authorities, Edwards Aquifer Authority, Texas Commission on Environmental Quality, and Texas Parks and Wildlife Department. These groups, and others, provided valuable input into the planning process.

The focus of the Plan is to identify activities to mitigate hazards selected from the State Hazard Mitigation Plan which are deemed to pose a risk to the planning area. For each of the hazards selected, a detailed risk assessment was conducted as part of the hazard mitigation planning process. The risk assessment enables the GBRA to prioritize mitigation actions based on hazards that pose the greatest risk to lives and property.

Purpose

The Plan was prepared by the Guadalupe-Blanco River Authority (GBRA) and H_2O Partners, Inc. The purpose of the Plan is to protect people and structures and to minimize the costs of disaster response and recovery. The goal of the Plan is to minimize or eliminate long-term risks to human life and property from known hazards by identifying and implementing cost-effective hazard mitigation actions, when possible. The planning process is an opportunity for the GBRA to evaluate and develop successful hazard mitigation actions to reduce future risk of loss of life and damage to property resulting from a disaster in the GBRA planning area.

[2] Source: http://www.fema.gov/hazard-mitigation-planning-resources

The Mission Statement of the Plan Update is, "*Maintaining a secure and sustainable future through the revision and development of targeted hazard mitigation actions to protect life and property.*"

The Guadalupe-Blanco River Authority identified 11 hazards to be addressed by the Plan. The specific goals of the Plan are to:

- Minimize disruption to the GBRA following a disaster;
- Streamline disaster recovery by articulating actions to be taken before a disaster strikes to reduce or eliminate future damage;
- Demonstrate a firm local commitment to hazard mitigation principles;
- Serve as a basis for future funding that may become available through grant and technical assistance programs offered by the State or Federal government. The Plan will enable the GBRA to take advantage of rapidly developing mitigation grant opportunities as they arise; and
- Ensure that GBRA maintains eligibility for the full range of future Federal disaster relief.

Authority

The Plan Update is tailored specifically for the Guadalupe-Blanco River Authority. The Plan complies with all requirements promulgated by the Texas Division of Emergency Management (TDEM) and all applicable provisions of the Robert T. Stafford Disaster Relief and Emergency Assistance Act, Section 104 of the Disaster Mitigation Act of 2000 (DMA 2000) (P.L. 106-390), and the Bunning-Bereuter-Blumenauer Flood Insurance Reform Act of 2004 (P.L. 108–264), which amended the National Flood Insurance Act (NFIA) of 1968 (42 U.S.C. 4001, et al). Additionally, the Plan complies with the Interim Final Rules for the Hazard Mitigation Planning and Hazard Mitigation Grant Program (44 CFR, Part 201), which specify the criteria for approval of mitigation plans required in Section 322 of the DMA 2000 and standards found in FEMA's "Local Mitigation Plan Review Guide" (October 2011) and the "Local Mitigation Planning Handbook" (March 2013). The Plan is also developed in accordance with FEMA's Community Rating System (CRS) Floodplain Management Plan standards and policies.

Summary of Sections

Sections 1 and 2 of the Plan outline the purpose and the process of development. Section 3 profiles the Guadalupe-Blanco River Authority and the Guadalupe River Basin in terms of population and economy.

Sections 4 through 15 present a hazard overview and information on individual hazards. For each hazard, the Plan presents a description of the hazard, a list of historical hazard events, and the results of the vulnerability and risk assessment process.

Section 16 presents mitigation goals and objectives. Previous mitigation actions are presented in Section 17 and the new mitigation actions for the GBRA are in Section 18, while Section 19 identifies plan maintenance mechanisms.

The list of planning team members and stakeholders is located in Appendix A. Public survey results are analyzed in Appendix B. Appendix C contains a detailed list of critical facilities for the area, and

Appendix D lists dam locations. Appendix E contains information regarding workshops and meeting documentation. Capability Assessment results for the GBRA are located in Appendix F.[3]

[3] Information contained in some of these appendices are exempt from public release under the Freedom of Information Act (FOIA).

SECTION 2: PLANNING PROCESS

Plan Preparation and Development

Hazard mitigation planning involves coordination with various constituents and stakeholders to develop a more disaster-resistant community. Section 2 provides an overview of the planning process including the identification of key steps and a detailed description of how stakeholders and the public were involved.

Overview of the Plan

The Guadalupe-Blanco River Authority (GBRA) solicited bids and hired the consultant team of H_2O Partners, Inc. to provide technical support and oversee the development of the Hazard Mitigation Action Plan, or *the Plan*. The Consultant Team used the FEMA "Local Mitigation Plan Review Guide" (October 2011) and the "Local Mitigation Planning Handbook" (March 2013) to develop the Plan. The overall planning process is shown in Figure 2-1 below.

Figure 2-1. Mitigation Planning Process

The Guadalupe-Blanco River Authority and the Consultant Team met in December 2016 to begin organizing resources, identifying Planning Team members, and conducting a Capability Assessment.

Planning Team

Key members of H_2O Partners, Inc. developed the Plan in conjunction with the Planning Team. The Planning Team was established using a direct representation model. Some of their responsibilities included: completing Capability Assessment surveys, providing input regarding the identification of hazards, identifying mitigation goals, and developing mitigation strategies. The Planning Team consists of key personnel from the Guadalupe-Blanco River Authority, shown in Table 2-1, and was formed to coordinate planning efforts, input, and participation in the planning process.

Table 2-1. Planning Team

ORGANIZATION	TITLE
Guadalupe-Blanco River Authority	Accounting Assistant
Guadalupe-Blanco River Authority	Assistant Chief Ranger - Lake Wood Park
Guadalupe-Blanco River Authority	Chief District Operator - WCWTP
Guadalupe-Blanco River Authority	Chief Operator - Luling WTP
Guadalupe-Blanco River Authority	Chief Operator - Port Lavaca WTP
Guadalupe-Blanco River Authority	Chief Operator - San Marcos WTP
Guadalupe-Blanco River Authority	Chief Operator-Western Canyon
Guadalupe-Blanco River Authority	Chief Ranger - Coleto Creek Park
Guadalupe-Blanco River Authority	Deputy Assistant - GBRA Headquarters

ORGANIZATION	TITLE
Guadalupe-Blanco River Authority	Deputy Division Manager - Hydro/RUD
Guadalupe-Blanco River Authority	Deputy FCO
Guadalupe-Blanco River Authority	Deputy General Manager
Guadalupe-Blanco River Authority	Deputy General Manager
Guadalupe-Blanco River Authority	Distribution Operator - Western Canyon
Guadalupe-Blanco River Authority	Division Manager - Calhoun & Refugio County
Guadalupe-Blanco River Authority	Division Manager - Hays & Caldwell County
Guadalupe-Blanco River Authority	Division Manager - Hydro/RUD
Guadalupe-Blanco River Authority	Division Manager - Western Canyon
Guadalupe-Blanco River Authority	Executive Manager of Project Engineering and Development
Guadalupe-Blanco River Authority	Executive Manager Operations and Water Quality
Guadalupe-Blanco River Authority	Grant Administrator - Seguin
Guadalupe-Blanco River Authority	Lab Director
Guadalupe-Blanco River Authority	Lockhart - Wastewater
Guadalupe-Blanco River Authority	Operator - Buda
Guadalupe-Blanco River Authority	Plant Manager - San Marcos WTP
Guadalupe-Blanco River Authority	Project and Community Representative
Guadalupe-Blanco River Authority	Project Coordinator
Guadalupe-Blanco River Authority	Reservoir Manager - Coleto Creek
Guadalupe-Blanco River Authority	RUD
Guadalupe-Blanco River Authority	RUD
Guadalupe-Blanco River Authority	Senior Advisor to the General Manager
Guadalupe-Blanco River Authority	Water Quality Project Manager

Additionally, a Stakeholder Group was invited to participate in the planning process via email. The Consultant Team, Planning Team, and Stakeholder Group coordinated to identify mitigation goals and develop mitigation strategies and actions for the Plan Update. Appendix A provides a complete listing of all participating Planning Team Members and stakeholders by organization and title.

Based on results of completed Capability Assessments, the Guadalupe-Blanco River Authority described methods for achieving future hazard mitigation measures by expanding existing capabilities. Options for improving capabilities include the following:

- Establishing Planning Team members with authority to monitor the Plan and identify grant funding opportunities for expanding staff.
- Identifying opportunities for cross-training or increasing the technical expertise of staff by attending free training available through FEMA and the Texas Division of Emergency Management (TDEM) by monitoring classes and availability through preparingtexas.org.
- Analyzing current water and power infrastructure for opportunities to increase resiliency and continuity of operations during an event.

Sample mitigation actions developed with similar hazard risk were shared at the meetings. These important discussions resulted in development of multiple mitigation actions that are included in the Plan to further mitigate risk from natural hazards in the future.

The Planning Team developed hazard mitigation actions for mitigating risk from potential flooding and hurricanes, including strengthening or hardening facilities, and installing flood warning/telemetry system at lift stations.

Planning Process

The process to prepare the Plan Update followed the four major steps included in Figure 2-1. After the Planning Team was organized, a capability assessment was developed and distributed at the Kick-Off Workshop. Hazards were identified and assessed, and results associated with each of the hazards were provided at the Risk Assessment Workshop. Based on identified vulnerabilities to the planning area, specific mitigation strategies were discussed and developed at the Mitigation Strategy Workshop. Finally, Plan maintenance and implementation procedures were developed and are included in Section 18. Participation of Planning Team members, stakeholders, and the public at each of the workshops is documented in Appendix E.

At the Plan development workshops held throughout the planning process described herein, the following factors were taken into consideration:

- The nature/magnitude of risks currently affecting the community;
- Hazard mitigation goals to address current and expected conditions;
- Whether current resources will be sufficient for implementing the Plan;
- Implementation problems, such as technical, political, legal, or coordination issues that may hinder development;
- Anticipated outcomes; and
- How the Guadalupe-Blanco River Authority, agencies, and partners will participate in implementing the Plan Update.

Kickoff Workshop

The Kickoff Workshop was held at the GBRA River Annex, in Seguin on December 8, 2016. This initial workshop informed GBRA officials and key department personnel about how the planning process pertained to their distinct roles and responsibilities, and engaged stakeholder groups such as members from several of the Counties that the GBRA is located within. In addition to the kickoff presentation, participants received the following information:

- Project overview regarding the planning process;
- Public Survey access information;
- Hazard Ranking form; and
- Capability Assessment survey for completion.

A risk ranking exercise was conducted at the Kickoff Workshop to get input from the Planning Team and stakeholders pertaining to various risks from a list of natural and human-caused hazards affecting the planning area. Participants ranked hazards high to low in terms of perceived level of risk, frequency of occurrence, and potential impact.

Hazard Identification

At the Kickoff Workshop and through a series of email and phone correspondences, the Planning Team conducted preliminary hazard identification. The Planning Team in coordination with the Consultant Team reviewed and considered a full range of natural hazards. Once identified, the teams narrowed the list to significant hazards by reviewing hazards affecting the area as a whole, the 2013 State of Texas Hazard Mitigation Plan Update, and initial study results from reputable sources such as federal and state agencies. Based on this initial analysis, the team identified a total of eleven natural hazards that pose risk to the planning area.

Risk Assessment

An initial risk assessment for the GBRA was completed in June 2017 and the results were presented to the Planning Team members at the Risk Assessment Workshop held on June 28, 2017. At the workshop, the characteristics and consequences of each hazard were evaluated to determine the extent to which the planning area would be affected in terms of potential danger to property and citizens.

Property and crop damages were estimated by gathering data from the National Centers for Environmental Information (NCEI) and National Oceanic and Atmospheric Administration (NOAA) for the 10-county GBRA district. The data was compared to GBRA's records to provide an estimated cost per event per hazard that is incurred by GBRA. The assessments examined the impact of various hazards on the built environment, including critical facilities, lifelines, and infrastructure owned by the GBRA. The resulting risk assessment profiled hazard events, provided information on previous occurrences, estimated probability of future events, and detailed the spatial extent and magnitude of impact on people and property. Each participant at the Risk Assessment Workshop was provided a risk ranking sheet that asked participants to rank hazards in terms of the probability or frequency of occurrence, extent of spatial impact, and the magnitude of impact. The results of the ranking sheets identified unique perspectives on varied risks throughout the planning area.

The assessments were also used to set priorities for mitigation strategy based on potential loss of life and dollar loss. A hazard profile and vulnerability analysis for each of the hazards can be found in Sections 4 through 15.

Mitigation Review and Development

Developing the Mitigation Strategy for the Plan Update involved identifying mitigation goals and new mitigation actions. A Mitigation Workshop was held at the GBRA River Annex, in Seguin on October 25, 2017. In addition to the Planning Team, stakeholder groups were invited to attend the workshop. Regarding hazard mitigation actions, Workshop participants emphasized the desire for those that addressed flood and hurricane hazards. Additionally, the GBRA was proactive in identifying mitigation actions to lessen the risk of all the identified hazards included in the Plan Update.

An inclusive and structured process was used to develop and prioritize new mitigation actions for the Plan. The prioritization method was based on FEMA's STAPLE+E criteria and included social, technical, administrative, political, legal, economic, and environmental considerations. As a result, each Planning Team Member assigned an overall priority to each hazard mitigation action. The overall priority of each action is reflected in the hazard mitigation actions found in Section 17.

Planning Team Members then developed actions plans identifying proposed actions, costs and benefits, the responsible organization(s), effects on new and existing buildings, implementation schedules, priorities, and potential funding sources.

Specifically, the process involved:

- Listing optional hazard mitigation actions based on information collected from previous plan reviews, studies, and interviews with federal, state, and local officials. Workshop participants reviewed the optional mitigation actions and selected actions that were most applicable to their area of responsibility, cost-effective in reducing risk, easily implemented, and likely to receive institutional and community support.
- Workshop participants inventoried federal and state funding sources that could assist in implementing the proposed mitigation actions. Information was collected, including the program name, authority, purpose of the program, types of assistance and eligible projects, conditions on funding, types of hazards covered, match requirements, application deadlines, and a point of contact.
- Planning Team members considered benefits that would result from implementing the hazard mitigation actions compared to the cost of those projects. Although detailed cost-benefit analyses were beyond the scope of this Plan, Planning Team Members utilized economic evaluation as a determining factor between hazard mitigation actions.
- Planning Team Members then selected and prioritized mitigation actions.

Hazard mitigation actions identified in the process were made available to the Planning Team for review. The Hazard Mitigation Action Plan was maintained on file by the GBRA at their office and was made available to the public for review.

Review and Incorporation of Existing Plans

Review

Background information utilized during the planning process included various studies, plans, reports, and technical information from sources such as FEMA, the United States Army Corps of Engineers (USACE), the U.S. Fire Administration, National Oceanic and Atmospheric Administration (NOAA), the Texas Water Development Board (TWDB), the Texas Commission on Environmental Quality (TCEQ), the Texas State Data Center, Texas Forest Service, the Texas Division of Emergency Management (TDEM), and local hazard assessments and plans. Section 4 and the hazard-specific sections of the Plan Update (Sections 5-15) summarize the relevant background information.

Some background documents, including those from FEMA, provided information on hazard risk, hazard mitigation actions currently being implemented, and potential mitigation actions. Previous hazard events, occurrences, and other descriptions were identified through NOAA's National Centers for Environmental Information (NCEI). Results of past hazard events were found through searching the NCEI. USACE studies were reviewed for their assessment of risk and potential projects in the region. State Data Center documents were used to obtain population projections. State Demographer webpages were reviewed for population and other projections and included in Section 3 of the Plan Update. Information from the Texas Forest Service was used to appropriately rank the wildfire hazard and to help identify potential grant opportunities. Materials from FEMA and TDEM were reviewed for guidance on Plan development requirements.

Incorporation of Existing Plans into the HMAP Process

A Capability Assessment was completed by key Guadalupe-Blanco River Authority departments which provided information pertaining to existing plans, policies, and regulations to be integrated into the goals and objectives of the Plan Update. The relevant information was included in a master Capability Assessment, Appendix F.

Existing projects and studies were utilized as a starting point for discussing hazard mitigation actions among Planning and Consultant Team members. For example, the GBRA has conducted several studies analyzing potential additional water supply projects, so several mitigation actions were included to ensure continuity of operations in time of a disaster. Other plans were reviewed, such as Evacuation Plans, to identify any additional mitigation actions. Finally, the 2013 State of Texas Mitigation Plan Update, developed by TDEM, was discussed in the initial planning meeting in order to develop a specific group of hazards to address in the planning effort. The 2013 Plan Update was also used as a guidance document along with FEMA materials in the development of the GBRA Hazard Mitigation Action Plan.

Incorporation of the HMAP into Other Planning Mechanisms

Planning Team members will integrate implementation of the Plan with other planning mechanisms for the GBRA, such as the Water Master Plan. Existing plans for the GBRA will be reviewed and incorporated into the Plan as appropriate. This section discusses how the Plan will be implemented by the GBRA. It also addresses how the Plan Update will be evaluated and improved over time and how the public will continue to be involved in the hazard mitigation planning process.

The GBRA will be responsible for implementing mitigation actions contained in Section 17. Each action has been assigned to a specific department that is responsible for tracking and implementing the action.

A funding source has been listed for each identified action and may be utilized to implement the action. An implementation time period has also been assigned to each hazard mitigation action as an incentive and to determine whether actions are implemented on a timely basis.

The GBRA will integrate hazard mitigation actions contained in the Plan Update with existing planning mechanisms such as Continuity of Operations Plan, Evacuation Plan, and other local and area planning efforts. The GBRA will work closely with area organizations to coordinate implementation of hazard mitigation actions that benefit the planning area financially and economically.

Upon formal adoption of the Plan Update, Planning Team members from the GBRA will review existing plans identified here, along with additional internal plans to guide development and ensure that hazard mitigation actions are implemented. Planning Team members will be responsible for coordinating periodic review of the Plan Update to ensure integration of hazard mitigation strategies into these planning mechanisms. The Planning Team will also conduct periodic reviews of its various existing planning mechanisms and analyze the need for any amendments or updates in light of the approved Plan. The GBRA will ensure that future long-term planning objectives will contribute to the goals of this hazard mitigation plan to reduce the long-term risk to life and property from moderate and high-risk hazards. Within one year of formal adoption of the hazard mitigation plan, existing planning mechanisms will be reviewed and analyzed as they pertain to the hazard mitigation plan.

Planning Team members will review and revise, as necessary, the long-range goals and objectives in its strategic plan and budgets to ensure that they are consistent with the Plan Update.

Further, the GBRA will work with the Counties within the Guadalupe River Basin to advance the goals of the Plan as it applies to ongoing, long-range planning goals and actions for mitigating risk to natural hazards throughout the planning area.

Table 2-2 identifies types of planning mechanisms and examples of methods for incorporating the Plan into other planning efforts.

Table 2-2. Examples of Methods of Incorporation

PLANNING MECHANISM	METHOD OF INCORPORATION
Grant Applications	The GBRA will consult the Plan whenever there are yearly grant funding cycles available through FEMA, including the Pre-Disaster Mitigation (PDM) cycle, and when there is a Disaster Declaration for Texas triggering Hazard Mitigation Grant Program (HMGP) funds. Mitigation actions will be reviewed by the planning team members and information will be updated for completing applications, such as maps and risk assessment data. If a project is not in the Plan, an amendment may be developed.
Annual Budget Review	The GBRA will review the Plan and mitigation actions therein when conducting its annual budget review. When allocating funds for upcoming operating and construction budgets, high priority mitigation actions will be reviewed during Board meetings. Each identified staff member/ planning team member will be responsible for bringing mitigation actions to the meeting to discuss feasibility of the potential project in terms of the availability of funds, grant assistance, and preliminary cost benefit review.
Emergency Planning	The Plan will be consulted during updates to the emergency operations and/or disaster recovery plan. Risk assessment and vulnerability data will be pulled from the plan and analyzed in conjunction with the review, renewal, or re-writing of an Emergency Operations Plan. This data will either be included within the new emergency planning mechanism or included as an appendix. Mitigation projects that relate to prevention and protection will also be reviewed for relevance to determine if they should be included.
Continuity of Operations Plan	Before any updates to the Continuity of Operations Plan are conducted, the GBRA will review the risk assessment and mitigation strategy sections of the Plan, as continuity of services is a priority during a hazard event. Mitigation projects that improve the continuity of operations will be reviewed to ensure that all facilities and services are discussed within the plan.
Evacuation Plan	The Plan will be consulted during updates to the evacuation plan. Mitigation projects that assist the evacuation process or improve evacuation routes will be reviewed to ensure the most up-to-date information is included in the evacuation plan.

PLANNING MECHANISM	METHOD OF INCORPORATION
Other Plans	The Plan will be utilized in updating and maintaining other internal plans that are related to water supply and quality. In updating or maintaining these plans, the Plan will be consulted for Risk Assessment and vulnerability data, along with flood risk and extent. In addition, mitigation projects will be reviewed for inclusion.

Appendix F provides an overview of Planning Team members' existing planning and regulatory capabilities to support implementation of mitigation strategy objectives.

It should be noted for the purposes of the Plan Update that the HMAP has been used as a reference during the development of the GBRA's annual work plan and budget to identify new and continuing initiatives that accomplish their strategic goals. The GBRA also references the HMAP when developing and updating the Flood Safety guide.

Plan Review and Plan Update

As with the development of this Plan, the Guadalupe-Blanco River Authority will oversee the review and update process for relevance and to make adjustments, as necessary. At the beginning of each fiscal year, Planning Team Members will meet to evaluate the Plan Update and review other planning mechanisms to ensure consistency with long-range planning efforts. In addition, participants will also meet twice a year, by conference call or presentation, to re-evaluate prioritization of the mitigation actions.

Timeline for Implementing Mitigation Actions

The Planning Team will engage in discussions regarding a timeframe for how and when to implement each hazard mitigation action. Considerations include when the action will be started, how existing planning mechanisms' timelines affect implementation, and when the action should be fully implemented. Timeframes may be general, and there will be short, medium, and long-term goals for implementation based on prioritization of each action, as identified on individual Hazard Mitigation Action worksheets included in the Plan Update for the Guadalupe-Blanco River Authority.

The Planning Team will evaluate and prioritize the most suitable mitigation actions for the community to implement. The timeline for implementation of actions will partially be directed by the GBRA's budgetary constraints and community needs. The GBRA is committed to addressing and implementing mitigation actions that may be aligned with and integrated into the Hazard Mitigation Action Plan.

Overall, the Planning Team is in agreement that goals and actions of the hazard mitigation plan shall be aligned with the timeframe for implementation of mitigation actions with respect to annual review and updates of existing plans and policies.

Public and Stakeholder Involvement

An important component of mitigation planning is public participation and stakeholder involvement. Input from individuals and the community as a whole provides the Planning Team with a greater understanding of local concerns, and increases the likelihood of successfully implemented hazard mitigation actions. If citizens and stakeholders, such as local businesses, non-profits, hospitals, and schools are involved, they are more likely to gain a greater appreciation of the hazards present in their community and take steps to reduce their impact.

The public was involved in the development of the Hazard Mitigation Action Plan at different stages prior to offical Plan approval and adoption. Public input was sought using three methods: (1) open public meetings, (2) survey instruments, and (3) making the draft Plan Update available for review at the Guadalupe-Blanco River Authority's office.

The draft Plan Update was made available at the Guadalupe-Blanco River Authority's office. The public was notified at the public meetings that the draft Plan Update would be available for review. No feedback was received in the draft Plan Update, although it was given on the public survey, and all relevant information was incorporated into the Plan Update.

The Plan Update will be available at GBRA's office upon approval from FEMA.

Stakeholder Involvement

Stakeholder involvement is essential to hazard mitigation planning since a wide range of stakeholders can provide input on specific topics and various points of view. Throughout the planning process, members of community groups, local businesses, Counties within the Guadalupe River Basin, and schools were invited to participate in the development of the Plan Update. The Stakeholder Working Group (Appendix A, Table A-2; and Table 2-3 below), included a broad range of representatives from both the public and private sector and served as a key component in the GBRA's outreach efforts for development of the Plan Update. Documentation of stakeholder's meetings is found in Appendix E. A list of organizations invited to attend via email is found in Table 2-3.

Table 2-3. Stakeholder Working Group

ORGANIZATION	TITLE
Caldwell County	Emergency Management Coordinator
Caldwell County	Public Works Administrator
Calhoun County	Emergency Management Coordinator
Calhoun County	Public Works Administrator
Comal County	Emergency Management Coordinator
Comal County	Public Works Administrator
DeWitt County	Emergency Management Coordinator
DeWitt County	Public Works Administrator
Gonzales County	Emergency Management Coordinator
Gonzales County	Public Works Administrator
Guadalupe County	Emergency Management Coordinator
Guadalupe County	Public Works Administrator
Hays County	Emergency Management Coordinator

ORGANIZATION	TITLE
Hays County	Public Works Administrator
Kendall County	Emergency Management Coordinator
Kendall County	Public Works Administrator
Refugio County	Emergency Management Coordinator
Refugio County	Public Works Administrator
Victoria County	Emergency Management Coordinator
Victoria County	Public Works Administrator
Texas A&M - Agrilife Extension	County Extension Agent
Guadalupe-Blanco River Trust	Trustee
Gonzales ISD	Superintendent
New Braunfels ISD	Superintendent
San Marcos ISD	Superintendent

Stakeholders and the participants from neighboring communities that attended the Planning Team and public meetings played a key role in the planning process and were key to identifying areas of concern and potential mitigation actions. Some examples include a fuels management program at GBRA facilities, and hardening of critical facilities.

Public Meetings

A series of public meetings were held to collect public and stakeholder input. Topics of discussion included the purpose of hazard mitigation, discussion of the planning process, and types of hazards. An email was sent out regarding the public meetings, the survey, and when the Plan was available for review to increase public participation in the Plan development process. Documentation on the public meetings are found in Appendix E.

Public meetings were held on the following dates and locations:

- September 28, 2017, GBRA River Annex
- March 29, 2018, GBRA River Annex

Public Participation Survey

In addition to the public meetings, the Planning and Consultant Teams developed a public survey designed to solicit public information during the planning process from citizens and stakeholders and to obtain data regarding the identification of any potential hazard mitigation actions or problem areas. The survey was promoted by email and a link was made available to access the survey. A total of 12 surveys were completed online, and the results are analyzed in Appendix B. The Planning Team reviewed the input from the surveys and decided which information to incorporate into the Plan as hazard mitigation actions. For example, many citizens mention an increase in public education and awareness as a step the GBRA could take to reduce or eliminate the risk of future hazard damages. As a result, several mitigation actions were added to purchase NOAA "All Hazards" radios for early warning and post-event information, as well as conducting public/employee education programs on the risks of the local hazards and mitigation steps that can be taken against these hazards.

SECTION 3: STUDY AREA PROFILE

Overview

Established by the Texas Legislature, GBRA was first created in 1933 under Section 59, Article 16 of the Constitution of Texas as a water conservation and reclamation district and a public corporation called Guadalupe River Authority. In 1935, it was reauthorized by an act of the Texas Legislature as the Guadalupe-Blanco River Authority.

GBRA provides stewardship for the water resources in its ten-county statutory district, which begins near the headwaters of the Guadalupe and Blanco Rivers, ends at San Antonio Bay, and includes Kendall, Comal, Hays, Caldwell, Guadalupe, Gonzales, DeWitt, Victoria, Calhoun and Refugio counties.

Planning and resource development efforts are carefully coordinated within the broader consideration of regional and statewide water needs to fulfil GBRA's primary responsibilities of developing, conserving and protecting the water resources of the Guadalupe River Basin.

This section profiles the Guadalupe River Basin, along with the 10 Counties the GBRA is located within, providing the following data:

- Population and Demographics;
- Economy Impact; and
- Land Use Trends.

Figure 3-1 shows the Guadalupe River Basin and the major cities and counties within GBRA's ten-county statutory district, which begins near the headwaters of the Guadalupe and Blanco Rivers and ends at San Antonio Bay.

Figure 3-1. Guadalupe River Basin Map[1]

Population and Demographics

GBRA is much more than a collection of buildings, divisions, plants and equipment. While these facilities are vital, the directors and employees – with their talents, specialized skills, hard-earned certificates and willingness to serve – are the difference-makers. The total authorized positions for 2017 was 192 positions. This was up from 183 positions in 2015. GBRA is governed by a board of nine directors appointed by the Governor and subject to confirmation by the Texas Senate. The General Manager and staff conduct management and administrative duties in accordance with polices established by the board.

GBRA's service area is geographically part of south central Texas, and includes ten counties: Caldwell, Calhoun, Comal, DeWitt, Gonzales, Guadalupe, Hays, Kendall, Refugio, and Victoria. The following provides population and demographics within these counties.

Between official U.S. Census population counts, the estimate uses a formula based on new residential building permits and household size. It is simply an estimate and there are many variables involved in achieving an accurate estimation of people living in a given area at a given time.

[1] Source: https://www.gbra.org/maps/basin.aspx

Table 3-1 highlights special needs populations in the counties where the Guadalupe-Blanco River Authority is located within.[2]

Table 3-1. Population Distribution by County

COUNTY	TOTAL 2010 POPULATION	ESTIMATED VULNERABLE OR SENSITIVE POPULATIONS	
		Elderly (Over 65)	Below Poverty Level
Caldwell County	38,066	4,510	7,014
Calhoun County	21,381	3,234	3,914
Comal County	108,472	16,855	11,356
DeWitt County	20,097	3,677	3,038
Gonzales County	19,807	2,992	3,443
Guadalupe County	131,533	15,297	15,190
Hays County	157,107	13,285	28,863
Kendall County	33,410	5,584	2,363
Refugio County	7,383	1,440	1,124
Victoria County	86,793	11,664	13,166

Population Growth

Over the past three decades, the population in the State of Texas has increased by 76.8 percent. Within the ten counties that the Guadalupe-Blanco River Authority is located, nine of those counties exhibited an increase in population between 1980 and 2010: Caldwell, Calhoun, Comal, DeWitt, Gonzales, Guadalupe, Hays, Kendall, and Victoria. Refugio County experienced a population loss from 1980 to 2010. Similarly, Refugio County experienced a population loss from 2000 to 2010, while all the other counties experienced a population growth. Table 3-2 provides historic growth rates for these counties.

Table 3-2. Population in Counties, 1980-2010

COUNTY	1980	1990	2000	2010	POP CHANGE 1980-2010	PERCENT OF CHANGE	POP CHANGE 2000-2010	PERCENT OF CHANGE
Caldwell County	23,637	26,392	32,194	38,066	14,429	61.04%	5,872	18.24%
Calhoun County	19,574	19,053	20,647	21,381	1,807	9.23%	734	3.55%
Comal County	36,446	51,832	78,021	108,472	72,026	197.62%	30,451	39.03%
DeWitt County	18,903	18,840	20,013	20,097	1,194	6.23%	84	0.42%

[2] Source: http://www.census.gov/quickfacts/table/PST045215/00

COUNTY	1980	1990	2000	2010	POP CHANGE 1980-2010	PERCENT OF CHANGE	POP CHANGE 2000-2010	PERCENT OF CHANGE
Gonzales County	16,949	17,205	18,628	19,807	2,858	16.86%	1,179	6.33%
Guadalupe County	46,708	64,873	89,023	131,533	84,825	181.61%	42,510	47.75%
Hays County	40,594	65,614	97,589	157,107	116,513	287.02%	59,518	60.99%
Kendall County	10,635	14,589	23,743	33,410	22,775	214.15%	9,667	40.72%
Refugio County	9,289	7,976	7,828	7,383	-1,906	-20.52%	-445	-5.68%
Victoria County	68,807	74,361	84,088	86,793	17,986	26.14%	2,705	3.22%
TEXAS	**14,225,513**	**16,986,335**	**20,851,80**	**25,145,561**	**10,920,048**	**76.8%**	**4,293,741**	**20.6%**

Future Development

To better understand how future growth and development in the GBRA might affect hazard vulnerability, it is useful to consider population growth, occupied and vacant land, the potential for future development in hazard areas, and current planning and growth management efforts. This section includes an analysis of the projected population change.

Population projections from 2010 to 2040 are listed in Table 3-3, as provided by the Office of the State Demographer, Texas State Data Center, and the Institute for Demographic and Socioeconomic Research. Population projections are based on a 0.5 scenario growth rate, which is 50 percent of the population growth rate that occurred during 2000-2010. This information is only available at the County level; however, the population projection shows an increase in population density for the ten counties, which would mean overall growth for the Guadalupe River Basin.

Table 3-3. County Population Projections

County	LAND AREA (SQ MI)	2010		2020		2030		2040	
		Population							
		Total Number	Density (Land Area, SQ MI)	Total Number	Density (Land Area, SQ MI)	Total Number	Density (Land Area, SQ MI)	Total Number	Density (Land Area, SQ MI)
Caldwell	547	38,066	69.59	44,401	81.17	51,327	93.83	57,444	105.02
Calhoun	1,033	21,381	20.70	23,935	23.17	26,659	25.81	29,203	28.27
Comal	575	108,472	188.65	128,974	224.30	150,591	261.90	169,835	295.37
DeWitt	910	20,097	22.08	20,574	22.61	21,154	23.25	21,453	23.57
Gonzales	1,070	19,807	18.51	21,771	20.35	23,979	22.41	25,891	24.20

County	LAND AREA (SQ MI)	2010		2020		2030		2040	
		Population							
		Total Number	Density (Land Area, SQ MI)	Total Number	Density (Land Area, SQ MI)	Total Number	Density (Land Area, SQ MI)	Total Number	Density (Land Area, SQ MI)
Guadalupe	715	131,533	183.96	158,712	221.97	189,140	264.53	220,138	307.89
Hays	680	157,107	231.04	211,934	311.67	273,247	401.83	346,625	509.74
Kendall	663	33,410	50.39	38,847	58.59	44,741	67.48	50,357	75.95
Refugio	818	7,383	9.03	7,659	9.36	7,906	9.67	7,937	9.70
Victoria	889	86,793	97.63	93,902	105.63	100,465	113.01	105,735	118.94

Economic Impact

GBRA's service area includes ten counties and more than seventy cities and communities. This geographic diversity in turn provides economic diversity with a unique combination of agriculture, oil and gas, defense, high tech and heavy industry.

GBRA provides a variety of services to rural water corporations, electric cooperatives, industries and individuals within this ten-county district. The array of services includes water sales and distribution, water treatment, wastewater treatment, hydroelectric generation, laboratory analysis and recreation opportunities.

This diversity allows the local economy to be among the State's growth leaders and outpace the national economy as well as weather the effects of any global economic problems better than other areas may. The local economy is also being spurred by tremendous population growth along the I-35 Corridor and the Eagle Ford Shale oil boom.

GBRA also makes an economic impact within its ten-county district by its employment base and by supporting local businesses. GBRA has put a total of $19,949,095 back into the economy of the communities within the GBRA service area during the last year.[3]

Existing and Future Land Use and Development Trends

The GBRA Enabling Act clearly provides that it is the responsibility of GBRA to develop, conserve and protect the waters of the Guadalupe River Basin. Also, implicit within that Act is the ability for GBRA to supply water on a short-term, temporary basis to the region adjacent to GBRA's district. GBRA has worked closely throughout its history with municipalities and other entities in the river basin to fulfil that mandate. Yet it remains an ever-growing as well as challenging mandate as the population of Texas continues to grow and periodic droughts place limitation on existing water supplies. GBRA is developing or has developed several new water supply projects to help meet these needs.

[3] Source: https://gbra.org/documents/public/fy2017budget.pdf

Section 3: Study Area Profile

GBRA is the owner and operator of Lake Dunlap, Lake McQueeney, Lake Placid, Lake Nolte, Lake H-4, and Lake Wood located in Comal, Guadalupe, and Gonzales Counties:

- Lake Dunlap is a 410-acre lake that has a storage capacity of 5,900 acre-feet and a maximum depth near the dam of 40 feet.
- Lake McQueeney's pond area is 400 acres with a storage capacity of 5,050 acre-feet. The lake's prominent feature is Treasure Island, a residential area reached by a connecting bridge. Most of the lake is approximately 10 feet deep, with deeper sections along the center channel.
- Lake Placid's pond area is 248 acres with a storage capacity of 2,624 acre-feet. Most of the lake is shallow with maximum depths of 30-35 feet near the dam.
- Lake Nolte's pond area is 153 acres with a storage capacity of 1,550 acre-feet. This small narrow lake provides less area for skiers and more undisturbed fishing for anglers, including bait chunkers and trotliners. Maximum depth is about 35 feet.
- Lake H-4, or Lake Gonzales's pond area is 696 acres with a storage capacity of 7,500 acre-feet. Water depths of 25-30 feet are located in the river channel.
- Lake Wood Recreation Area is located on the shore of Lake Wood, a hydroelectric lake owned and operated by the GBRA to impound water needed to generate electricity. The pond area is 488 acres with a storage capacity of 4,000 acre-feet.

SECTION 4: RISK OVERVIEW

Hazard Identification

Section 4 is the first phase of the Risk Assessment and provides background information for the hazard identification process and descriptions for the hazards identified. The Risk Assessment continues with Sections 5 through 15, which include hazard descriptions and vulnerability assessments.

Upon a review of the full range of natural hazards suggested under FEMA planning guidance, the Guadalupe-Blanco River Authority identified eleven natural hazards that are to be addressed in the Hazard Mitigation Action Plan, or *the Plan.* Based on this review, ten natural hazards and one quasi-technological[1] hazard (dam failure) were identified as significant, as shown in Table 4-1. The hazards were identified through input from Planning Team members and a review of the current 2013 State of Texas Hazard Mitigation Plan Update (State Plan Update). Readily available online information from reputable sources, such as federal and state agencies, were also evaluated and utilized to supplement information as needed.

In general, there are three main categories of natural hazards including atmospheric, hydrologic, and technological. Atmospheric hazards are events or incidents associated with weather generated phenomenon. The atmospheric hazards identified as significant from Table 4-1 include: extreme heat, hail, hurricane, lightning, thunderstorm wind, tornado, and winter storm.

Hydrologic hazards are events or incidents associated with water related damage and account for over 75 percent of federal disaster declarations in the United States. Hydrologic hazards identified as significant includes flood and drought.

Technological hazards refer to the origins of incidents that can arise from human activities, such as the construction and maintenance of dams. Technological hazards are distinct from natural hazards primarily because they originate from human activity. While the risks presented by natural hazards may be increased or decreased as a result of human activity, they are not inherently human-induced. Therefore, dam failure is classified as a quasi-technological hazard, referred to as “technological,” in Table 4-1 for purposes of description.

For the purposes of the risk assessment, the wildfire hazard is considered “other,” since they may be natural or human-caused and are neither atmospheric nor hydrologic.

[1] While dam failure is generally considered a quasi-technological hazard, it is profiled in the Plan as a natural hazard, i.e. a breach caused by extensive rainfall or flooding.

Table 4-1. Hazard Descriptions

HAZARD	DESCRIPTION
ATMOSPHERIC	
Extreme Heat	Extreme heat is the condition whereby temperatures hover ten degrees or more above the average high temperature in a region for an extended period.
Hail	Hailstorms are a potentially damaging outgrowth of severe thunderstorms. Early in the developmental stages of a hailstorm, ice crystals form within a low-pressure front due to the rapid rising of warm air into the upper atmosphere and subsequent cooling of the air mass.
Lightning	Lightning is a sudden electrostatic discharge that occurs during an electrical storm. This discharge occurs between electrically charged regions of a cloud, between two clouds, or between a cloud and the ground.
Hurricane	A hurricane is an intense tropical weather system of strong thunderstorms with a well-defined surface circulation and maximum sustained winds of 74 miles per hour (mph) or higher.
Thunderstorm Wind	A thunderstorm is a storm with thunder and lightning and typically is accompanied with heavy rain or hail. Severe thunderstorms can produce a tornado, winds of at least 58 mph, and/or hail at least 1 inch in diameter.
Tornado	A tornado is a violently rotating column of air that has contact with the ground and is often visible as a funnel cloud. Its vortex rotates cyclonically with wind speeds ranging from as low as 40 mph to as high as 300 mph. The destruction caused by tornadoes ranges from light to catastrophic, depending on the intensity, size, and duration of the storm.
Winter Storm	Severe winter storms may include snow, sleet, freezing rain, or a mix of these wintry forms of precipitation. Blizzards, the most dangerous of all winter storms, combine low temperatures, heavy snowfall, and winds of at least 35 mph, reducing visibility to only a few yards. Ice storms occur when moisture falls and freezes immediately upon impact on trees, power lines, communication towers, structures, roads, and other hard surfaces. Winter storms and ice storms can down trees, cause widespread power outages, damage property, and cause fatalities and injuries to human life.
HYDROLOGIC	
Drought	A prolonged period of less than normal precipitation such that the lack of water causes a serious hydrologic imbalance. Common effects of drought include crop failure, water supply shortages, and fish and wildlife mortality.
Flood	The accumulation of water within a body of water, which results in the overflow of excess water onto adjacent lands, usually floodplains. The floodplain is the land adjoining the channel of a river, stream, ocean, lake, or other watercourse or water body that is susceptible to flooding. Most floods fall into the following three categories: riverine flooding, coastal flooding, or shallow flooding.

HAZARD	DESCRIPTION
OTHER	
Wildfire	A wildfire is an uncontrolled fire burning in an area of vegetative fuels such as grasslands, brush, or woodlands. Heavier fuels with high continuity, steep slopes, high temperatures, low humidity, low rainfall, and high winds all work to increase the risk for people and property located within wildfire hazard areas or along the urban/wildland interface. Wildfires are part of the natural management of forest ecosystems, but most are caused by human factors.
TECHNOLOGICAL	
Dam Failure	Dam failure is the collapse, breach, or other failure of a dam structure resulting in downstream flooding. In the event of a dam failure, the energy of the water stored behind a dam is capable of causing sudden, catastrophic loss of life and severe property damage if development exists downstream of the dam.

Hazards that weren't considered significant and were not included in the Plan are located in Table 4-2, along with the evaluation process used for determining the significance of each of these hazards. Hazards not identified for inclusion at this time may be addressed during future evaluations and updates.

Table 4-2. Hazard Identification Process

HAZARD CONSIDERED	REASON FOR DETERMINATION
Earthquakes	According to the State Plan, an earthquake occurrence for the planning area is considered exceedingly rare. Earthquake events are not considered to pose a risk to the planning area. There is no history of impact to critical structures, systems, populations or other GBRA assets or vital services as a result of earthquakes and none is expected in the future.
Expansive Soils	There is no history of impact to critical structures, systems, populations or other GBRA assets or vital services as a result of expansive soils and none is expected in the future.
Land Subsidence	There are no historical occurrences of land subsidence for the planning area and it is located in an area where occurrences are considered rare. There is no history of impact to critical structures, systems, populations or other GBRA assets or vital services as a result of land subsidence and none is expected in the future.

Natural Hazards and Climate Change

Climate change is defined as a long-term hazard which can increase or decrease the risk of other weather hazards. It directly endangers property and biological organisms due to sea level rise and habitat destruction.

Global climate change is expected to exacerbate the risk of certain types of natural hazards impacted through rising sea levels, warmer ocean temperatures, higher humidity, the possibility of stronger storms, and an increase in wind and flood damages due to storm surges. While sea level rise is a natural phenomenon and has been occurring for several thousand years, the general scientific consensus is that the rate has increased in the past 200 years, from 0.5 millimeters per year to 2 millimeters per year.

Texas is considered one of the more vulnerable states in the U.S. to both abrupt climate changes and to the impact of gradual climate changes to the natural and built environments. Mega-droughts can trigger abrupt changes to regional ecosystems and the water cycle, drastically increase extreme summer temperature and fire risk, and reduce availability of the water resources, as Texas experienced during 2011-2012.

Paleoclimate records also show that the climate over Texas had large changes between periods of frequent mega-droughts and the periods of mild droughts that Texas is currently experiencing. While the cause of these fluctuations is unclear, it would be wise to anticipate that such change could occur again, and may even be occurring now.

Overview of Hazard Analysis

The methodologies utilized to develop the Risk Assessment are a historical analysis and a statistical approach. Both methodologies provide an estimate of potential impact by using a common, systematic framework for evaluation.

Records retrieved from National Centers for Environmental Information (NCEI) and National Oceanic and Atmospheric Administration (NOAA) were reported for the 10-county GBRA district. Remaining records identifying the occurrence of hazard events in the planning area and the maximum recorded magnitude of each event were also evaluated. Based on this data and GBRA's records, a cost incurred per hazard event was provided for each hazard.

The use of geographic information system (GIS) technology to identify and assess risks for the GBRA planning area, and evaluate assets and their vulnerability to the hazards.

The four general parameters that are described for each hazard in the Risk Assessment include frequency of return, approximate annualized losses, a description of general vulnerability, and a statement of the hazard's impact.

Frequency of return was calculated by dividing the number of events in the recorded time period for each hazard by the overall time period that the resource database was recording events. Frequency of return statements are defined in Table 4-3, and impact statements are defined in Table 4-4 below.

Table 4-3. Frequency of Return Statements

PROBABILITY	DESCRIPTION
Highly Likely	Event is probable in the next year.
Likely	Event is probable in the next three years.
Occasional	Event is probable in the next five years.
Unlikely	Event is probable in the next ten years.

Table 4-4. Impact Statements

POTENTIAL SEVERITY	DESCRIPTION
Substantial	Multiple deaths. Complete shutdown of facilities for 30 days or more. More than 50 percent of property destroyed or with major damage.
Major	Injuries and/or illnesses result in permanent disability. Complete shutdown of critical facilities for at least two weeks. More than 25 percent of property destroyed or with major damage.
Minor	Injuries and/or illnesses do not result in permanent disability. Complete shutdown of critical facilities for more than one week. More than 10 percent of property destroyed or with major damage.
Limited	Injuries and/or illnesses are treatable with first aid. Minor quality of life lost. Shutdown of critical facilities and services for 24 hours or less. Less than 10 percent of property destroyed or with major damage.

Each of the hazard profiles includes a description of a general Vulnerability Assessment. Vulnerability is the total of assets that are subject to damages from a hazard, based on historic recorded damages. Assets in the region were inventoried and defined in hazard zones where appropriate. The total amount of damages, including property and crop damages, for each hazard is divided by the total number of assets (building value totals) in that community in order to find the percentage of damage that each hazard can cause to the community.

Hazard Vulnerability for the Guadalupe-Blanco River Authority was reviewed based on recent development changes that occurred throughout the Guadalupe River Basin. To better understand how future growth and development in the basin might affect hazard vulnerability, it is useful to consider population growth, occupied and vacant land, the potential for future development in hazard areas, and current planning and growth management efforts. The basin has experienced an increase in growth between 2000 and 2017 according to the U.S. Census Bureau, therefore the vulnerability to the population, infrastructure, and buildings has increased for hazards that do not have a geographical boundary.

Once loss estimates and vulnerability were known, an impact statement was applied to relate the potential impact of the hazard on the assets within the area of impact.

Section 5: Flood

Hazard Description

Floods generally result from excessive precipitation, and the severity of a flooding event is typically determined by a combination of several major factors, including stream and river basin topography and physiography; precipitation and weather patterns; recent soil moisture conditions; and the degree of vegetative clearing and impervious surface. Generally, floods are long-term events that may last for several days.

The primary types of general flooding are inland and coastal flooding. Inland or riverine flooding is a result of excessive precipitation levels and water runoff volumes within the watershed of a stream or river. Inland or riverine flooding is overbank flooding of rivers and streams, typically resulting from large-scale weather systems that generate prolonged rainfall over a wide geographic area, thus it is a naturally occurring and inevitable event. Some river floods occur seasonally when winter or spring rainfalls fill river basins with too much water, too quickly. Torrential rains from decaying hurricanes or tropical systems can also produce river flooding.

Coastal flooding occurs when normally dry, low-lying land is flooded by seawater. The extent of coastal flooding is a function of the elevation inland flood waters penetrate which is controlled by the topography of the coastal land exposed to flooding.

Coastal flooding is largely a natural event, however human influence on the coastal environment can exacerbate coastal flooding. Extraction of water from groundwater reservoirs in the coastal zone can enhance subsidence of the land increasing the risk of flooding. Engineered protection structures along the coast such as sea walls alter the natural processes of the beach, often leading to erosion on adjacent stretches of the coast which also increases the risk of flooding. Coastal flooding is covered in detail under the profile for Hurricanes (Section 8).

Location

Locations of GBRA structures and infrastructure located in flood zones throughout the planning area based on the digital Flood Insurance Rate Map (DFIRM) from FEMA are illustrated in Figures 5-1 through 5-10.

Figure 5-1. GBRA Facilities Estimated Flood Zones in Caldwell County

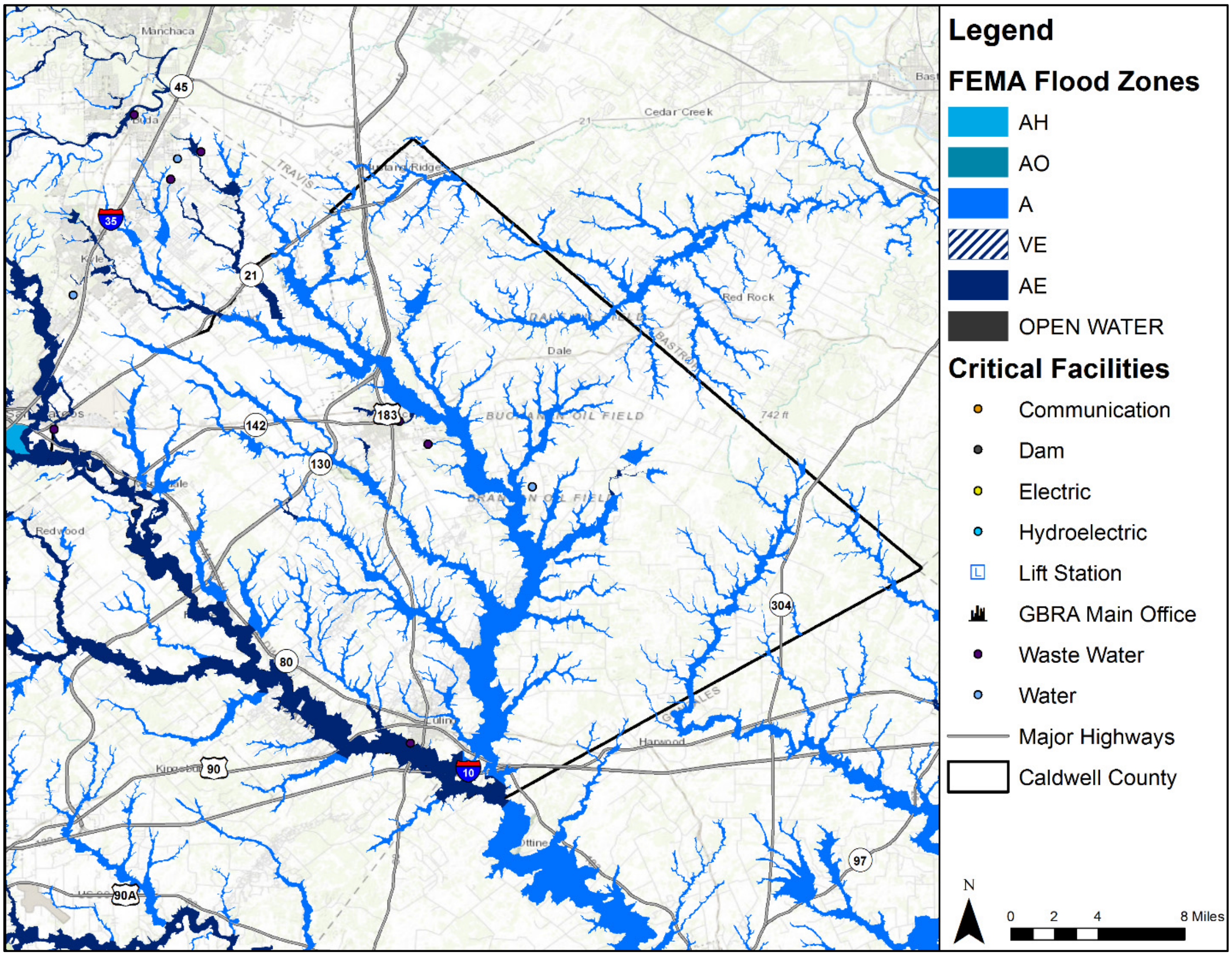


Figure 5-2. GBRA Facilities Estimated Flood Zones in Calhoun County

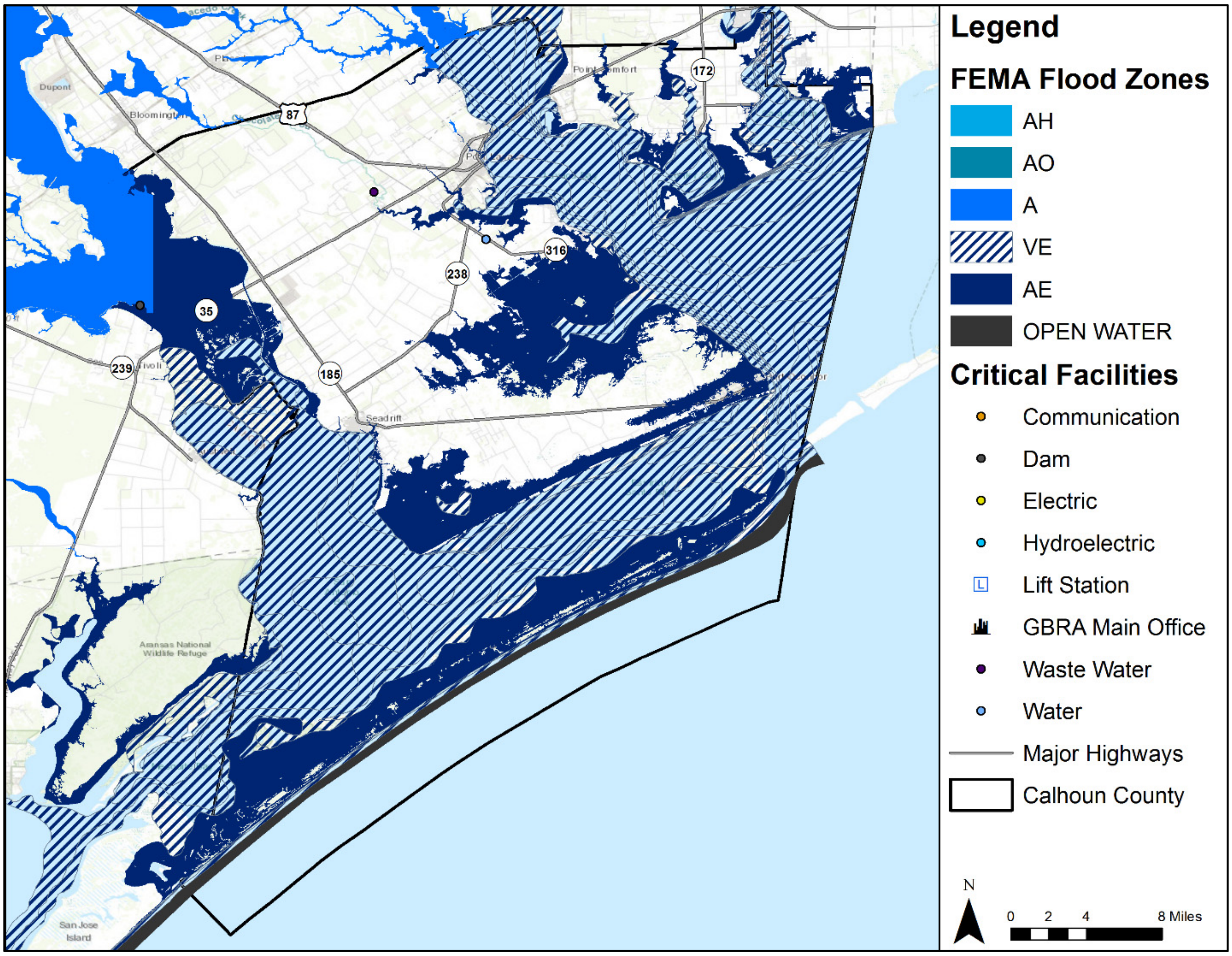


Figure 5-3. GBRA Facilities Estimated Flood Zones in Comal County

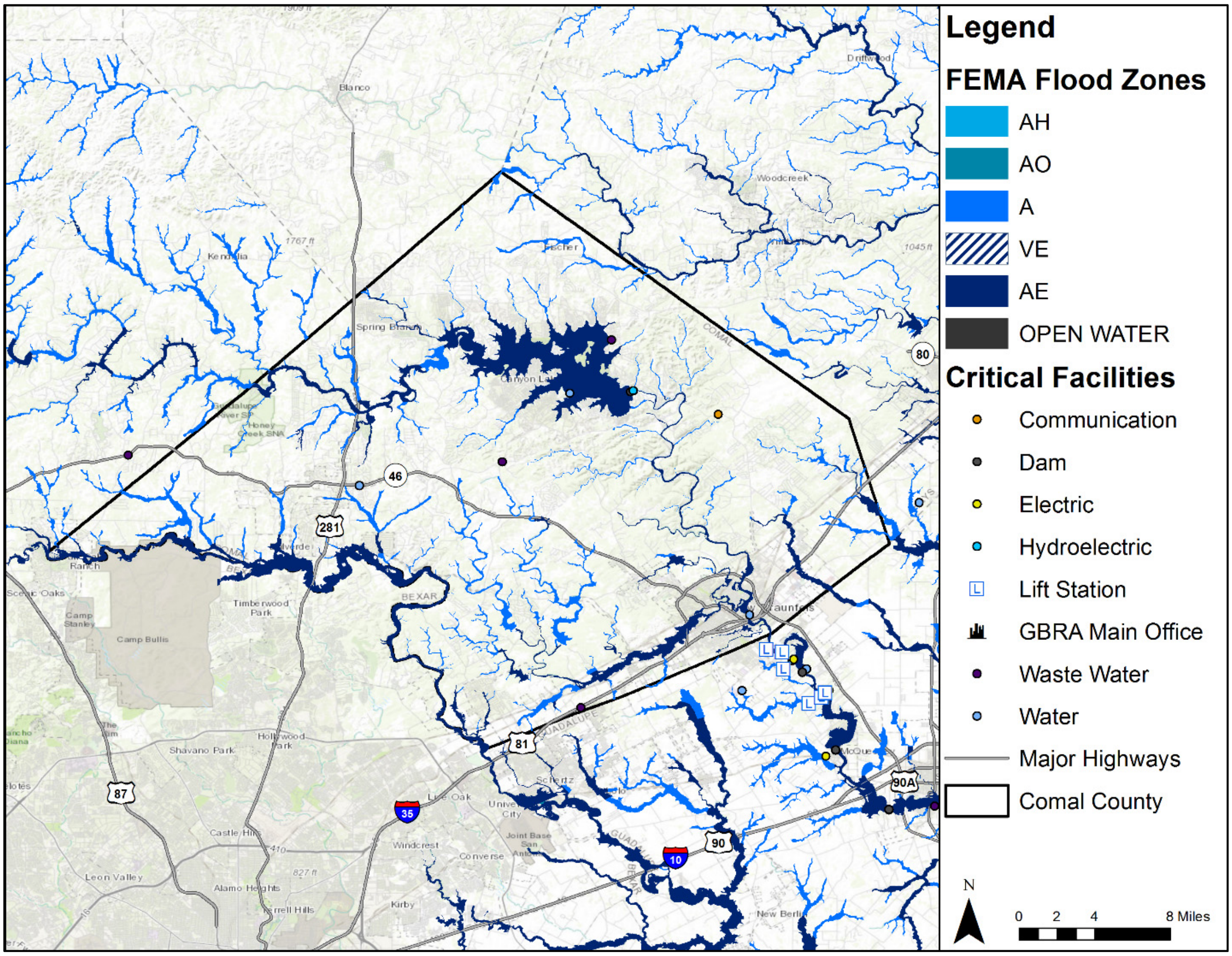


Figure 5-4. GBRA Facilities Estimated Flood Zones in DeWitt County

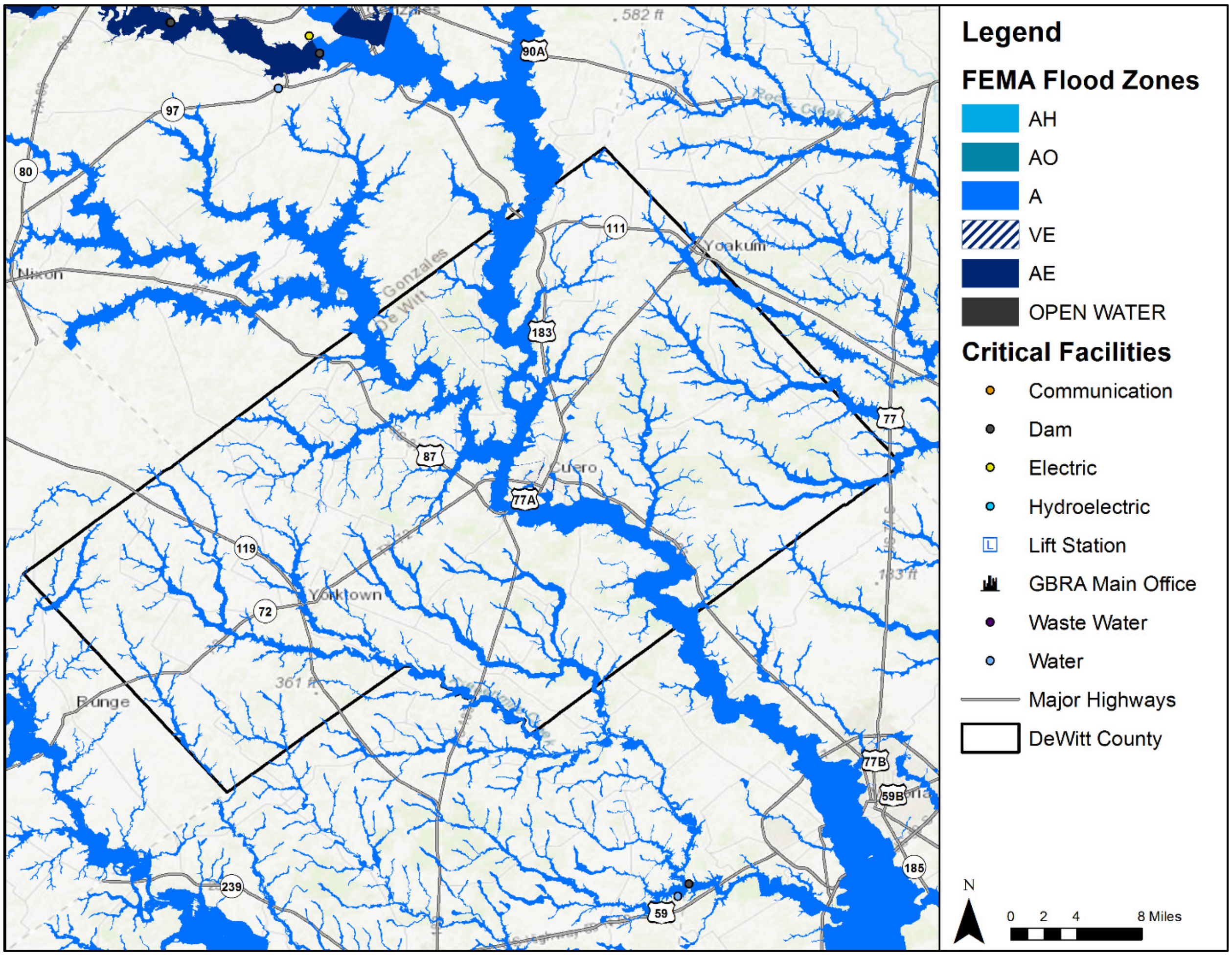


Figure 5-5. GBRA Facilities Estimated Flood Zones in Gonzales County

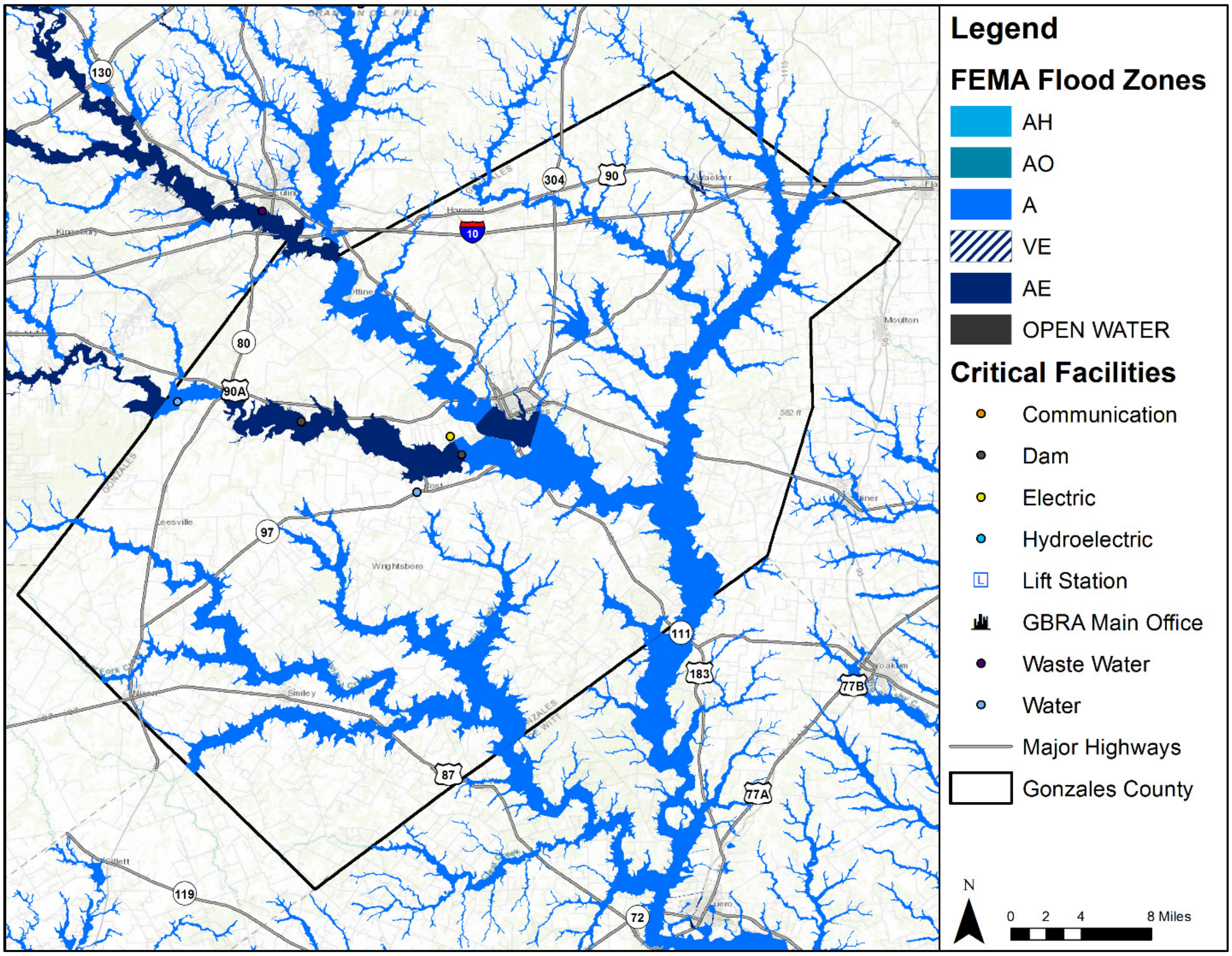


Figure 5-6. GBRA Facilities Estimated Flood Zones in Guadalupe County

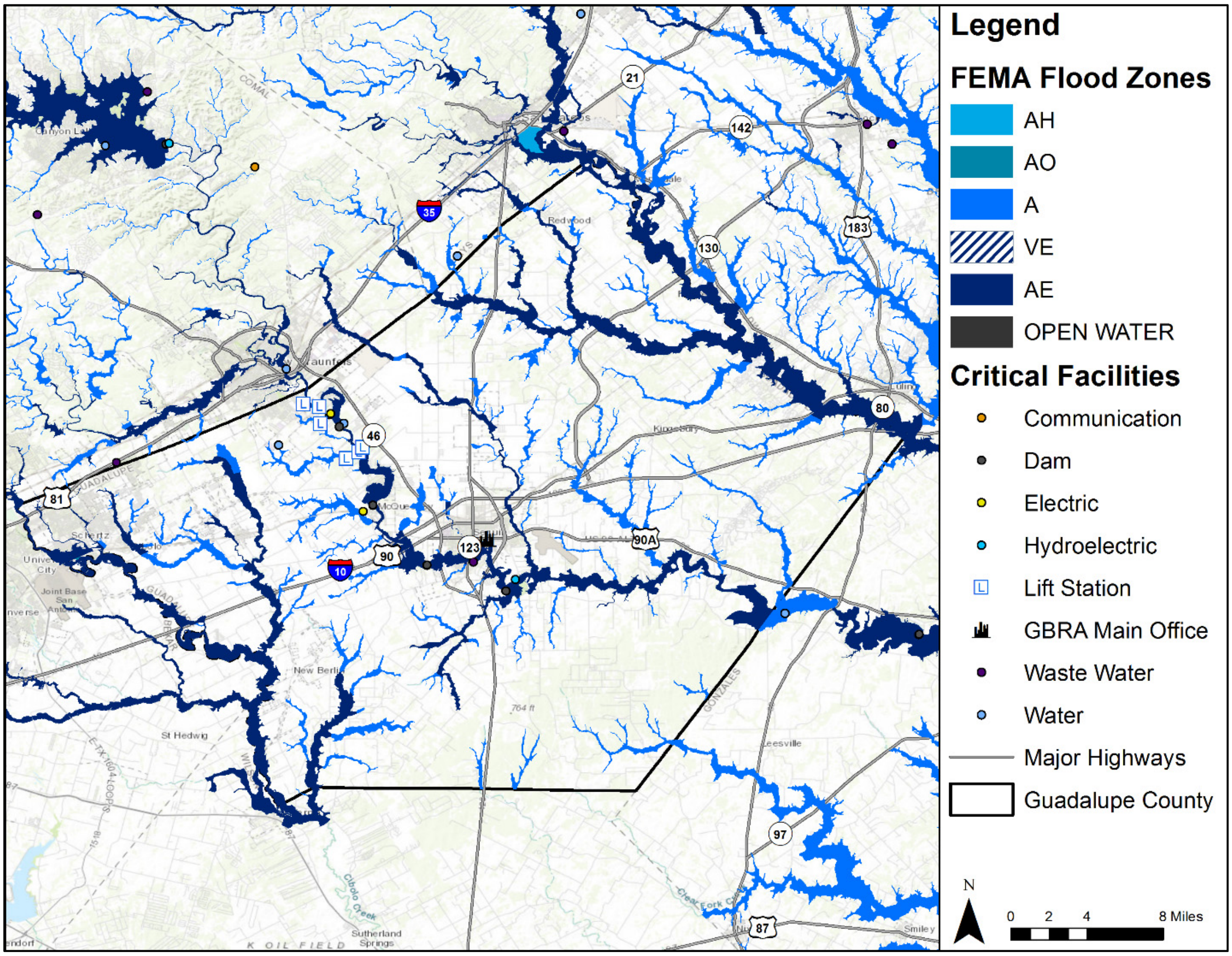


Figure 5-7. GBRA Facilities Estimated Flood Zones in Hays County

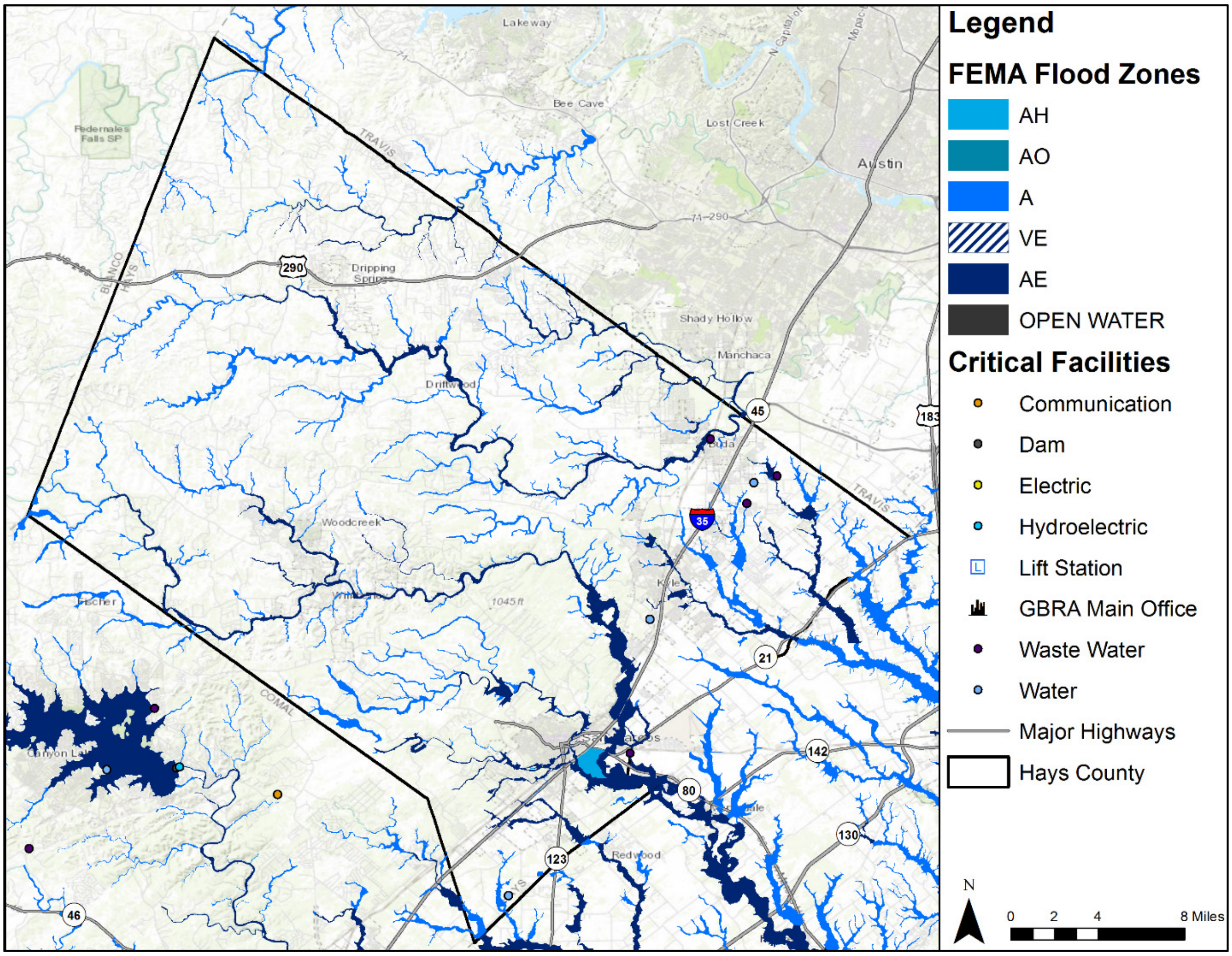


Figure 5-8. GBRA Facilities Estimated Flood Zones in Kendall County

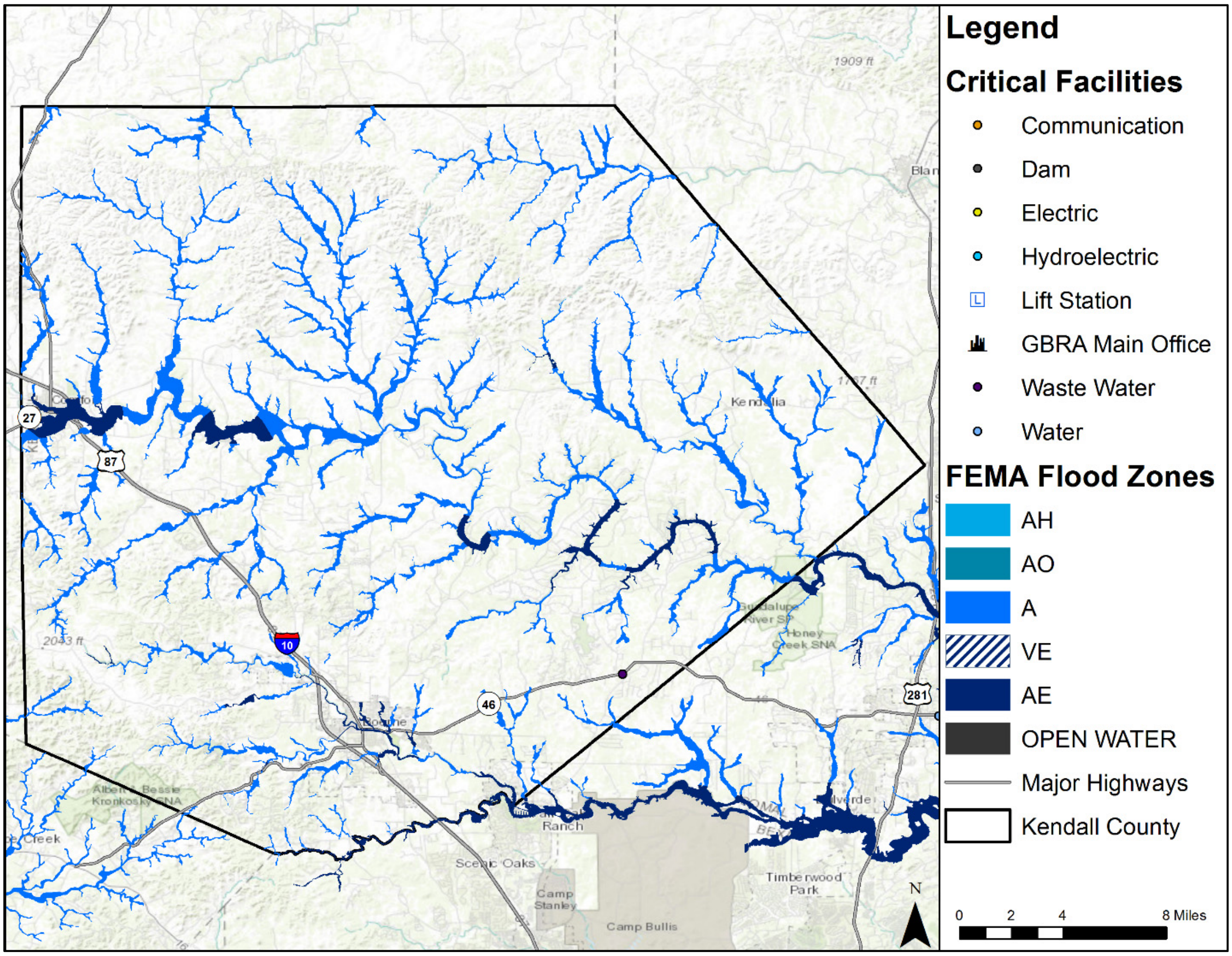


Figure 5-9. GBRA Facilities Estimated Flood Zones in Refugio County

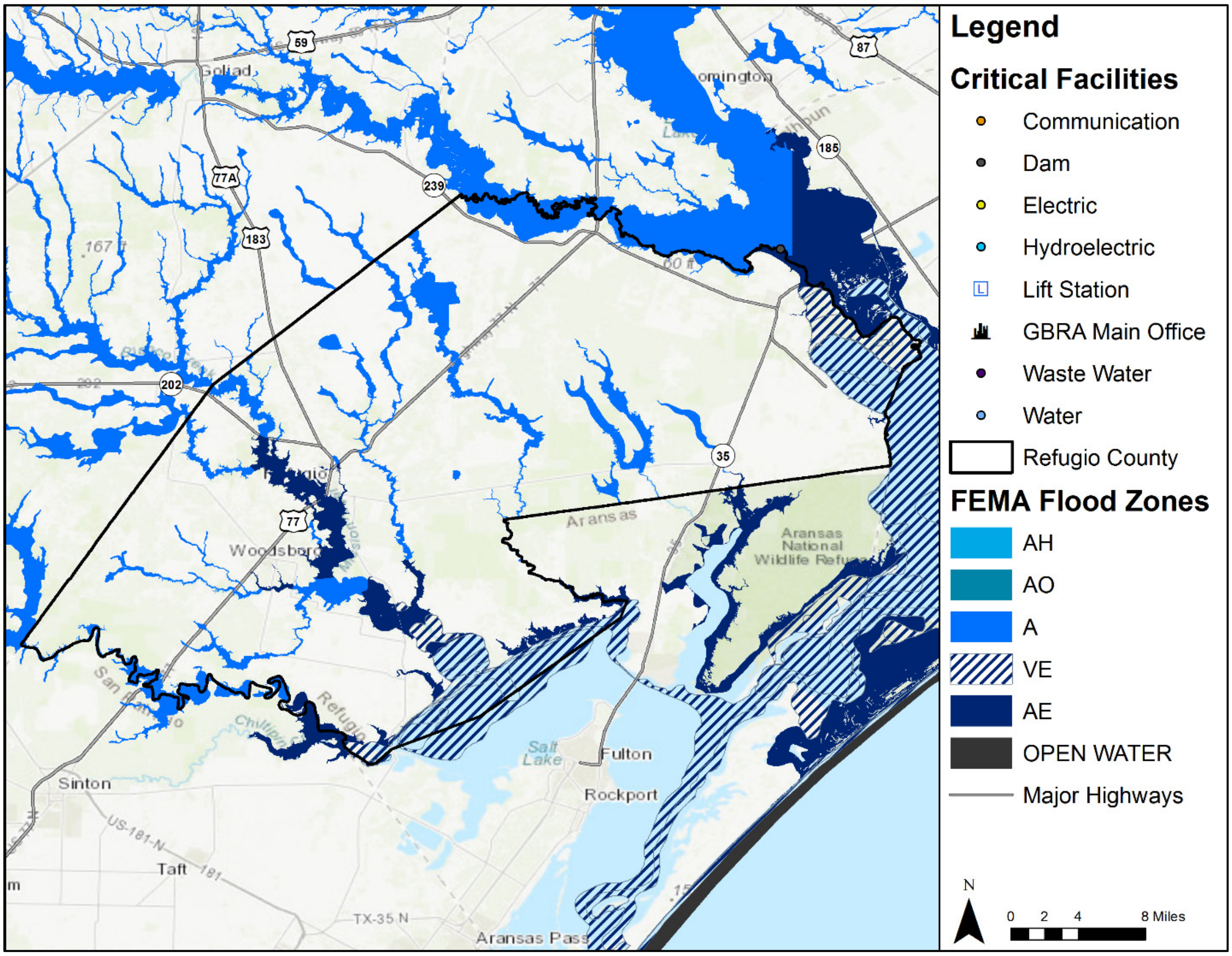
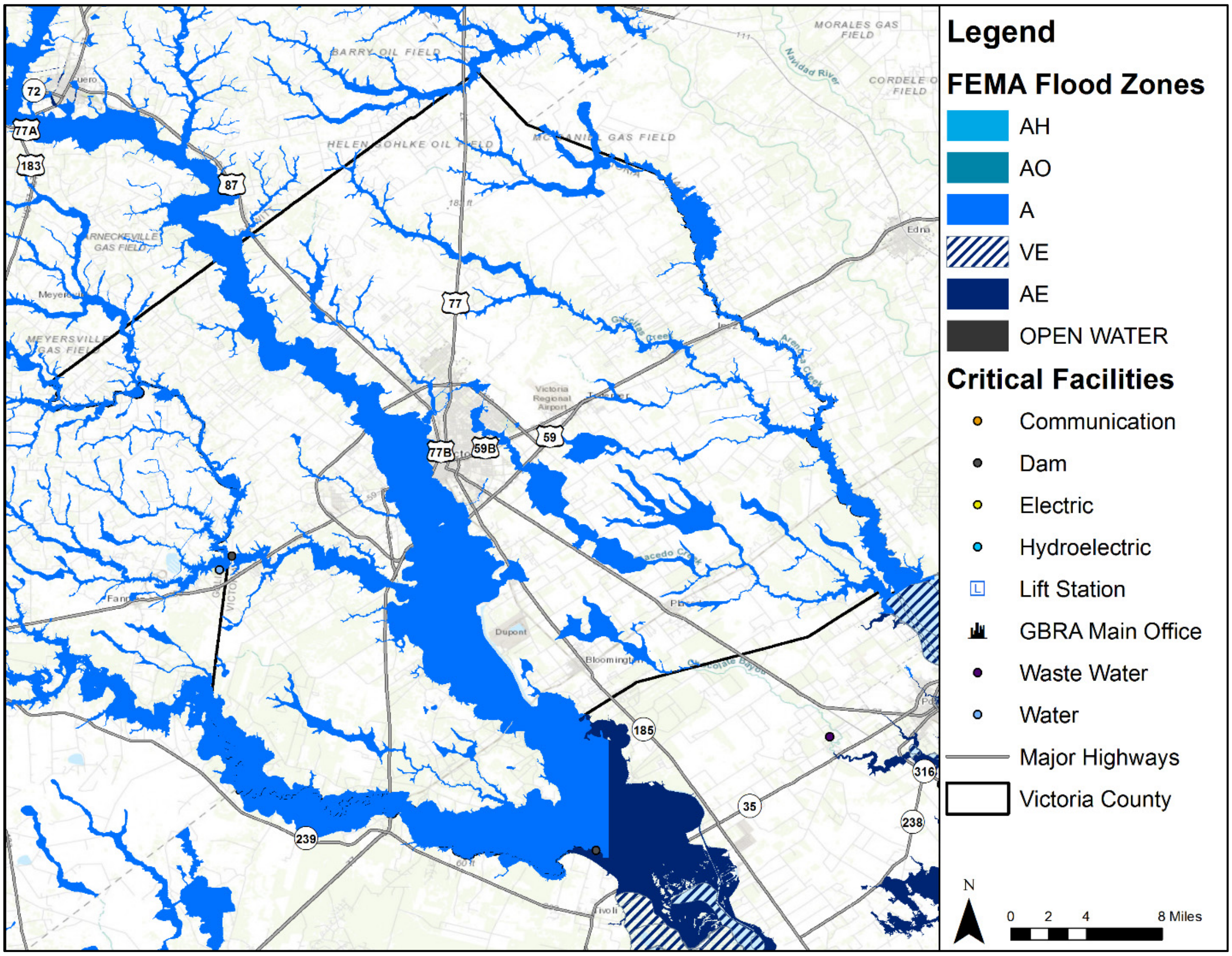


Figure 5-10. GBRA Facilities Estimated Flood Zones in Victoria County



Extent

The severity of a flood event is typically determined by a combination of several factors including: stream and river basin topography and physiography; precipitation and weather patterns; recent soil moisture conditions; and degree of vegetative clearing and impervious surface. Generally, floods are long-term events that may last for several days.

Determining the intensity and magnitude of a flood event is dependent upon the flood zone and location of the flood hazard area in addition to depths of flood waters. FEMA categorizes areas on the terrain according to how the area will convey the discharge of flood water. The extent of flood damages can be expected to be more damaging in the areas where a base flood can occur. A base flood is defined by FEMA as a flood having a one percent chance of being equaled or exceeded in any given year. This is the regulatory standard also referred to as the "100-year flood." The base flood is the national standard used by the National Flood Insurance Program (NFIP) and all Federal agencies for the purposes of requiring the purchase of flood insurance and regulating new development.[1] Flood

[1] Base Flood. (n.d.). Retrieved from http://www.fema.gov/base-flood

zones are the categories that are mapped on Flood Insurance Rate Maps. Table 5-1 provides a description of FEMA flood zones and the flood impact in terms of severity or potential harm. Flood Zone A, AE, AO, AH, and VE are the hazard areas mapped in the planning area. Figures 5-1 through 5-10 should be read in conjunction with the extent for flooding in Tables 5-1, 5-2, and 5-3 to determine the intensity of a potential flooding event.

Table 5-1. Flood Zones

INTENSITY	ZONE	DESCRIPTION
HIGH	ZONE A	Areas with a 1% annual chance of flooding and a 26% chance of flooding over the life of a 30-year mortgage. Because detailed analyses are not performed for such areas, no depths or base flood elevations are shown within these zones.
	ZONE A1-30	These are known as numbered A Zones (e.g., A7 or A14). This is the base floodplain where the FIRM shows a Base Flood Elevation (BFE) (old format).
	ZONE AE	The base floodplain where base flood elevations are provided. AE Zones are now used on the new format FIRMs instead of A1-A30 Zones.
	ZONE AO	River or stream flood hazard areas and areas with a 1% or greater chance of shallow flooding each year, usually in the form of sheet flow, with an average depth ranging from 1 to 3 feet. These areas have a 26% chance of flooding over the life of a 30-year mortgage. Average flood depths derived from detailed analyses are shown within these zones.
	ZONE AH	Areas with a 1% annual chance of shallow flooding, usually in the form of a pond, with an average depth ranging from 1 to 3 feet. These areas have a 26% chance of flooding over the life of a 30-year mortgage. Base flood elevations derived from detailed analyses are shown at selected intervals within these zones.
	ZONE A99	Areas with a 1% annual chance of flooding that will be protected by a federal flood control system where construction has reached specified legal requirements. No depths or base flood elevations are shown within these zones.
	ZONE AR	Areas with a temporarily increased flood risk due to the building or restoration of a flood control system (such as a levee or a dam). Mandatory flood insurance purchase requirements will apply, but rates will not exceed the rates for unnumbered A zones if the structure is built or restored in compliance with Zone AR floodplain management regulations.

INTENSITY	ZONE	DESCRIPTION
MODERATE to LOW	ZONE X 500	An area inundated by 500-year flooding; an area inundated by 100-year flooding with average depths of less than 1 foot or with drainage areas less than 1 square mile; or an area protected by levees from 100-year flooding.

Zone A is interchangeably referred to as the 100-year flood, one-percent-annual chance flood, Special Flood Hazard Area (SFHA), or more commonly, base flood. Zone A is the area where the base flood will occur, and therefore constitutes a threat to the planning area.

Structures built in the Special Flood Hazard Area are subject to damage by rising waters and floating debris. Moving flood water exerts pressure on everything in its path and causes erosion of soil and solid objects. Utility systems, such as heating, ventilation, air conditioning, fuel, electrical systems, sewage maintenance systems, and water systems, if not elevated above base flood elevation, may also be damaged.

In addition to the flood zones, extent is provided in terms of depth of flood waters. Table 5-2 below describes the category of risk and potential magnitude of an event. The water depths depicted in Table 5-2 are an approximation based on elevation data (above sea level rather than above ground). Table 5-3 reflects extent associated with stream gauge data provided by the United States Geological Survey (USGS).

Table 5-2. Extent Scale – Water Depth / Mean Sea Level (MSL)

SEVERITY	MSL (in feet)	DESCRIPTION
BELOW FLOOD STAGE	0 to 15	Water begins to exceed low sections of banks and the lowest sections of the floodplain.
ACTION STAGE	16 to 23	Flow is well into the floodplain, minor lowland flooding reaches low areas of the floodplain. Livestock should be moved from low lying areas.
FLOOD STAGE	24 to 28	Homes are threatened and properties downstream of river flows or in low lying areas begin to flood.
MODERATE FLOOD STAGE	29 to 32	At this stage the lowest homes downstream flood. Roads and bridges in the floodplain flood severely and are dangerous to motorists.
MAJOR FLOOD STAGE	33 and above	Major flooding approaches homes in the floodplain. Primary and secondary roads and bridges are severely flooded and very dangerous. Major flooding extends well into the floodplain, destroying property, equipment and livestock.

Table 5-3. Extent for the GBRA Planning Area[2]

COUNTY[3]	ESTIMATED SEVERITY PER FLOOD EVENT[4]	PEAK FLOOD EVENT
Caldwell County	Flood Stage, 24 to 28 feet	Major Flood Stage: San Marcus River at Luling in Caldwell had floodwaters reach 42 feet in October 1999.
Caldwell County	Action Stage, 16 to 23 feet	Flood Stage: Plum Creek near Luling in Caldwell County, had floodwaters reach 31 feet in July 1936, and 27 feet in May 1975.
Caldwell County	Below Flood Stage, 0 to 15 feet	Action Stage: Plum Creek at Lockhart in Caldwell County, had floodwaters reach 23 feet in October 1998.
Calhoun County	Below Flood Stage, 0 to 15 feet	Action Stage: Guadalupe River near Tivoli in Calhoun County had floodwaters reach 16 feet in June 2015.
Comal County	Below Flood Stage, 0 to 15 feet	Action Stage: Cibolo Creek near Bulverde in Comal County reached an overflow elevation of 23 feet in May 1958.
Comal County	Action Stage, 16 to 23 feet	Major Flood Stage: Guadalupe River near Spring Branch in Comal County reached an overflow elevation of 53 feet in 1869, 45 feet in August 1978 and 45 feet in June 1997.
Comal County	Below Flood Stage, 0 to 15 feet	Major Flood Stage: Guadalupe River at Sattler, TX in Comal County reached an overflow elevation of 36 feet in July 2002.
Comal County	Below Flood Stage, 0 to 15 feet	Flood Stage: Dry Comal Creek at Loop 337, near New Braunfels in Comal County reached an overflow elevation of 25 feet in October 2009.
Comal County	Below Flood Stage, 0 to 15 feet	Major Flood Stage: Guadalupe River at New Braunfels in Comal County reached an overflow elevation of 39 feet in October 1998.
Comal County	Below Flood Stage, 0 to 15 feet	Major Flood Stage: Guadalupe River above the Comal River at New Braunfels in Comal County reached an overflow elevation of 36 feet in October 1998.

[2] Severity estimated by averaging floods at certain stage level over the history of flood events. Severity and peak events are based on U.S. Geological Survey data.
[3] Severity is provided for jurisdictions where peak data was provided.
[4] Severity estimated by averaging floods at certain stage level over the history of flood events.

COUNTY[3]	ESTIMATED SEVERITY PER FLOOD EVENT[4]	PEAK FLOOD EVENT
Comal County	Below Flood Stage, 0 to 15 feet	Major Flood Stage: Comal River at New Braunfels in Comal County reached an overflow elevation of 39 feet in October 1998.
DeWitt County	Action Stage, 16 to 23 feet	Flood Stage: Fifteenmile Creek near Weser in DeWitt County reached an overflow elevation of 27 feet in June 1997.
DeWitt County	Flood Stage, 24 to 28 feet	Major Flood Stage: Guadalupe River at Cuero in DeWitt County reached an overflow elevation of 50 feet in June 1997.
DeWitt County	Action Stage, 16 to 23 feet	Major Flood Stage: Sandies Creek near Westhoff in DeWitt County reached an overflow elevation of 33 feet in July 1936 and 32 feet in September 1981.
Gonzales County	Flood Stage, 24 to 28 feet	Major Flood Stage: Peach Creek below Dilworth in Guadalupe County reached an overflow elevation of 33 feet in May 1970.
Gonzales County	Moderate Flood Stage, 29-32 feet	Major Flood Stage: Guadalupe River at Gonzales in Gonzales County reached an overflow elevation of 50 feet in October 1999.
Guadalupe County	Flood Stage, 24 to 28 feet	Major Flood Stage: Guadalupe River at FM 1117 near Seguin in Guadalupe County reached an overflow elevation of 36 feet in November 2005.
Hays County	Flood Stage, 24 to 28 feet	Flood Stage: Onion Creek near Driftwood in Hays County reached an overflow elevation of 26 feet in October 2015.
Hays County	Below Flood Stage, 0 to 15 feet	Major Flood Stage: Blanco River at Winberley in Hays County reached an overflow elevation of 45 feet in May 2015.
Hays County	Action Stage, 16 to 23 feet	Major Flood Stage: Blanco River near Kyle in Hays County reached an overflow elevation of 41 feet in May 2015.
Hays County	Below Flood Stage, 0 to 15 feet	Major Flood Stage: San Marcus River at San Marcos in Hays County reached an overflow elevation of 21 feet in October 1999.
Kendall County	Action Stage, 16 to 23 feet	Major Flood Stage: Guadalupe River near Comfort, TX, Kendall County had floodwaters reach an overflow elevation of 41 feet in August 1978.

COUNTY[3]	ESTIMATED SEVERITY PER FLOOD EVENT[4]	PEAK FLOOD EVENT
Kendall County	Below Flood Stage, 0 to 15 feet	Action Stage: Cibolo Creek near Boerne, TX, Kendall County had floodwaters reach an overflow elevation of 20 feet in May 2015.
Refugio County	Flood Stage, 24 to 28 feet	Major Flood Stage: San Antonio River near McFaddin in Refugio County reached an overflow elevation of 34 feet in August 2007.
Refugio County	Action Stage, 16 to 23 feet	Major Flood Stage: Mission River at Refugio in Refugio County reached an overflow elevation of 38 feet in September 1971.
Refugio County	Below Flood Stage, 0 to 15 feet	Action Stage: Copano Creek near Refugio in Refugio County reached an overflow elevation of 21 feet in September 1971.
Victoria County	Action Stage, 16 to 23 feet	Major Flood Stage: Coleto Creek near the City of Victoria reached an overflow elevation of 42 feet in September of 1967.
Victoria County	Below Flood Stage, 0 to 15 feet	Major Flood Stage: Coleto Creek reached an overflow elevation of 33.47 feet in September of 1967 near Schroeder, Texas.
Victoria County	Flood Stage, 25 to 28 feet	Major Flood Stage: Guadalupe River at the City of Victoria reached an overflow elevation of 34.04 feet in October of 1998.
Victoria County	Action Stage, 16 to 23 feet	Major Flood Stage: Garcitas Creek reached an overflow elevation of 33.43 feet in October of 1995 near Inez, Texas.
Victoria County	Action Stage, 16 to 23 feet	Major Flood Stage: Placedo Creek reached an overflow elevation of 31.90 feet in September of 1967 near Placedo, Texas.

The range of intensity that the GBRA planning area can experience is high, or Zone A. Based on reporting from the USGS peak MSL data, the average flood event places the GBRA planning area at the extent of “Action Stage” as shown in Tables 5-2 and 5-3. However, the GBRA planning area has experienced flooding over 33 feet MSL. Based on historical occurrences, the GBRA planning area could expect to experience a range of flooding as indicated by location in Table 5-4 below.

Table 5-4. Expected Rainfall by County in GBRA Planning Area[5]

COUNTY	ESTIMATED RAIN FALL	ESTIMATED TIME FRAME
Caldwell County	5.3 Inches	6.5 Hour Period
Calhoun County	7.9 Inches	11.5 Hour Period
Comal County	5.5 Inches	6 Hour Period
DeWitt County	4.8 Inches	5 Hour Period
Gonzales County	4.9 Inches	5 Hour Period
Guadalupe County	5.5 Inches	6 Hour Period
Hays County	5.3 Inches	6 Hour Period
Kendall County	8 Inches	12 Hour Period
Refugio County	8.9 Inches	14.5 Hour Period
Victoria County	6 Inches	4 Hour Period

Reading Tables 5-1 through 5-3 together with Figures 5-1 through 5-10 and historical occurrences for the planning area, provides estimated and potential flood event magnitude and severity for the GBRA planning area. The planning area may experience a range of flooding events from below 15 feet upwards to above 33 feet or from “Below Flood Stage” to a “Major Flood Stage.”

Historical Occurrences

Historical evidence shows that areas within the GBRA planning area are susceptible to flooding, especially in the form of flash flooding. Only flood events that have been reported have been factored into this Risk Assessment. It is likely that additional flood occurrences have gone unreported before and during this recording period. Table 5-5 shows a summary of historical incident information for the GBRA planning area by county which resulted in injuries, fatalities or property damage.[6] Historical data is provided by the Storm Prediction Center (NOAA) and NCEI databases for the GBRA planning area, by county, from 1996 through 2017. Table 5-6 provides the direct GBRA estimated costs of response and repair per flood event.

[5] Estimates derived from NCEI storm event database. Only those events with estimated rainfall amounts were utilized in the analysis.

[6] Comprehensive list of historical events available upon request.

Table 5-5. Historical Flood Events Summary, 1996-2017

COUNTY	NUMBER OF EVENTS	FATALITIES	INJURIES	PROPERTY DAMAGE (2017 DOLLARS)
Caldwell County	89	9	620	$163,419,053
Calhoun County	36	0	0	$1,010,673
Comal County	125	6	920	$400,862,741
DeWitt County	114	0	1,120	$55,678,682
Gonzales County	93	0	730	$25,956,185
Guadalupe County	96	8	829	$72,970,122
Hays County	110	14	177	$236,241,155
Kendall County	80	6	20	$8,599,939
Refugio County	41	0	0	$0
Victoria County	57	0	0	$7,965,064
GBRA Planning Area Losses	**841**	**43**	**4,416**	**$972,703,614**

Table 5-6. Estimated GBRA Response, Recovery and Restoration Damages, 1996-2017

ESTIMATED COST PER EVENT[7]	NUMBER OF EVENTS	TOTAL GBRA COSTS
$83,456	841	$70,186,496

Based on the list of historical flood events for the GBRA planning area (listed above), 195 of the events have occurred since the 2011 Plan.

Significant Events

Flood on October 17-19, 1998 – All Ten GBRA Counties

The Guadalupe River at New Braunfels crested at 35.1 feet, with flood stage at 7 feet. Homes were destroyed, moved downstream, or severely damaged from just below Sattler, near the Bear Creek confluence, across the remainder of Comal County. Homes along the entire reach were flooded well away from the channel, in areas that never flooded before. Along River Road, numerous autos, RVs, and homes were strewn along the flood plain. Recreational camps and outfitters headquarters buildings were destroyed. Homes near Common Street in New Braunfels had slabs as low as 12.5 feet. These homes had 23 feet of torrential flow over the slabs. At the New Braunfels gauge below the Comal River confluence just above IH 35, the Guadalupe crested at 39.3 feet. Water seeped into the Pepperell Mills plant. A large apartment complex left bank just downstream had flow through the windows of the lowest floors. Water was within five feet of the IH 35 bridge bottom. Below IH 35, fine

[7] Estimated cost per event represents the average cost of response, recovery and restoration per county event.

two-story homes were destroyed, or severely damaged. Several RV trailers were washed from an RV park below the IH 35 Bridge.

As the Guadalupe continued southward into Guadalupe County, RVs and permanent homes on the banks were flooded all the way down Lake Dunlap and along Lake McQueeney, where the Las Brisas subdivision had very expensive, two-story homes severely damaged. Treasure Island was almost completely under water with nearly all the high-end homes were flooded with several feet of water. The flooding was comprehensive over the entire flood plain below Sattler. In Seguin, some homes washed downstream in the flood plain below Lake Placid. Three fatalities occurred in Guadalupe County as a direct result of the flood.

In Gonzales, the Guadalupe crested at 51.7 feet, where flood stage is 31 feet. Flow was five feet over the sills of the windows of the old GBRA power plant. Flooding was several miles wide between Gonzales and the Guadalupe/San Marcos Rivers confluence. The city park was inundated with tens of feet of water in lower sections. Flow backed up Tinsley Creek and flooded homes miles into Gonzales.

Some of the most extensive flooding along the Guadalupe River took place in DeWitt County. One DeWitt County rancher lost three hundred cattle, and another near two hundred. Total livestock losses in the flood probably exceeded well over ten thousand head. At Cuero, the Guadalupe crested at 49.8 feet, with flood stage at 20 feet. The flooding was devastating, with homes two miles east of the channel washed downstream along the west edge of the downtown area. Several homes were washed across Highway 87. One home washed over Highway 87, but was stopped as it smashed into a more permanent commercial building, and came to rest in the eastbound (downstream) lane of Highway 87. There were many city blocks where homes were washing downstream, reflecting the deep flow and its velocity. The Guadalupe was reported to be between four and five miles wide just south of Cuero. At Thomaston, the Guadalupe flooded the county road over a mile away from the normal river channel. Over one hundred homes were flooded, with many washing downstream. Flow was near 20 feet over the lowest slabs of the River Haven, Cypress Valley, and River Oaks subdivisions.

In Caldwell County Plum Creek at Lockhart crested at 22.2 feet, with flood stage at 15 feet. The Creek was reported to be near a mile wide, flooding Highway 183 near Lockhart. Downstream in and near Martindale in Caldwell County, the San Marcos River flooded several subdivisions. At Luling, the river gauge appears to have hung at 38.7 feet and rising, where flood stage is 20 feet. In Luling, the golf course was completely inundated and structures in the nearby south section of Luling had several feet of water in them. Six fatalities occurred in Caldwell County as a direct result of the flood.

In Hays County, the flooding along the San Marcos River was most devastating to the eastern part of San Marcos, with many permanent homes flooded and several mobile homes washed from their sites, Homes and apartments were flooded along the San Marcos River on Riverside and Riviera Drives, along Purgatory Creek, and along Uhland and Post Roads.

Flooding was reported in the remaining counties with limited damages and no fatalities. The damages reported for the entire GBRA ten county planning area exceeded $690 million (2017 dollars) in property damages.

Probability of Future Events

Based on recorded historical occurrences over the past 22 years, a flood event is a highly likely occurrence for the GBRA planning area and multiple events are considered probable in the next year for some portion of the GBRA facilities and infrastructure.

Vulnerability and Impact

A property's vulnerability to a flood depends on its location in, or proximity to, the floodplain. Structures that lie along banks of a waterway are the most vulnerable and are often repetitive loss structures. The GBRA manages facilities, structures, and infrastructure over a ten-county area. While the GBRA encourages development of facilities outside of the floodplain, many of the facilities are located in close proximity to watercourses and are subject to flooding. The following GBRA facilities would be vulnerable to significant flood events:

Table 5-7. GBRA Assets at Risk[8]

COUNTY	ASSETS
Caldwell County	3 Structures (waste water treatment plant and 2 water treatment plants), Infrastructure, Acreage
Calhoun County	None
Comal County	3 Structures (Dam, Hydroelectric Plant, Pump Station), Acreage, River Gage, Pond
DeWitt County	None
Gonzales County	4 Structures (3 Dams, Hydroelectric Plant), Infrastructure, Acreage
Guadalupe County	9 Structures (4 Dams, 4 Hydroelectric Plants, Wastewater Treatment Plant), 3 Lift Stations, Infrastructure, Acreage
Hays County	None
Kendall County	None
Refugio County	None
Victoria County	1 Structure (Dam), Infrastructure (Park)
GBRA Total	**20 Structures, 3 Lift Stations, Infrastructure, Acreage, River Gage, Pond**

Based on historic events, flood impacts for the GBRA planning area are considered minor. Injuries and illness that do not result in permanent disability could be expected along with complete shutdown of facilities for more than 1 week and more than 10 percent of property destroyed or with major damage.

Historic loss estimates due to flood are presented in Table 5-8 below including an estimate of annualized loss for the GBRA planning area by county. Table 5-9 includes a summary of GBRA's direct elevated response, recovery and repair annualized losses. It should be noted that the average event cost represents the average range of events from minor to substantial such as large federally declared events.

[8] Source: County Central Appraisal Districts

Table 5-8. Historic Flood Event Summary and Annualized Loss

COUNTY	NUMBER OF EVENTS	PROPERTY LOSS (2017 DOLLARS)	ANNUAL LOSS ESTIMATE (2017 DOLLARS)
Caldwell County	89	$163,419,053	$7,428,139
Calhoun County	36	$1,010,673	$45,940
Comal County	125	$400,862,741	$18,221,034
DeWitt County	114	$55,678,682	$2,530,849
Gonzales County	93	$25,956,185	$1,179,827
Guadalupe County	96	$72,970,122	$3,316,824
Hays County	110	$236,241,155	$10,738,234
Kendall County	80	$8,599,939	$390,906
Refugio County	41	$0	$0
Victoria County	57	$7,965,064	$362,048

Table 5-9. GBRA Historic Flood Event Summary and Direct Annualized Loss, 1996-2017

ESTIMATED COST PER EVENT	NUMBER OF EVENTS	TOTAL GBRA COSTS (2017 DOLLARS)	ANNUAL LOSS ESTIMATE (2017 DOLLARS)
$83,456	841	$70,186,496	$3,190,295

Assessment of Impacts

Flooding is the deadliest natural disaster that occurs in the U.S. each year, and it poses a constant and significant threat to the health and safety of the people in the planning area.

The direct impacts to the GBRA facilities and services may include:

- Injury or illness to vulnerable employees;
- Extensive power outages;
- Reduction in water supply capacity;
- Reduction in water quality;
- Damaged or destroyed structures and infrastructure;
- Employees unable to report for duty;
- Damages to power grid and hydroelectric power infrastructure;
- Inadequate staffing for repair work;
- Decreased revenue;
- Dissatisfied customers.

Impacts to counties in the planning area that could indirectly impact GBRA:

- Recreation activities may be unavailable and tourism can be unappealing for years following a large flood event, devastating directly related local businesses and negatively impacting economic recovery.

- Area wildlife may suffer significant mortality rates during and following a flood due to damaged or destroyed ecosystems and water contamination.
- Bridges may be damaged or inaccessible, cutting off critical emergency services to neighborhoods.
- Flood-related rescues may be necessary at swift water and low water crossings or in flooded neighborhoods where roads have become impassable, placing first responders in harm's way.
- Evacuations may be required for entire neighborhoods because of rising floodwaters, further taxing limited response capabilities and increasing sheltering needs for displaced residents.
- Health risks and threats to residents are elevated after the flood waters have receded due to contaminated flood waters (untreated sewage and hazardous chemicals) and mold growth typical in flooded buildings and homes.
- Significant flood events often result in widespread power outages, increasing the risk to more vulnerable portions of the population who rely on power for health and/or life safety.
- Extended power outage can result in an increase in structure fires and/or carbon monoxide poisoning, as individuals attempt to cook or heat their home with alternate, unsafe cooking or heating devices, such as grills.
- Floods can destroy or make residential structures uninhabitable, requiring shelter or relocation of residents in the aftermath of the event.
- First responders are exposed to downed power lines, contaminated and potentially unstable debris, hazardous materials, and generally unsafe conditions, elevating the risk of injury to first responders and potentially diminishing emergency response capabilities.
- Emergency operations and services may be significantly impacted due to damaged facilities.
- Significant flooding can result in the inability of emergency response vehicles to access areas of the community.
- Critical staff may suffer personal losses or be otherwise impacted by a flood event and unable to report for duty, limiting response capabilities.
- City or County departments may be flooded, delaying response and recovery efforts for the entire community.
- Private sector entities that the City and its residents rely on, such as utility providers, financial institutions, and medical care providers may not be fully operational and may require assistance from neighboring communities until full services can be restored.
- Damage to infrastructure may slow economic recovery since repairs may be extensive and lengthy.
- Some businesses not directly damaged by the flood may be negatively impacted while utilities are being restored or water recedes, further slowing economic recovery.
- When the community is affected by significant property damage it is anticipated that funding would be required for infrastructure repair and restoration, temporary services and facilities, overtime pay for responders, as well as normal day-to-day operating expenses.
- Displaced residents may not be able to immediately return to work, further slowing economic recovery.
- Residential structures substantially damaged by a flood may not be rebuilt for years and uninsured or underinsured residential structures may never be rebuilt, reducing the tax base for the community.
- Large floods may result in a dramatic population fluctuation, as people are unable to return to their homes or jobs and must seek shelter and/or work outside of the affected area.
- Businesses that are uninsured or underinsured may have difficulty reopening, which results in a net loss of jobs for the community and a potential increase in the unemployment rate.
- Flooding may cause significant disruptions of clean water and sewer services, elevating health risks and delaying recovery efforts.

- The psycho-social effects on flood victims and their families can traumatize them for long periods of time, creating long term increases in medical treatment and services.
- Extensive or repetitive flooding can lead to decreases in property value for the affected community.
- Flood poses a potential catastrophic risk to annual and perennial crop production and overall crop quality, leading to higher food costs.
- Flood related declines in production may lead to an increase in unemployment.
- Large floods may result in loss of livestock, potential increased livestock mortality due to stress and water borne disease, and increased cost for feed.

The overall extent of damages caused by floods is dependent on the extent, depth, and duration of flooding, and the velocities of flows in the flooded areas. The level of preparedness and pre-event planning done by government, businesses, and citizens will contribute to the overall economic and financial conditions in the aftermath of a flood event.

NFIP Participation

The GBRA is not an eligible National Flood Insurance Program (NFIP) participant. The GBRA facilities are insured by a private insurance company for losses to GBRA property. The GBRA has a vested interest in taking flood loss reduction steps and works with cities, counties, and state and federal agencies to reduce the likelihood of flood damage.

Repetitive Loss

The Severe Repetitive Loss (SRL) Grant Program under FEMA provides federal funding to assist states and communities in implementing mitigation measures to reduce or eliminate the long-term risk of flood damage to SRL residential structures insured under the NFIP. The Texas Water Development Board (TWDB) administers the SRL grant program for the State of Texas. One of the goals of the FMA program is to reduce the burden of repetitive loss and severe repetitive loss properties on the NFIP through mitigation activities that significantly reduce or eliminate the threat of future flood damages.

Repetitive Loss properties are defined as structures that are:

- Any insurable building for which 2 or more claims of more than $1,000 each, paid by the National Flood Insurance Program (NFIP) within any 10-year period, since 1978;
- May or may not be currently insured under the NFIP.

Severe Repetitive Loss properties are defined as residential properties that are:

- covered under the NFIP and have at least four flood related damage claim payments (building and contents) over $5,000 each, and
- the cumulative amount of such claims payments exceeds $20,000; or
- At least two separate claim payments (building payments only) have been made with the cumulative amount of the building portion of such claims exceeding the market value of the building.

In either scenario, at least two of the referenced claims must have occurred within any ten-year period, and must be greater than 10 days apart.[9]

[9] Source: Texas Water Development Board

While repetitive loss structures are located in all ten counties of the GBRA planning area, the GBRA does not have any repetitive or severe repetitive loss properties among the GBRA-owned facilities.

SECTION 6: DROUGHT

Hazard Description

Drought is a period of time without substantial rainfall that persists from one year to the next. Drought is a normal part of virtually all climatic regions, including areas with high and low average rainfall. Drought is the consequence of anticipated natural precipitation reduction over an extended period of time, usually a season or more in length. Droughts can be classified as meteorological, hydrologic, agricultural, and socioeconomic. Table 6-1 presents definitions for these different types of drought.

Table 6-1. Drought Classification Definitions[1]

METEOROLOGICAL DROUGHT	The degree of dryness or departure of actual precipitation from an expected average or normal amount based on monthly, seasonal, or annual time scales.
HYDROLOGIC DROUGHT	The effects of precipitation shortfalls on stream flows and reservoir, lake, and groundwater levels.
AGRICULTURAL DROUGHT	Soil moisture deficiencies relative to water demands of plant life, usually crops.
SOCIOECONOMIC DROUGHT	The effect of demands for water exceeding the supply as a result of a weather-related supply shortfall.

Droughts are one of the most complex of all natural hazards because it is difficult to determine the precise beginning or ending of the event. Additionally, droughts can lead to other hazards such as extreme heat and wildfires. The impact of a drought event on wildlife and farming is enormous, often killing crops, grazing land, edible plants, and trees in severe cases. A secondary hazard to drought is wildfire because dying vegetation serves as a prime ignition source. Therefore, a heat wave combined with a drought can pose a high risk to the GBRA planning area.

Location

Droughts are a normal condition that occur regularly throughout Texas and the GBRA planning area. However, drought events can vary greatly in intensity and duration. The Drought Monitor shows the

[1] Source: Multi-Hazard Identification and Risk Assessment: A Cornerstone of the National Mitigation Strategy, FEMA

vast majority of the planning area is currently experiencing abnormally dry conditions, with most of Kendall County experiencing moderate drought conditions (Figure 6-1). However, the planning area has experienced abnormally dry to exceptional drought conditions over the last ten years (Figure 6-2). There is no distinct geographic boundary to drought; therefore, it can occur throughout the entire GBRA planning area equally.

Figure 6-1. U.S. Drought Monitor, November 2017

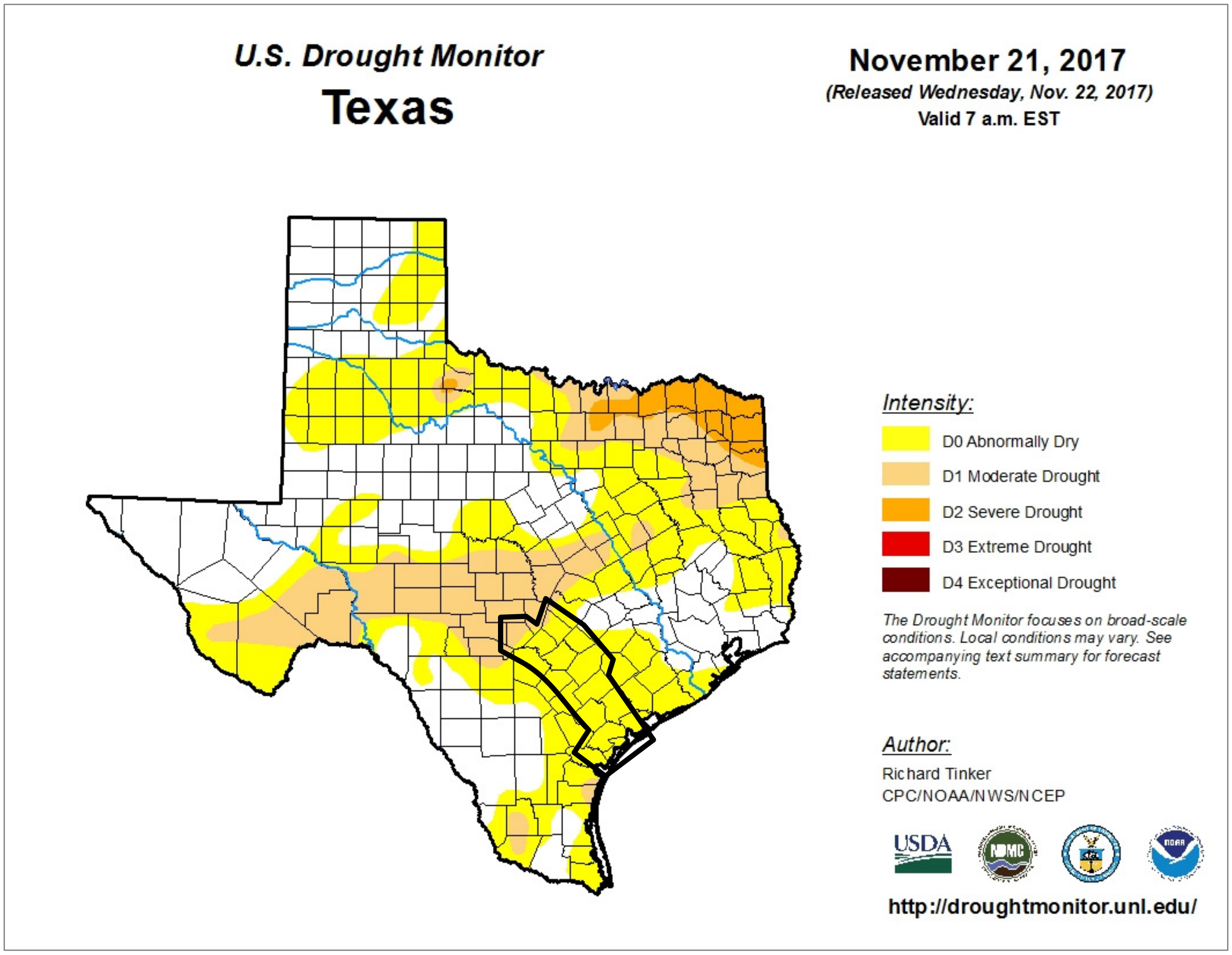
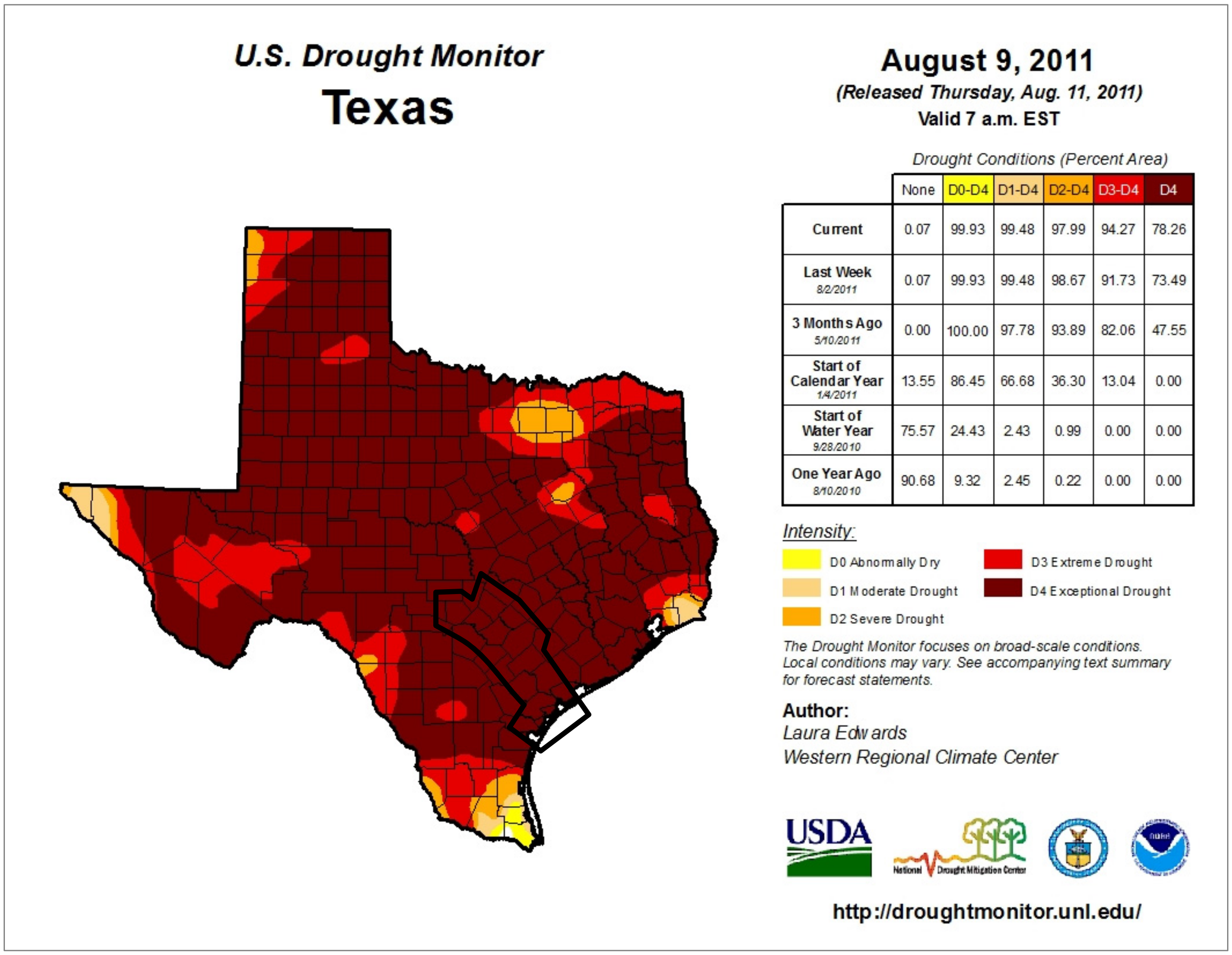


Figure 6-2. U.S. Drought Monitor, August 2011



Extent

The Palmer Drought Severity Index is used to measure the extent of drought by measuring the duration and intensity of long-term, drought-inducing circulation patterns. Long-term drought is cumulative, thus the intensity of a drought during a single month is dependent upon that month's weather patterns plus the cumulative weather patterns of previous months. The hydrological impacts of drought (e.g., reservoir levels, groundwater levels, etc.) take longer to develop. Table 6-2 provides classification descriptions for the Palmer Drought Severity Index, and Table 6-3 depicts the magnitude of drought according to the Index.

Table 6-2. Palmer Drought Severity Index – Category Descriptions[2]

CATEGORY	DESCRIPTION	POSSIBLE IMPACTS	PALMER DROUGHT SEVERITY INDEX
D0	Abnormally Dry	Going into drought: short-term dryness slowing planting, growth of crops or pastures; fire risk above average. Coming out of drought: some lingering water deficits; pastures or crops not fully recovered.	-1.0 to -1.9
D1	Moderate Drought	Some damage to crops, pastures; fire risk high; streams, reservoirs, or wells low; some water shortages developing or imminent; voluntary water use restrictions requested.	-2.0 to -2.9
D2	Severe Drought	Crop or pasture losses likely; fire risk very high; water shortages common; water restrictions imposed.	-3.0 to -3.9
D3	Extreme Drought	Major crop/pasture losses; extreme fire danger; widespread water shortages or restrictions.	-4.0 to -4.9
D4	Exceptional Drought	Exceptional and widespread crop/pasture losses; exceptional fire risk; shortages of water in reservoirs, streams, and wells, creating water emergencies.	-5.0 or less

Table 6-3. Palmer Drought Severity Index

PALMER DROUGHT SEVERITY INDEX	DROUGHT CONDITION CLASSIFICATIONS						
	Extreme	Severe	Moderate	Normal	Moderately Moist	Very Moist	Extremely Moist
Z Index	-2.75 and below	-2.00 to -2.74	-1.25 to -1.99	-1.24 to +.99	+1.00 to +2.49	+2.50 to +3.49	n/a
Meteorological	-4.00 and below	-3.00 to -3.99	-2.00 to -2.99	-1.99 to +1.99	+2.00 to +2.99	+3.00 to +3.99	+4.00 and above
Hydrological	-4.00 and below	-3.00 to -3.99	-2.00 to -2.99	-1.99 to +1.99	+2.00 to +2.99	+3.00 to +3.99	+4.00 and above

Drought is monitored nationwide by the National Drought Mitigation Center (NDMC). Indicators are used to describe broad scale drought conditions across the U.S. Indicators correspond to the intensity of drought.

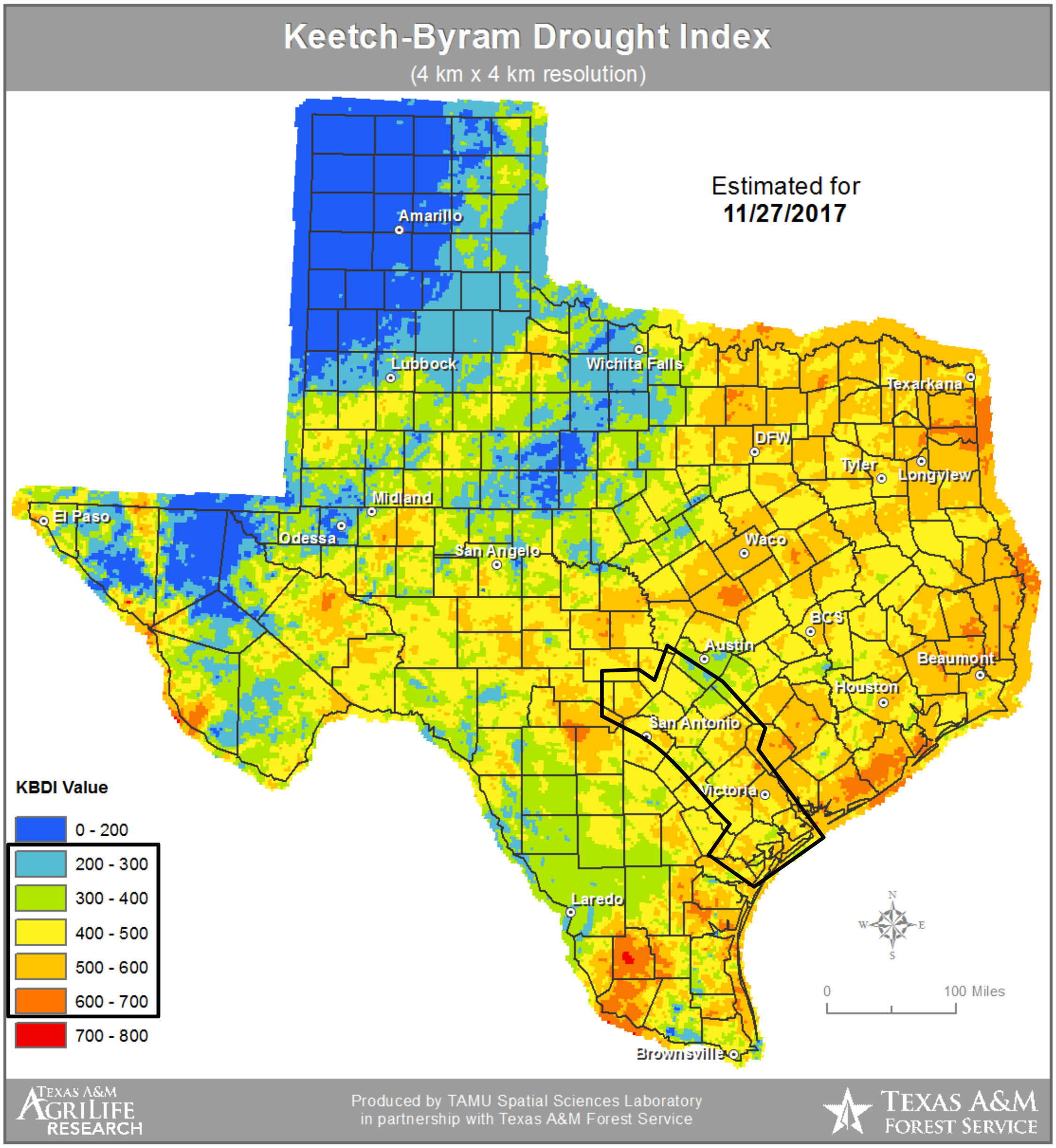
[2] Source: National Drought Mitigation Center

Section 6: Drought

Based on historical occurrences for drought the planning area can anticipate a range of drought from abnormally dry to exceptional drought or D0 to D4 based on the Palmer Drought Severity Index.

The Texas Forest Service uses the Keetch-Byram Drought Index to determine the fire potential based on daily water balance, precipitation, and soil moisture. Figure 6-3 shows the Texas Drought Index according to Keetch-Byram Drought Index, which uses a rating classification that is color coded with a scale of 0 to 800 (low risk to high risk).

Figure 6-3. Texas Drought Index according to Keetch-Byram Drought Index[3]



[3] The black rectangle indicates the GBRA planning area.

The planning area's averaged risk is considered significant (Figure 6-3), which means more frequent wildfires and intense, deep burning fire potential. Downwind spotting can be expected and live fuels can potentially burn at this level, exposing mineral soils in some locations.

Historical Occurrences

The GBRA planning area can typically experience a severe drought. Table 6-4 and 6-5 list historical events that have occurred in the 10 county GBRA planning area as reported in the National Centers for Environmental Information (NCEI). Historical drought information, as provided by the NCEI, show drought activity across a multi-county forecast area for each event. The appropriate percentage of the total property damage reported for the entire forecast area has been allocated to each county impacted by the event.

Only drought events that have been reported have been factored into this Risk Assessment. It is likely that additional drought occurrences have gone unreported before and during the recording period. Table 6-5 shows the historical incident information summary by county for the planning area. None of the reported drought events in the GBRA ten county planning area resulted in damages or injuries. Table 6-6 provides the direct GBRA estimated costs of response and repair per drought event.

Table 6-4. Historical Drought Years and Locations, 1996-2017

DROUGHT YEAR	LOCATION
1996	Caldwell, Calhoun, Comal, DeWitt, Guadalupe, Gonzales, Hays, Kendall, Victoria
1997	Comal
2000	Caldwell, Comal, DeWitt, Guadalupe, Gonzales, Hays, Kendall
2006	Calhoun, Refugio, Victoria
2008	Calhoun, Refugio, Victoria
2009	Calhoun, Refugio, Victoria
2011	Caldwell, Calhoun, Comal, DeWitt, Guadalupe, Gonzales, Hays, Kendall, Refugio, Victoria
2012	Caldwell, Calhoun, Comal, DeWitt, Guadalupe, Gonzales, Hays, Kendall, Refugio, Victoria
2013	Caldwell, Calhoun, Comal, DeWitt, Guadalupe, Gonzales, Hays, Kendall, Refugio, Victoria
2014	Caldwell, Calhoun, Comal, DeWitt, Guadalupe, Gonzales, Hays, Kendall, Refugio, Victoria
2015	Caldwell, DeWitt, Guadalupe, Kendall, Victoria
10 unique drought periods[4] (71 events by County)	

[4] Drought periods are determined by dates and times across multiple counties. Drought reported for 2011 and 2012 covers the same continuous drought period.

Table 6-5. Historical Drought Event Summary, 1996-2017

COUNTY	REPORTED EVENTS	UNIQUE DROUGHT PERIODS	DEATHS OR INJURIES	PROPERTY DAMAGE (2017 DOLLARS)
Caldwell County	32	10	0	$0
Calhoun County	55	9	0	$0
Comal County	37	9	0	$0
DeWitt County	41	8	0	$0
Gonzales County	26	7	0	$0
Guadalupe County	29	9	0	$0
Hays County	27	8	0	$0
Kendall County	57	8	0	$0
Refugio County	56	6	0	$0
Victoria County	62	9	0	$0

Table 6-6. Estimated GBRA Response, Recovery and Restoration Damages, 1996-2017

ESTIMATED COST PER EVENT[5]	NUMBER OF EVENTS	TOTAL GBRA COSTS
$21,148	71	$1,501,508

Based on the list of historical drought events for the GBRA planning area (listed above), 60 of the unique events have occurred since the 2011 Plan.

Significant Events

April 2011 through April 2012 – GBRA Planning Area

During April of 2011 Calhoun and Victoria County were experiencing extreme drought conditions. Limited rainfall since January continued through the month of April. By May of 2011 all ten counties in the GBRA planning area were experiencing extreme to exceptional drought conditions. Area lakes and reservoirs remained below normal pool elevations, some as much as 32 feet below normal. Over the next eight months all ten counties continued to experience exceptional drought. There were several significant rainfall events at the end of January with precipitation estimates of two to six inches over much of the eastern half of South Central Texas. Conditions in Caldwell, Comal, Guadalupe, and Hays Counties were considered normal by February. Drought conditions in Calhoun, DeWitt, Gonzales, Kendall, Refugio, and Victoria Counties were upgraded to severe drought. By the end of April, conditions across all ten counties in the GBRA planning area were considered normal.

[5] Estimated cost per event represents the average cost of response, recovery and restoration per county event.

Probability of Future Events

Based on available records of historic events, there have been 422 recorded events (across 10 counties) over 10 extended time periods within a 22 year reporting period. This does not mean that there were 422 separate events. The GBRA planning area averages one drought every one to two years. This frequency supports a highly likely probability of future events.

Vulnerability and Impact

Drought impacts large areas and crosses jurisdictional boundaries. All existing and future buildings, facilities, and populations are exposed to this hazard and could potentially be impacted. However, drought impacts are mostly experienced as water shortages, crop losses, and livestock losses on agricultural lands, and typically have no impact on buildings.

Population, agriculture, property, and environment are all vulnerable to drought. The average person will survive only a few days without water, and this timeframe can be drastically shortened for those people with more fragile health including children, the elderly, and the ill. The population is also vulnerable to food shortages when drought conditions exist and potable water is in short supply. Potable water is used for drinking, sanitation, patient care, sterilization, equipment, heating and cooling systems, and many other essential functions in medical facilities.

The GBRA provides a reliable water supply to residents in South Central Texas. The most significant threat to the GBRA during extended periods of drought includes the capabilities to meet water needs to area residents. In addition, prolonged periods of drought has the potential to significantly reduce hydroelectric power generation. As water levels diminish, less power can be generated. The GBRA owns and operates two hydro-power operations that would be at risk during prolonged droughts.

While the power and water services are at greater risk during drought events, all of the GBRA facilites are vulnerable to drought. Table 6-7 includes the total GBRA assets at risk by county.[6]

Table 6-7. GBRA Assets at Risk[7]

COUNTY	EMPLOYEES	ASSETS	MARKET VALUE	ACREAGE
Caldwell County	0	2 Structures, Acreage	$2,238,594	281
Calhoun County	0	Acreage	$610,370	620
Comal County	0	6 Structures, Meter Station, Acreage	$6,686,026	61
DeWitt County	0	2 Structures, Infrastructure	$5,785,030	44
Gonzales County	0	10 Structures, Infrastructure, Acreage	$1,154,710	46

[6] GBRA assets include land and improvements including buildings, power substations, dams, radio tower sites, gas storage facilities, electric generating complexes, and support infrastructure.
[7] Source: County Central Appraisal Districts

COUNTY	EMPLOYEES	ASSETS	MARKET VALUE	ACREAGE
Guadalupe County	174	15 Structures, Lift Station,17 Substations, Infrastructure, Acreage	$64,993,426	199
Hays County	0	Acreage	$35,800	3
Kendall County	0	1 Structure, Acreage	$60,010	1
Refugio County	0	Acreage	$13,360	10
Victoria County	0	Infrastructure	$510,180	0
GBRA Total	**174**	**36 Structures, 17 Substations, Lift Station, Meter Stations, Infrastructure, Acreage**	**$82,087,506**	**1,265**

The economic impact of drought events can be significant and produce complex impacts in various sectors of the economy beyond the area experiencing physical drought. This complexity exists because water is integral to our ability to produce goods and provide services. If a drought event extends over a number of years, the direct and indirect economic impact can be significant. Based on the 10 reported previous occurrences and potential exposure for the hazard, the potential severity of impact of droughts is "Limited" with less than 10 percent of property destroyed or revenue lost, and has resulted in no injuries or fatalities. Annualized loss over the 22-year reporting period in GBRA ten county planning area is $0. Annualized losses directly incurred by the GBRA would be approximately $68,250.[8] The GBRA elevated response cost is only counted once per drought event month, for each county impacted.

Table 6-8. GBRA Historic Drought Event Summary and Direct Annualized Losses, 1996-2017

ESTIMATED COST PER EVENT	NUMBER OF EVENTS	TOTAL GBRA COSTS (2017 DOLLARS)	ANNUALIZED LOSS ESTIMATE (2017 DOLLARS)
$21,148	71	$1,501,508	$68,250[9]

Assessment of Impacts

Drought is frequently associated with a variety of impacts. The GBRA planning area may suffer long term economic losses during extended periods of drought.

The direct impacts to the GBRA facilities and services may include:

- Diminished water quality, lower customer satisfaction;
- Diminished capacity, inability to provide meet the water needs to residents;
- Lower water quality;

[8] GBRA loss estimates were developed as an average cost per elevated response per year, per county, unless specific event damages were reported.

[9] GBRA loss estimates were developed as an average cost per elevated response per year, per county, unless specific event damages were reported.

- Hydroelectric power generation facilities and infrastructure would have significantly diminished generation capability. Dams simply cannot produce as much electricity from low water levels as they can from high water levels;
- Decreased revenue;
- Elevated response level with increased labor and maintenance costs.

Impacts to counties in the planning area that could indirectly impact GBRA:

- The number of health-related low-flow issues (e.g., diminished sewage flows, increased pollution concentrations, reduced firefighting capacity, cross-connection contamination) will increase as the drought intensifies.
- Public safety from forest/range/wildfires will increase as water availability and/or pressure decreases.
- Respiratory ailments may increase as the air quality decreases.
- There may be an increase in disease due to wildlife concentrations (e.g., rabies, Rocky Mountain spotted fever, Lyme disease).
- Jurisdictions and residents may disagree over water use/water rights, creating conflict.
- Political conflicts may increase between municipalities, counties, states, and regions.
- Water management conflicts may arise between competing interests.
- Increased law enforcement activities may be required to enforce water restrictions.
- Severe water shortages could result in inadequate supply for human needs as well as lower quality of water for consumption.
- Firefighters may have limited water resources to aid in firefighting and suppression activities, increasing risk to lives and property.
- During drought there is an increased risk for wildfires and dust storms.
- The community may need increased operational costs to enforce water restriction or rationing.
- Prolonged drought can lead to increases in illness and disease related to drought.
- Utility providers can see decreases in revenue as water supplies diminish.
- Utilities providers may cut back energy generation and service to their customers to prioritize critical service needs.
- Fish and wildlife food and habitat will be reduced or degraded over time during a drought and disease will increase, especially for aquatic life.
- Wildlife will move to more sustainable locations creating higher concentrations of wildlife in smaller areas, increasing vulnerability and further depleting limited natural resources.
- Severe and prolonged drought can result in the reduction of a species.
- Plant life will suffer from long-term drought. Wind and erosion will also pose a threat to plant life as soil quality will decline.
- Dry and dead vegetation will increase the risk of wildfire.
- Land subsidence threat increases as groundwater is depleted.
- Recreational activities that rely on water may be curtailed, such as hunting and fishing, resulting in fewer tourists and lower revenue.
- Drought poses a significant risk to annual and perennial crop production and overall crop quality leading to higher food costs.
- Drought related declines in production may lead to an increase in unemployment.
- Drought may limit livestock grazing resulting in decreased livestock weight, potential increased livestock mortality, and increased cost for feed.
- Negatively impacted water suppliers may face increased costs resulting from the transport water or develop supplemental water resources.
- Long term drought may negatively impact future economic development.

Section 6: Drought

The overall extent of damages caused by periods of drought is dependent on its extent and duration. The level of preparedness and pre-event planning done by the GBRA in coordination with local government, businesses, and citizens will contribute to the overall economic and financial conditions throughout a drought.

SECTION 7: LIGHTNING

Hazard Description

Lightning is a discharge of electrical energy resulting from the buildup of positive and negative charges within a thunderstorm, creating a “bolt” when the buildup of charges becomes strong enough. This flash of light usually occurs within the clouds or between the clouds and the ground. A bolt of lightning can reach temperatures approaching 50,000 degrees Fahrenheit. Lightning rapidly heats the sky as it flashes but the surrounding air cools following the bolt. This rapid heating and cooling of the surrounding air causes the thunder which often accompanies lightning strikes. While most often affiliated with severe thunderstorms, lightning often strikes outside of heavy rain and might occur as far as 10 miles away from any rainfall.

According to Federal Emergency Management Agency (FEMA), an average of 300 people are injured and 80 people are killed in the United States each year by lightning. Direct lightning strikes also have the ability to cause significant damage to buildings, critical facilities, and infrastructure. Lightning is also responsible for igniting wildfires that can result in widespread damages to property before firefighters have the ability to contain and suppress the resultant fire.

Location

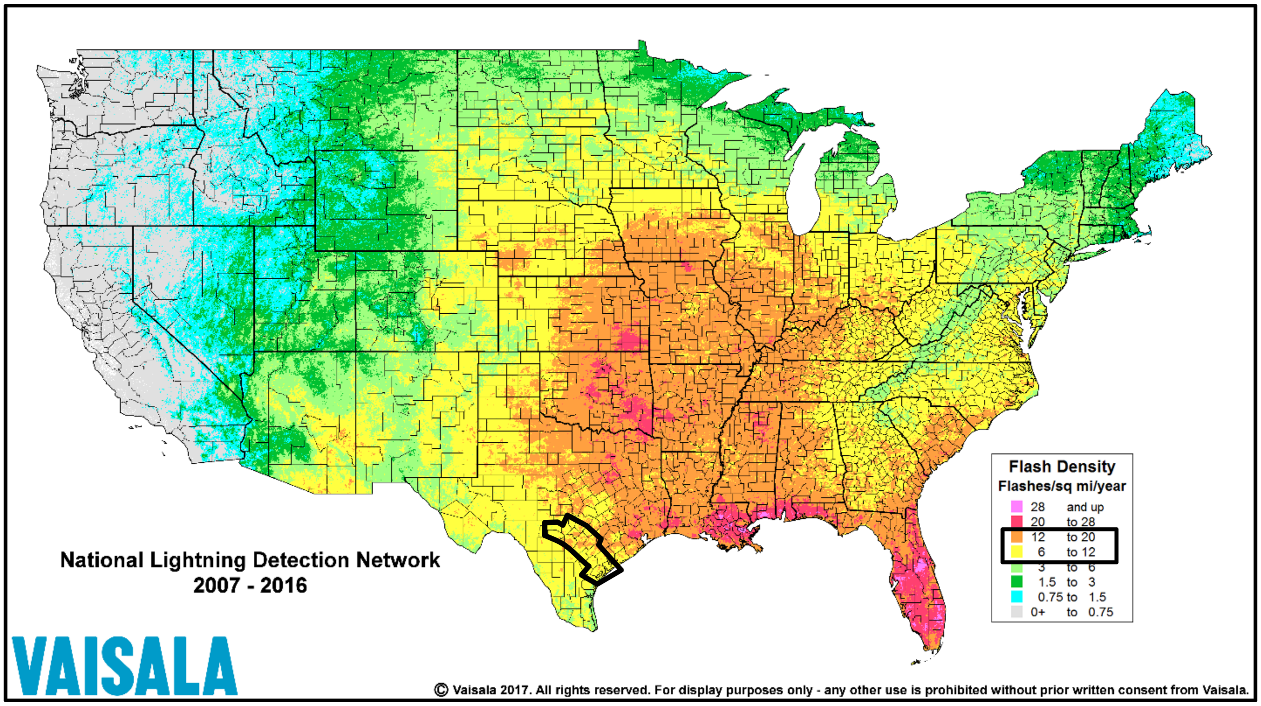
Lightning can strike in any geographic location and is considered a common occurrence in Texas. The GBRA planning area is located in a region of the country that is moderately susceptible to lightning strike. Therefore, lightning could occur at any location within the entire planning area. It is assumed that the entire GBRA planning area is uniformly exposed to the threat of lightning.

Extent

According to the NOAA, the average number of cloud-to-ground flashes for the State of Texas between 2007 and 2016 was 11.3 flashes per square mile. Vaisala’s U.S. National Lightning Detection Network lightning flash density map (Figure 7-1) shows a range of 6 to 20 cloud-to-ground lightning flashes per square mile per year for the entire GBRA planning area. This rate equates to an average of approximately 41,760 to 139,200 flashes per year for the entire ten county planning area.

Section 7: Lightning

Figure 7-1. Lightning Flash Density, 2007-2016[1]



The extent for lightning can be expressed in terms of the number of strikes in an interval. NOAA utilizes lightning activity levels (LALs) on a scale from 1□6. LAL rankings reflect the frequency of cloud□to□ground lightning either forecast or observed (Table 7-1).

Table 7-1. NOAA Lightning Activity Levels (LAL)

LAL	CLOUD & STORM DEVELOPMENT	LIGHTNING STRIKES/ 15 MIN
1	No thunderstorms.	-
2	Cumulus clouds are common but only a few reach the towering cumulus stage. A single thunderstorm must be confirmed in the observation area. The clouds produce mainly virga, but light rain will occasionally reach the ground. Lightning is very infrequent.	1-8
3	Towering cumulus covers less than two-tenths of the sky. Thunderstorms are few, but two to three must occur within the observation area. Light to moderate rain will reach the ground, and lightning is infrequent.	9-15
4	Towering cumulus covers two to three-tenths of the sky. Thunderstorms are scattered and more than three must occur within the observation area. Moderate rain is common and lightning is frequent.	16-25

[1] GBRA is indicated by the black outline.

LAL	CLOUD & STORM DEVELOPMENT	LIGHTNING STRIKES/ 15 MIN
5	Towering cumulus and thunderstorms are numerous. They cover more than three-tenths and occasionally obscure the sky. Rain is moderate to heavy and lightning is frequent and intense.	>25
6	Similar to LAL 3 except thunderstorms are dry.	

The NCEI does not include the LAL for historical lightning events, therefore in order to determine the extent of lightning strikes, the yearly average range of estimated number of lightning strikes within the planning area (41,760 to 139,200 flashes) and a cloud-to-ground flash density of 6 to 20 per square mile, were divided by the average number[2] of thunderstorm events that occur annually in the planning area. The GBRA planning area should expect an average range of 4 to 13 lightning strikes within 15 minutes at any given time during a lightning or combined lightning and thunderstorm event, indicating lightning strikes have an average LAL range of 2 to 3.

Historical Occurrences

Table 7-2 depicts a summary of historical occurrences of lightning for the GBRA planning area by county with associated damages according to the National Centers for Environmental Information (NCEI) data.[3] Since January 1999, 20 recorded lightning events are known to have impacted the GBRA planning area, based upon NCEI records.

The NCEI is a national data source organized under the National Oceanic and Atmospheric Administration (NOAA) and is the largest archive available for climate data. It is important to note that only incidents reported to the NCEI have been factored into this risk assessment. Damage estimates provided in a table for losses have been modified to reflect the damage in 2017 dollars.

With limited reported incidents in the planning area, the team also utilized the most current lightning flash density estimate in the risk assessment for future probability.

Table 7-2. Historical Lightning Events Summary, 1999-2017

COUNTY	NUMBER OF EVENTS	FATALITIES	INJURIES	PROPERTY DAMAGE (2017)
Caldwell County	1	0	0	$10,470
Calhoun County	2	1	1	$17,451
Comal County	1	0	8	$0
DeWitt County	1	0	0	$22,969
Gonzales County	1	0	6	$0
Guadalupe County	2	0	0	$123,830

[2] Analysis includes the highest number of events recorded in a given year during the reporting period in order to account for typical under reporting of thunderstorm and lightning events

[3] Comprehensive list of historical events available upon request.

COUNTY	NUMBER OF EVENTS	FATALITIES	INJURIES	PROPERTY DAMAGE (2017)
Hays County	5	0	0	$190,514
Kendall County	0	0	0	$0
Refugio County	1	0	0	$2,552
Victoria County	6	0	0	$50,731
GBRA PLANNING AREA LOSSES	**20**	**1**	**15**	**$418,517**

Table 7-3. Estimated GBRA Response, Recovery and Restoration Damages, 1999-2017

ESTIMATED COST PER EVENT[4]	NUMBER OF EVENTS	TOTAL GBRA COSTS
$22,117	242	$5,352,314

Based on the list of historical lightning events for the GBRA planning area (listed above), 12 of the events have occurred since the 2011 Plan.

Significant Past Events

September 25, 1999 – GBRA Planning area – Gonzales County
In Gonzales, lightning struck a tree near where a crowd of people had gathered. Several people in the group were injured by the strike, including a 12-year old girl who was standing under the tree. The girl was knocked unconscious, and was taken to a local hospital where she was listed in critical condition with severe burns. She later recovered.

May 31, 2004 – GBRA Planning area – Comal County
Eight people were riding tubes down the Guadalupe River when large hail began falling. They exited the river and were trying to avoid the hail by hiding under a tree when lightning struck. The most seriously injured of the group was leaning against the tree trunk. He suffered a heart stoppage but was resuscitated. Another victim was reported to have suffered a spinal injury. All later recovered.

July 18, 2009 – GBRA Planning area - Guadalupe County
A late afternoon thunderstorm tracked over Cibolo. Lightning struck a house and caused a fire, causing significant damage to the residence. Another storm in Val Verde County produced damaging winds. Lightning struck a house and caused significant damage due to a resulting fire.

May 15, 2010 – GBRA Planning area – Hays County
A cold front moved into South Central Texas and stalled. This lead to the development of two mesoscale convective systems which produced severe thunderstorms, lightning and flash flooding. The Austin American Statesman reported that a house in Hays County caught fire as a result of a lightning strike. The house was destroyed.

[4] Estimated cost per event represents the average cost of response, recovery and restoration per county event.

March 9, 2016 – GBRA Planning area – Refugio County
Severe thunderstorms impacted the coastal counties of South Texas around daybreak, with the storms producing damaging straight-line winds. In the City of Refugio, lightning struck a 200 barrel oil storage tank on North Swift Street creating a large oil fire. Multiple emergency vehicles were required to contain the fire.

Probability of Future Events

Based on historical records, the U.S. National Lightning Detection Network, and input from the planning team, the probability of occurrence for future lightning events in the GBRA planning area, is considered highly likely, or an event probable in the next year. According to NOAA, the GBRA planning area is located in a part of the country that experiences 6 to 20 lightning flashes per square mile per year (approximately 41,760 to 139,200 flashes per year over the ten-county planning area). Given this estimated frequency of occurrence, it can be expected that future lightning events will continue to threaten life and cause minor property damages throughout the planning area.

Vulnerability and Impact

Vulnerability is difficult to evaluate since lightning events can occur at different strength levels, in random locations, and can create a broad range of damages depending on the strike location. Due to the randomness of these events, all existing and future structures, facilities, and assets in the GBRA planning area could potentially be impacted and remain vulnerable to possible injury and property loss from lightning strikes.

The direct and indirect losses associated with these events include injury and loss of life, damage to structures and infrastructure, utility failure (power outages), revenue losses, and stress on community resources. The entire GBRA planning area is considered exposed to the hazard of lightning. The peak lightning season in the State of Texas is from June to August; however, the most fatalities occur in July. Fatalities occur most often when people are outdoors and/or participating in some form of recreation. Employees working outdoors part or full time are considered at risk and more vulnerable to a lightning strike compared to employees inside a structure. Moving to a lower risk location will decrease a person's vulnerability.

The entire general building stock and all infrastructure of the GBRA planning area are considered exposed to the lightning hazard. Lightning can be responsible for damages to buildings; cause electrical, forest and/or wildfires; and damage infrastructure such as lift stations and communication towers.

Table 7-4 includes includes the total GBRA assets at risk by county.[5]

Table 7-4. GBRA Assets at Risk[6]

COUNTY	EMPLOYEES	ASSETS	MARKET VALUE	ACREAGE
Caldwell County	0	2 Structures, Acreage	$2,238,594	281

[5] GBRA assets include land and improvements including buildings, power substations, dams, radio tower sites, gas storage facilities, electric generating complexes, and support infrastructure.
[6] Source: County Central Appraisal Districts

COUNTY	EMPLOYEES	ASSETS	MARKET VALUE	ACREAGE
Calhoun County	0	Acreage	$610,370	620
Comal County	0	6 Structures, Meter Station, Acreage	$6,686,026	61
DeWitt County	0	2 Structures, Infrastructure	$5,785,030	44
Gonzales County	0	10 Structures, Infrastructure, Acreage	$1,154,710	46
Guadalupe County	174	15 Structures, Lift Station,17 Substations, Infrastructure, Acreage	$64,993,426	199
Hays County	0	Acreage	$35,800	3
Kendall County	0	1 Structure, Acreage	$60,010	1
Refugio County	0	Acreage	$13,360	10
Victoria County	0	Infrastructure	$510,180	0
GBRA Total	**174**	**36 Structures, 17 Substations, Lift Station, Meter Stations, Infrastructure, Acreage**	**$82,087,506**	**1,265**

The GBRA elevates the response level for lightning events, resulting in increases in labor and maintenance costs. The GBRA employees typically engaged in outdoor work-related tasks could be at an elevated risk during lightning events, including approximately 70 employees (40% of the total work force).

A lightning event can also result in damage to the hydroelectric plants, resulting in repair costs and lost revenue. Impact of lightning experienced in the GBRA planning area has resulted in 15 injuries and 1 fatality (none directly related to the GBRA facilities or employees). Impact of lightning events experienced in the GBRA planning area would result in "Limited" damages and facilities would be shut down for 24 hours or less. GBRA direct response and repair costs as a result of lightning events are estimated at $442,340, having an approximate annual loss estimate of $20,106 (Table 7-6).

Table 7-5. Potential Annualized Losses for GBRA Planning Area

COUNTY	NUMBER OF EVENTS	PROPERTY LOSS (2017 DOLLARS)	ANNUAL LOSS ESTIMATES (2017 DOLLARS)
Caldwell County	1	$10,470	$476
Calhoun County	2	$17,451	$793
Comal County	1	$0	$0
DeWitt County	1	$22,969	$1,044
Gonzales County	1	$0	$0

COUNTY	NUMBER OF EVENTS	PROPERTY LOSS (2017 DOLLARS)	ANNUAL LOSS ESTIMATES (2017 DOLLARS)
Guadalupe County	2	$123,830	$5,629
Hays County	5	$190,514	$8,660
Kendall County	0	$0	$0
Refugio County	1	$2,552	$116
Victoria County	6	$50,731	$2,306
GBRA Planning Area Losses	**20**	**$418,517**	**$19,024**

Table 7-6. GBRA Historic Lightning Event Summary and Direct Annualized Losses, 1996-2017

ESTIMATED COST PER EVENT[7]	NUMBER OF EVENTS[8]	TOTAL GBRA COSTS	AVERAGE ANNUALIZED LOSS
$22,117	20	$442,340	$20,106

Assessment of Impacts

Lightning events have the potential to pose a significant risk to people, and can create dangerous and difficult situations for public health and safety officials.

The direct impacts to the GBRA facilities and services may include:

- Injury to vulnerable employees;
- Extensive power outages;
- Damaged structures and infrastructure;
- Employees unable to report for duty;
- Damages to hydroelectric capabilities;
- Inadequate staffing for repair work;
- Decreased revenue;
- Dissatisfied customers.

Impacts to counties in the planning area that could indirectly impact GBRA:

- Lightning events could impact recreational water activities, placing boaters and campers in imminent danger, potentially requiring emergency services or lake evacuation.
- Individuals exposed to the storm can be directly struck, posing significant health risks and potential death.
- Structures can be damaged or crushed by falling trees damaged by lightning, which can result in physical harm to the occupants.

[7] GBRA loss estimates were developed as an average cost per elevated response per year, per county, unless specific event damages were reported.
[8] Analysis includes the highest number of events recorded in a given year during the reporting period in order to account for typical under reporting of thunderstorm/lightning events.

- Lightning strikes can result in widespread power outages, increasing the risk to more vulnerable portions of the population who rely on power for health and/or life safety.
- Extended power outages often result in an increase in structure fires and carbon monoxide poisoning, as individuals attempt to cook or heat their homes with alternate, unsafe cooking or heating devices, such as grills.
- Lightning strikes can be associated with structure fires and wildfires, creating additional risk to residents and first responders.
- Emergency operations and services may be significantly impacted due to power outages and/or loss of communications.
- City or county departments may be damaged, delaying response and recovery efforts for the entire community.
- Economic disruption due to power outages and fires negatively impacts the programs and services provided by the community due to short and long-term loss in revenue.
- Some businesses not directly damaged by lightning events may be negatively impacted while utilities are being restored, further slowing economic recovery.
- Businesses that are more reliant on utility infrastructure than others may suffer greater damages without a backup power source.

The economic and financial impacts of lightning will depend entirely on the scale of the event, what is damaged, and how quickly repairs to critical components of the economy can be implemented. The level of preparedness and pre-event planning conducted by the GBRA in coordination with local government, businesses, and citizens will contribute to the overall economic and financial conditions in the aftermath of any lightning event.

SECTION 8: HURRICANE

Hazard Description

According to the National Oceanic and Atmospheric Administration (NOAA), a hurricane is an intense tropical weather system of strong thunderstorms with well-defined surface circulation and maximum sustained winds of 74 mph or higher. In the Northern Hemisphere circulation of winds near the Earth's surface is counterclockwise.

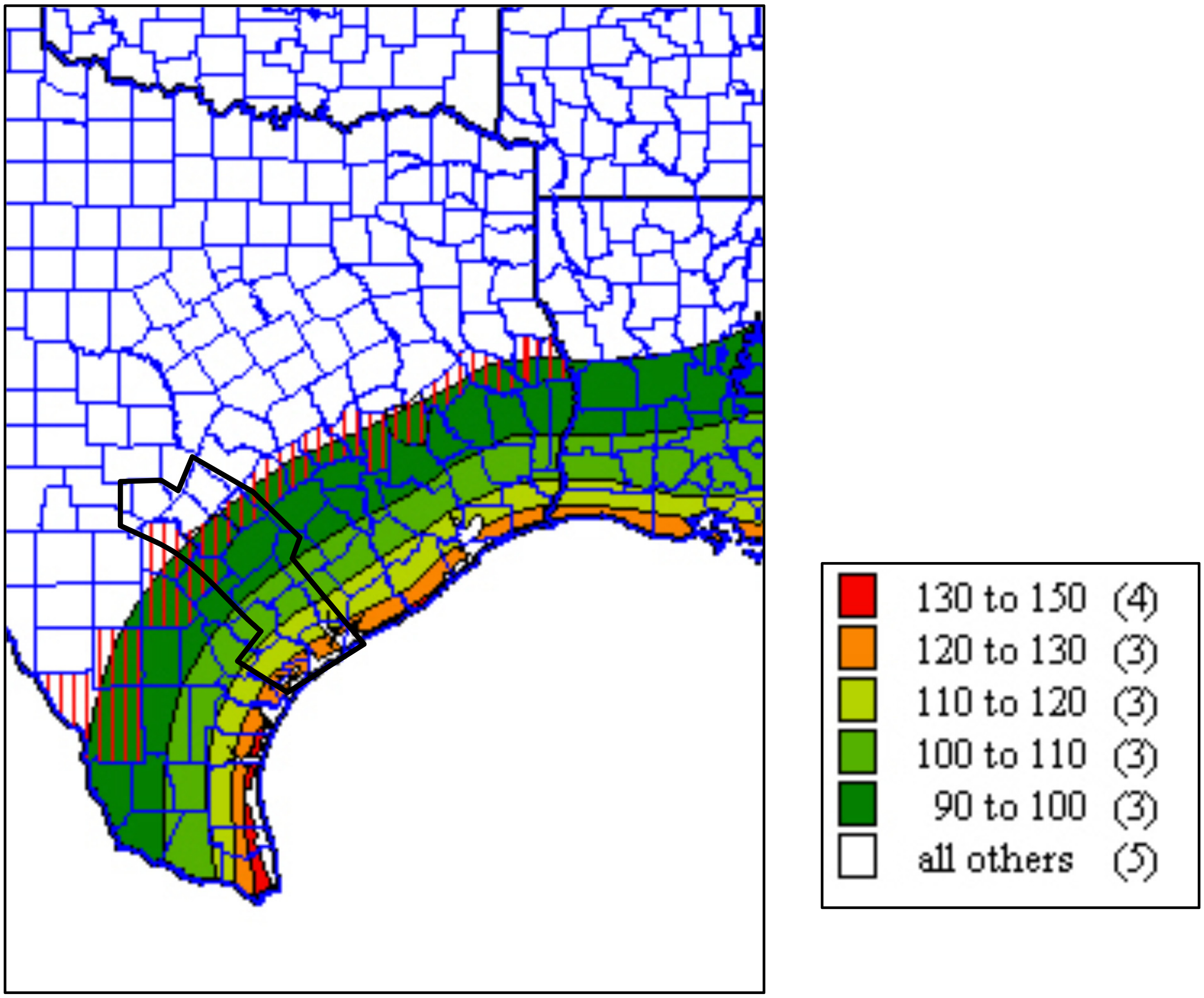
Hurricanes often begin as tropical depressions that intensify into tropical storms when maximum sustained winds increase to between 35 – 64 knots (39 – 73 mph). At these wind speeds, the storm becomes more organized and circular in shape and begins to resemble a hurricane. Tropical storms resulting in high winds and heavy rainfall can be equally problematic without ever becoming a hurricane and can be dangerous to people and property, resulting in high winds and heavy rainfall. Once sustained winds reach or exceed 74 mph, the storm becomes a hurricane. The intensity of a land falling hurricane is expressed in categories relating wind speeds to potential damage. Tropical storm-force winds are strong enough to be dangerous to those caught in them.

Location

The GBRA planning area covers ten counties including both coastal and inland area. Calhoun and Refugio Counties are located on the Gulf Coast and are vulnerable to threats directly and indirectly related to a hurricane event, such as high-force winds, storm surge, flooding, and coastal erosion. Victoria, DeWitt, Gonzales, Guadalupe and Caldwell Counties are all located in lower risk regions with the potential for hurricane winds between 90 and 120 mph. While these areas may suffer potential damaging hurricane winds, the most significant and statistical probable threat lies in with the coastal counties. The remaining counties are located inland from the coast and are outside of the hurricane wind speed hazard areas. These areas are susceptible to the indirect threats of a hurricane, including high winds and flooding. Hurricanes and/or tropical storms can impact high risk counties from June to

November, the official Atlantic U.S. hurricane season. The GBRA planning area is partially located in a moderate to high risk area for hurricane wind speeds of 95 to 130 miles per hour (mph) as shown in Figure 8-1.

Figure 8-1. Location of Hurricane Wind Zones[1]



Extent

As a hurricane develops, the barometric pressure (measured in millibars or inches) at its center falls and winds increase. If the atmospheric and oceanic conditions are favorable, it can intensify into a tropical depression. When maximum sustained winds reach or exceed 39 miles per hour, the system is designated a tropical storm, given a name, and is closely monitored by the National

[1] Source: American Society of Civil Engineers (ASCE); the black rectangle indicates the GBRA planning area.

Hurricane Center in Miami, Florida. When sustained winds reach or exceed 74 miles per hour the storm is deemed a hurricane.

Hurricanes are categorized according to the strength and intensity of their winds using the Saffir-Simpson Hurricane Scale (Table 8-1). A Category 1 storm has the lowest wind speeds, while a Category 5 hurricane has the highest. However, a lower category storm can inflict greater damage than higher category storms depending on where they strike, the amount of storm surge, other weather with which they may interact, and how slow they move.

Table 8-1. Extent Scale for Hurricanes[2]

CATEGORY	MAXIMUM SUSTAINED WIND SPEED (Mph)	MINIMUM SURFACE PRESSURE (Millibars)	STORM SURGE (Feet)
1	74 – 95	Greater than 980	3 – 5
2	96 – 110	979 – 965	6 – 8
3	111 – 130	964 – 945	9 – 12
4	131 – 155	944 – 920	13 – 18
5	155 +	Less than 920	19+

Based on the historical storm tracks for hurricanes and the location of the GBRA planning area, the average extent to be mitigated is for a Category 2 storm for the planning area. The strongest historical event recorded for the planning area was a Category 4 Hurricane which made landfall in Calhoun County. The maximum extent to be mitigated in the future for the planning area is a Category 4.

Historical Occurrences

By the time hurricanes and tropical storms have made landfall at various magnitudes (categories) in the GBRA planning area, the storms have usually weakened to tropical storms or depressions, being near the end of their life cycle except in Calhoun and Refugio Counties. With the storms having reduced winds in the majority of the planning area, extreme rainfall is the hazard of concern. In Figures 8-2 through 8-11 below, hurricane tracks are reflective of their strength in the GBRA planning area. Table 8-2 lists a summary of the storms that have tracked through the planning area by county with associated damages where available.[3] Historical hurricane data for the planning area are provided on a County-wide basis per the National Centers for Environmental Information (NCEI), and the National Oceanic and Atmospheric Administration (NOAA). Table 8-3 provides the direct GBRA estimated costs of response and repair per hurricane/tropical storm event.

[2] Source: National Hurricane Center

[3] Comprehensive list of historical events available upon request.

Figure 8-2. Location of Historic Storm Tracks Caldwell County

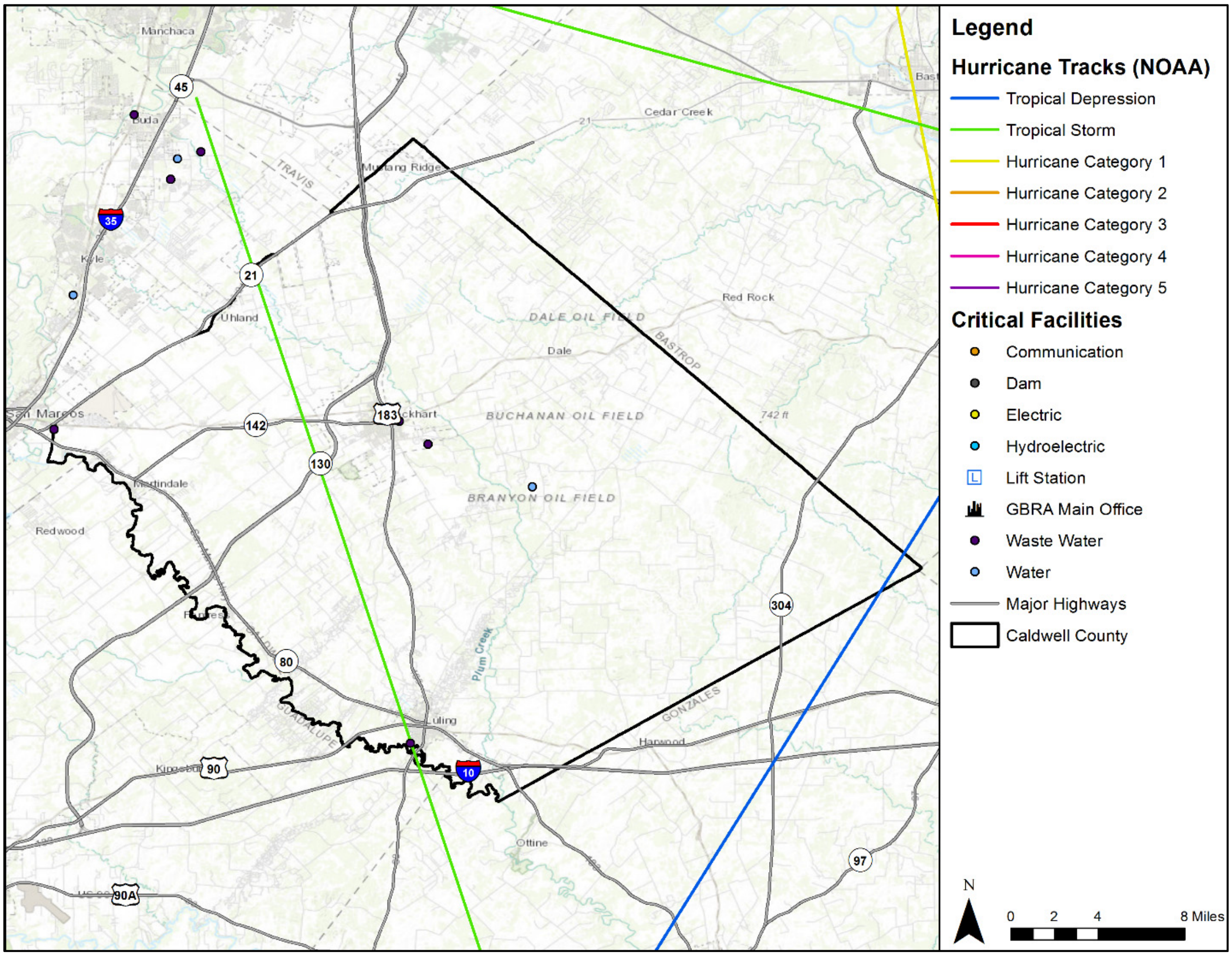


Figure 8-3. Location of Historic Storm Tracks Calhoun County

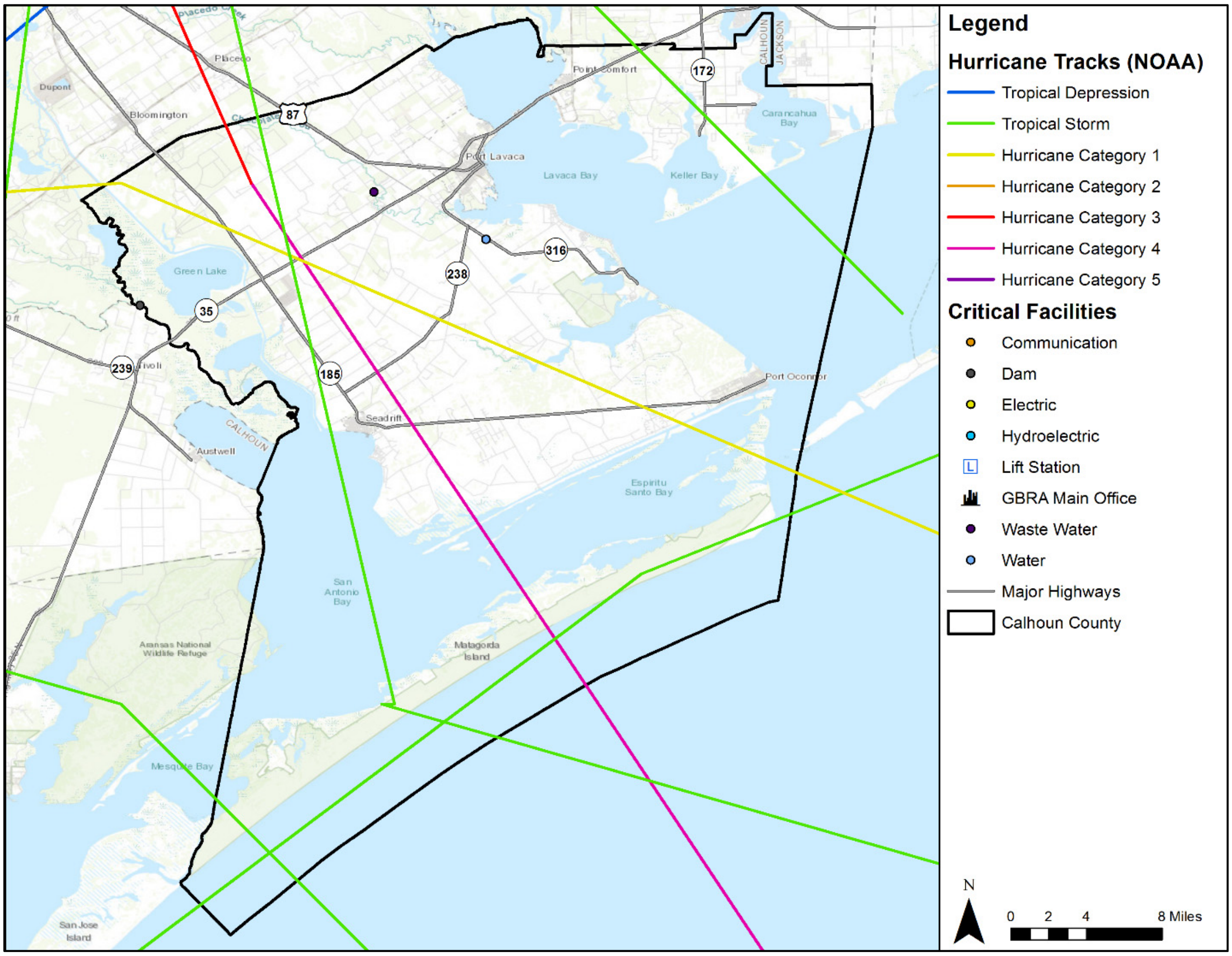


Figure 8-4. Location of Historic Storm Tracks Comal County

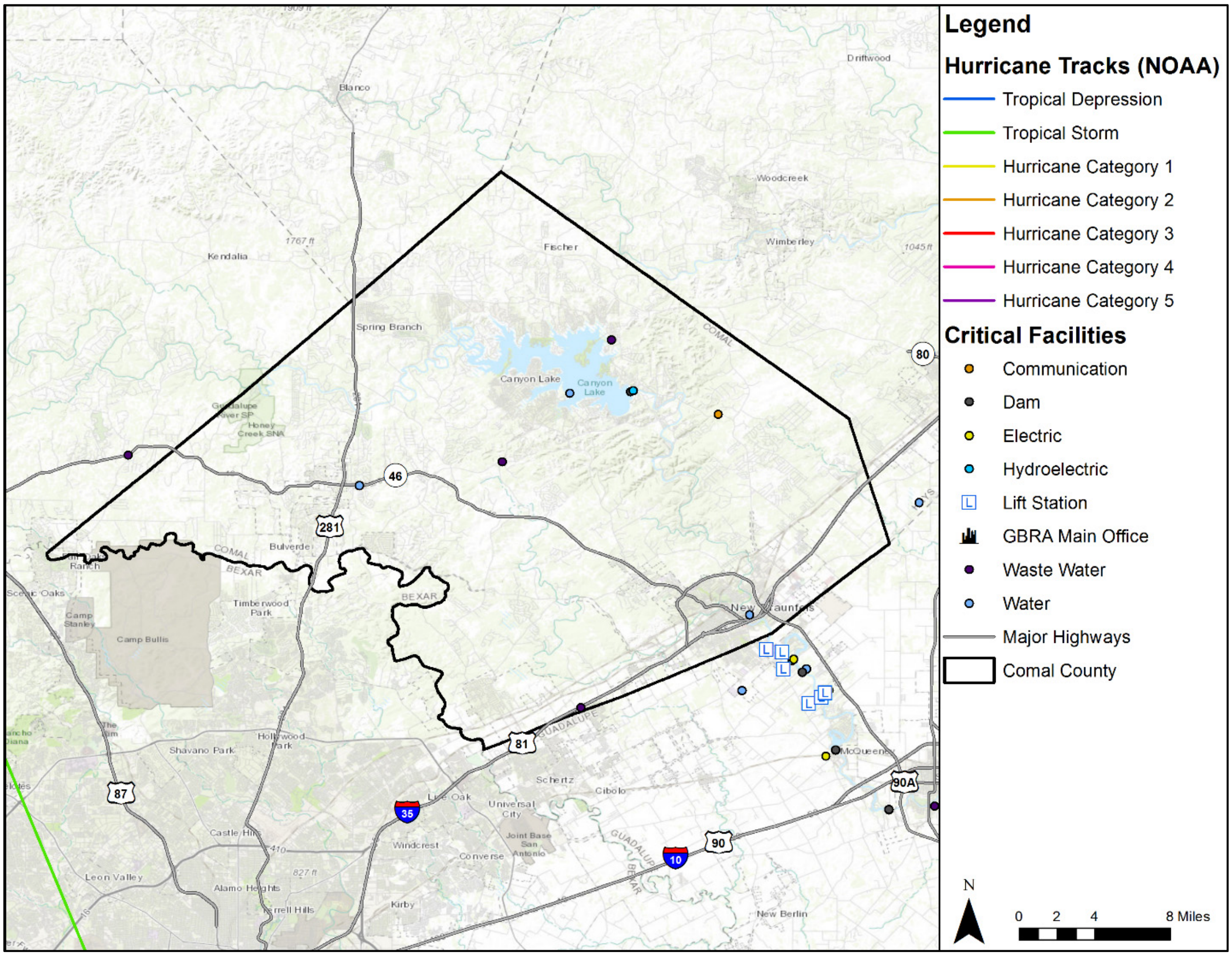


Figure 8-5. Location of Historic Storm Tracks DeWitt County

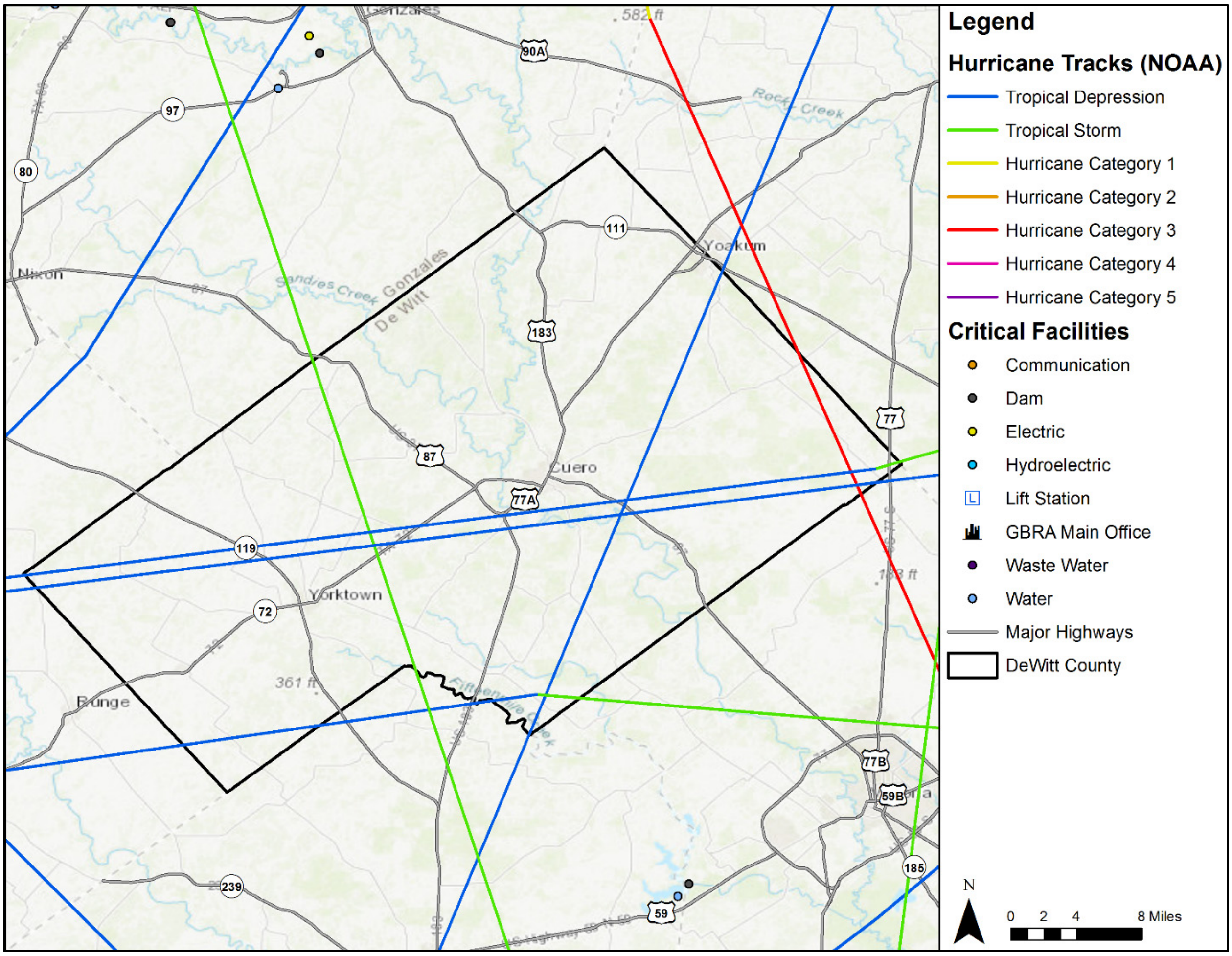


Figure 8-6. Location of Historic Storm Tracks Gonzales County

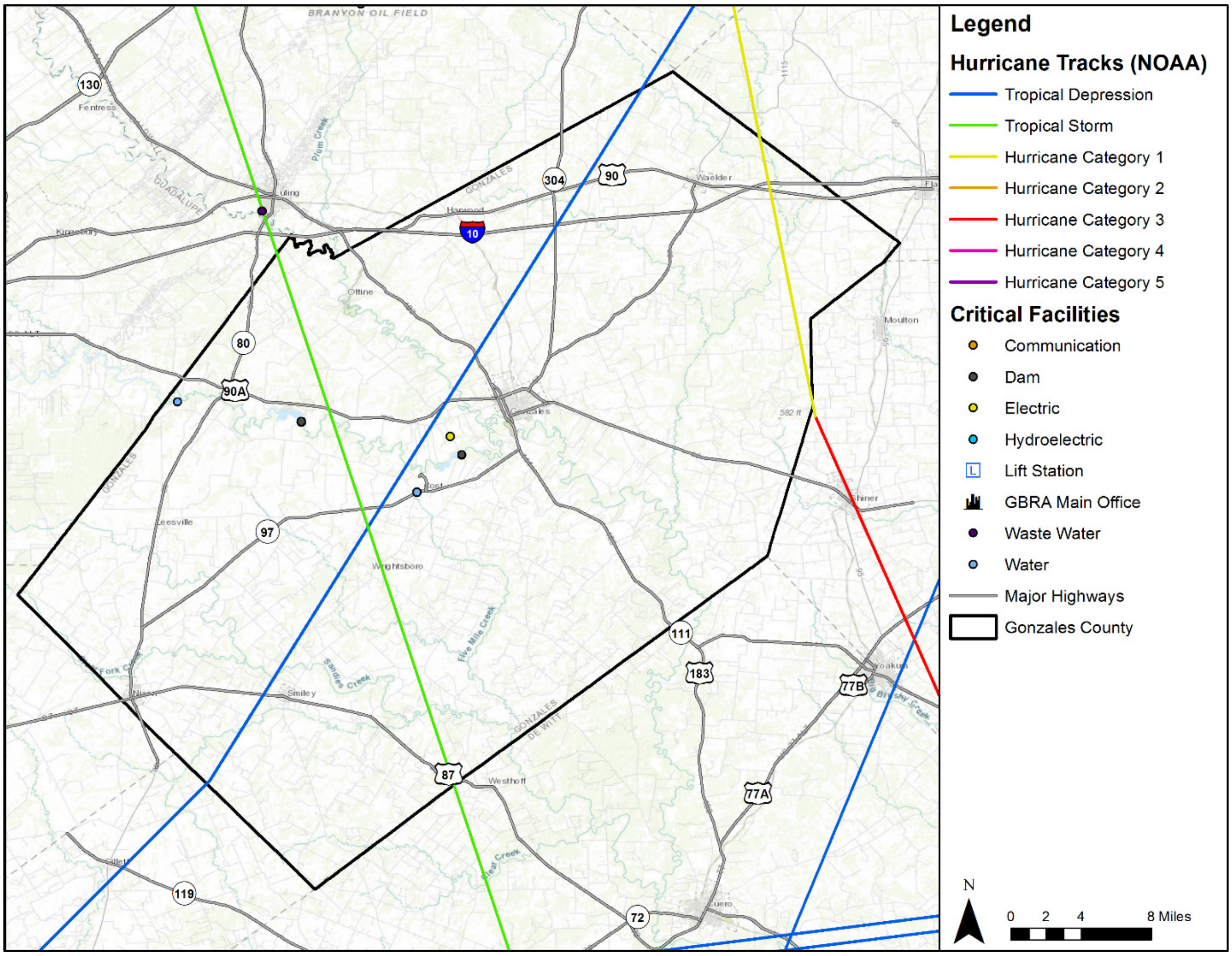


Figure 8-7. Location of Historic Storm Tracks Guadalupe County

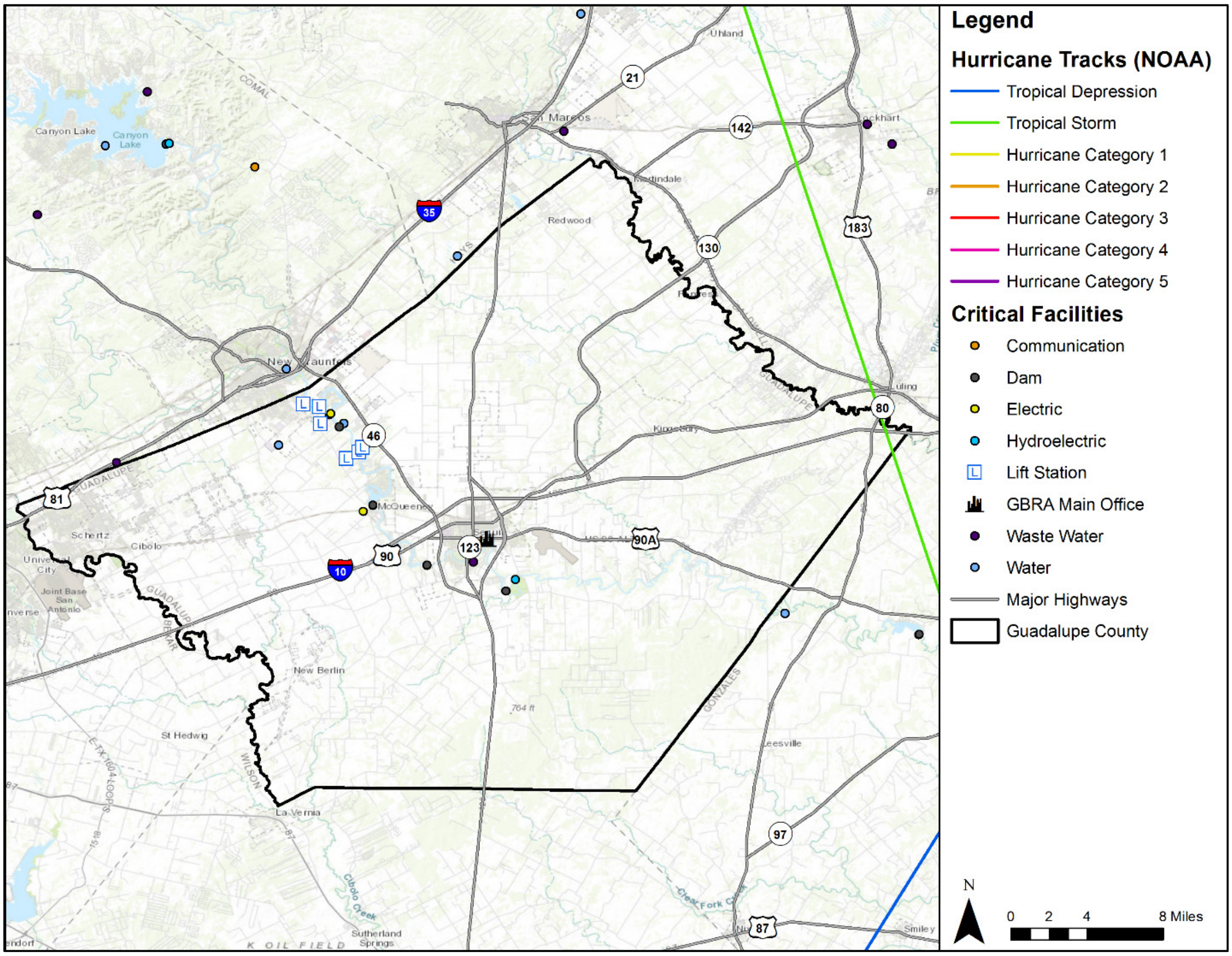


Figure 8-8. Location of Historic Storm Tracks Hays County

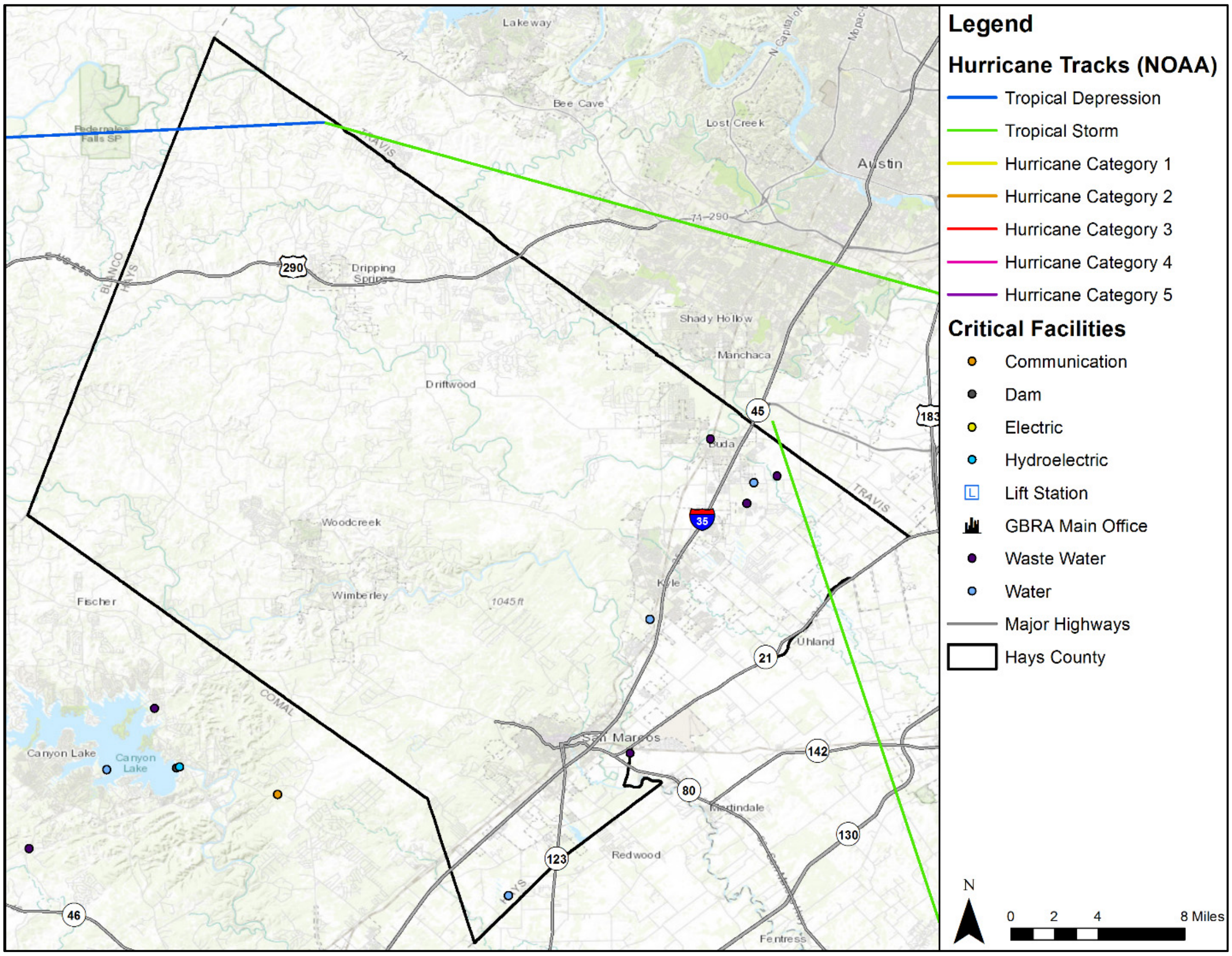


Figure 8-9. Location of Historic Storm Tracks Kendall County

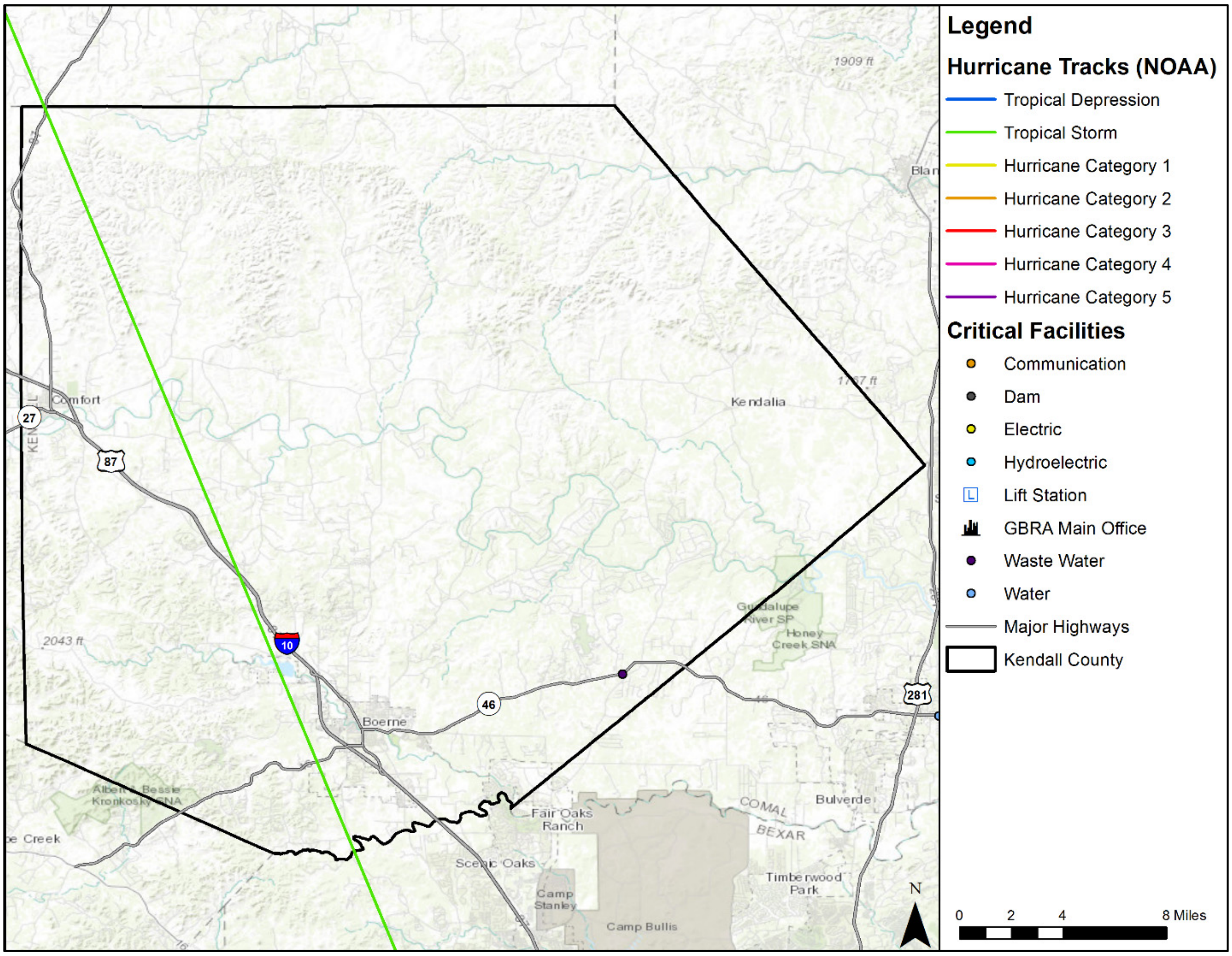


Figure 8-10. Location of Historic Storm Tracks Refugio County

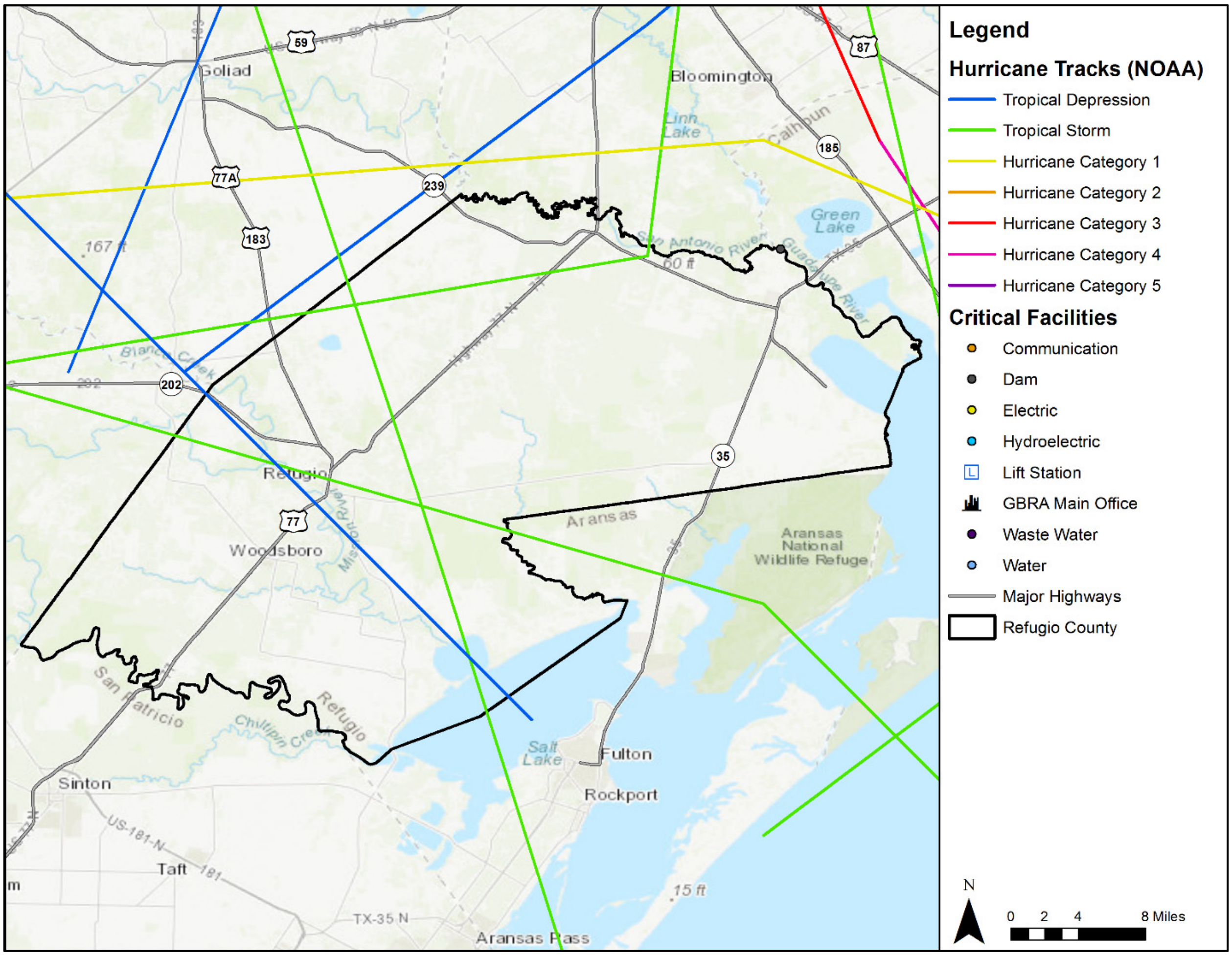


Figure 8-11. Location of Historic Storm Tracks Victoria County

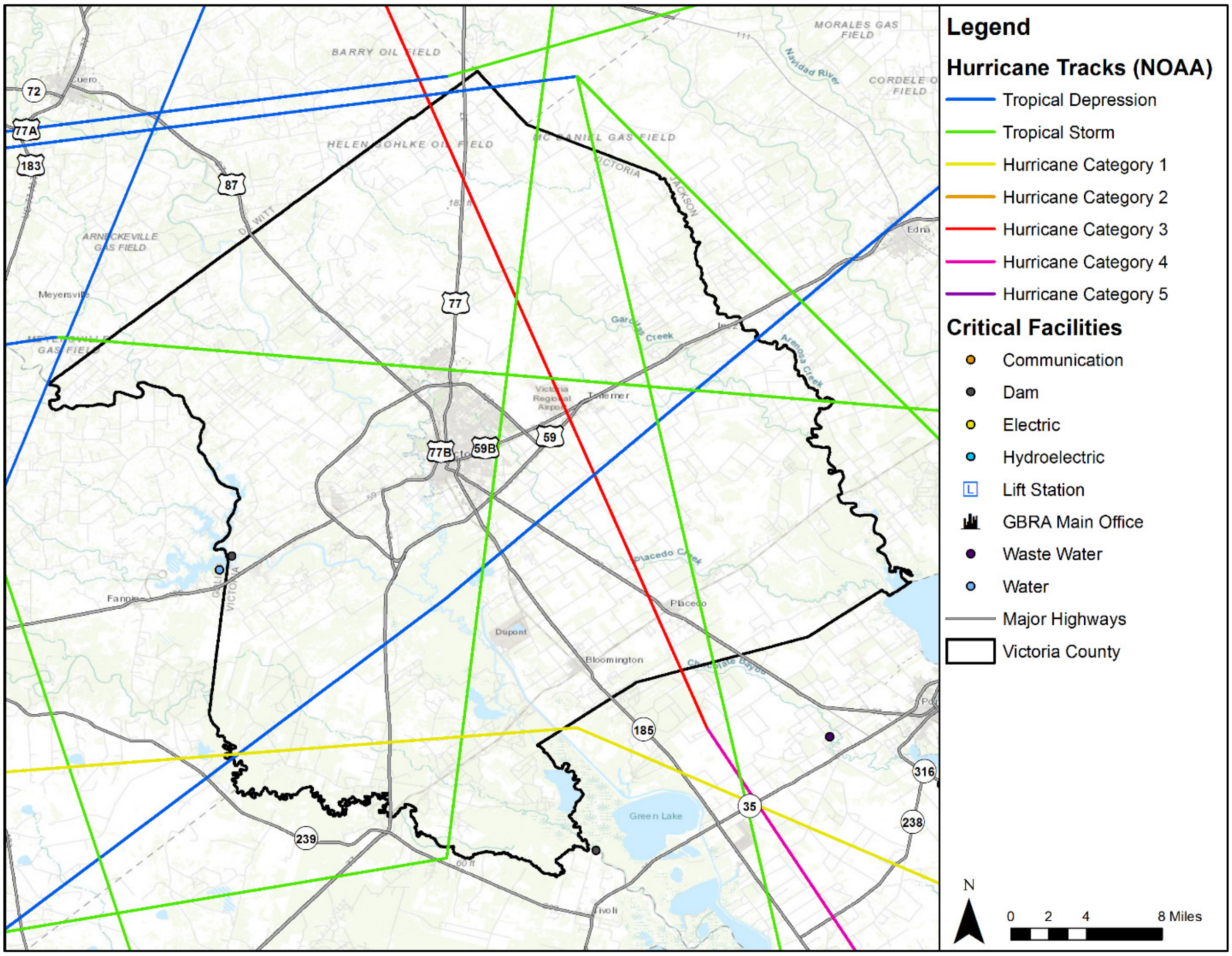


Table 8-2. Historic Storm Events Summary, 1933-2017[4]

COUNTY	NUMBER OF EVENTS	MAGNITUDE (Max Extent)	PROPERTY DAMAGE (2017 DOLLARS)
Caldwell County	4	Tropical Storm	N/A
Calhoun County	11	Category 4	N/A
Comal County	3	Tropical Depression	$467,116
DeWitt County	13	Category 3	N/A
Gonzales County	9	Tropical Storm	N/A
Guadalupe County	3	Tropical Storm	N/A
Hays County	4	Tropical Storm	$1,336,651
Kendall County	5	Category 2	$1,000,000

[4] N/A means data was not available.

COUNTY	NUMBER OF EVENTS	MAGNITUDE (Max Extent)	PROPERTY DAMAGE (2017 DOLLARS)
Refugio County	12	Category 4	$12,850,000
Victoria County	13	Category 3	$100,000

Table 8-3. Estimated GBRA Response, Recovery and Restoration Damages, 1933-2017[5]

ESTIMATED COST PER EVENT[6]	NUMBER OF EVENTS	TOTAL GBRA COSTS
$35,534	38	$1,350,292

Based on the list of historical hurricane events for the GBRA planning area (listed above), 9 of the events have occurred since the 2011 Plan.

Significant Events

Hurricane Claudette, July 15, 2003 – Calhoun, DeWitt, and Refugio Counties
Hurricane Claudette strengthened just prior to making landfall near Port O'Connor. Its outer rain bands moved into South Central Texas through the afternoon Tuesday, July 15. DeWitt County was the first county in South Central Texas to feel the effects of Claudette, then at tropical storm force. Winds struck just after noon, blowing over trees and power poles, and causing minor damage to around 50 homes. Winds were unofficially estimated at between 70 and 80 mph with gusts to near 100 mph.

Hurricane Harvey, August 26-27, 2017 – Caldwell, Comal, Gonzales, Guadalupe, and Hays Counties
Hurricane Harvey moved onshore as a Category 4 hurricane over San Jose Island east of Rockport during the late evening of August 25th. Harvey moved inland entering southern DeWitt County during the morning of August 26th as a Category 1 hurricane. It continued to weaken as it moved farther inland eventually reaching south central Gonzales County as a tropical storm during the late evening of August 26th. The center of the storm made a loop through Gonzales, Karnes, and DeWitt Counties before exiting the County Warning Area during the afternoon of August 27th moving into Victoria County. The maximum sustained winds were 46 mph recorded at Austin Bergstrom International Airport and at two private weather stations, one near Yorktown and the other near Smiley. The maximum recorded wind gusts were 58 mph at New Braunfels Airport, Randolph AFB, and at a private weather station near Smiley. The highest rainfall total was 29.19 inches outside of LaGrange in Fayette County. A number of places in Fayette, Lavaca, and Bastrop Counties received 20 or more inches of rain. Tropical storm force winds with estimated gusts up to 60 mph caused damage across the region. Trees and branches were knocked down by the winds. Some of these in turn knocked down power lines causing power outages in Bastrop, Comal, Hays, and Guadalupe Counties. At one point, 15,000 customers in Comal County were without power. There was also some minor structural damage in Caldwell, Comal, and Lavaca Counties. Maximum rainfall totals in these counties ranged from 4.67 inches in Bexar to 29.19 in Fayette. Flooding and flash flooding forced 608 people to be evacuated

[5] The GBRA was created in 1933. Events prior to that date do not represent direct damages to the GBRA.

[6] Estimated cost per event represents the average cost of elevated response, recovery and restoration per county event unless specific event damages were reported.

from their homes. Most of these, 400, were in Fayette County. Damages for the entire impacted area exceeded $14 million.

Probability of Future Events

Based on historical occurrences of significant hurricane/tropical storm wind events, the GBRA typically experiences hurricane/tropical storm winds every three years in some portions of the planning area. Hence, the likelihood or future probability of a hurricane event in at least some portion of the GBRA planning area is likely.

Vulnerability and Impact

Hurricane-force winds can cause major damage to large areas; hence all existing buildings, facilities and populations are equally exposed and vulnerable to this hazard and could potentially be impacted. Warning time for hurricanes has lengthened due to modern and early warning technology. Hurricane-force winds can easily destroy poorly constructed buildings and mobile homes. Debris such as signs, roofing materials, and small items left outside can become extremely hazardous in hurricanes and tropical storms. Extensive damage to trees, towers, and underground utility lines from uprooted trees and fallen poles can cause considerable damages to GBRA assets as well as causing civic disruption. Older structures may suffer greater damages from hurricane and tropical storm force winds along the coast due to lower elevation of foundations and lower construction standards. While all ten counties in the GBRA planning area are at risk for Hurricane or Tropical Storm force winds, counties closest to the coast are significantly more vulnerable including Calhoun County, Refugio County, and Victoria County.

Table 8-4 includes the total GBRA assets at risk by county.[7]

Table 8-4. GBRA Assets at Risk[8]

COUNTY	EMPLOYEES	ASSETS	MARKET VALUE	ACREAGE
Caldwell County	0	2 Structures, Acreage	$2,238,594	281
Calhoun County	0	Acreage	$610,370	620
Comal County	0	6 Structures, Meter Station, Acreage	$6,686,026	61
DeWitt County	0	2 Structures, Infrastructure	$5,785,030	44
Gonzales County	0	10 Structures, Infrastructure, Acreage	$1,154,710	46
Guadalupe County	174	15 Structures, Lift Station,17 Substations, Infrastructure, Acreage	$64,993,426	199
Hays County	0	Acreage	$35,800	3

[7] GBRA assets include land and improvements including buildings, power substations, dams, radio tower sites, gas storage facilities, electric generating complexes, and support infrastructure.
[8] Source: County Central Appraisal Districts

COUNTY	EMPLOYEES	ASSETS	MARKET VALUE	ACREAGE
Kendall County	0	1 Structure, Acreage	$60,010	1
Refugio County	0	Acreage	$13,360	10
Victoria County	0	Infrastructure	$510,180	0
GBRA Total	**174**	**36 Structures, 17 Substations, Lift Station, Meter Stations, Infrastructure, Acreage**	**$82,087,506**	**1,265**

Only hurricane wind events that have been reported have been factored into this Risk Assessment. It is likely that additional hurricane wind occurrences have gone unreported before and during the recording period. Table 8-5 shows the annualized losses based on historical incident information for the planning area by county. The average annual loss estimate for GBRA planning area is $185,338. GBRA direct response and repair costs as a result of hurricane/tropical storm events are estimated at $1,350,292, having an approximate annual loss estimate of $15,886 (Table 8-6).[9]

Table 8-5. Historic Hurricane Event Summary and Annualized Losses, 1933-2017

COUNTY	NUMBER OF EVENTS	PROPERTY DAMAGE (2017 DOLLARS)	ANNUAL LOSS ESTIMATE (2017 DOLLARS)
Caldwell County	2	N/A	N/A
Calhoun County	8	N/A	N/A
Comal County	1	$467,116	$5,495
DeWitt County	7	N/A	N/A
Gonzales County	3	N/A	N/A
Guadalupe County	1	N/A	N/A
Hays County	2	$1,336,651	$15,725
Kendall County	1	$1,000,000	$11,765
Refugio County	5	$12,850,000	$151,176
Victoria County	8	$100,000	$1,176
GBRA	**38**	**$15,753,767**	**$185,338**

[9] GBRA loss estimates were developed as an average cost per elevated response unless specific event damages were reported.

Table 8-6. GBRA Historic Hurricane Events Summary and Direct Annualized Loss, 1933-2017[10]

ESTIMATED COST PER EVENT[11]	NUMBER OF EVENTS	TOTAL GBRA COSTS	ANNUAL LOSS ESTIMATE (2017 DOLLARS)
$35,534	38	$1,350,292	$15,886

The potential severity of impact from a hurricane for the GBRA planning area is classified as limited, meaning minor quality of life lost, shutdown of critical facilities and services for 24 hours or less, and less than 10 percent of property destroyed or with major damage.

Assessment of Impacts

Hurricane events have the potential to pose a significant risk to people and can create dangerous and difficult situations for public health and safety officials.

The direct impacts to the GBRA facilities and services may include:

- Injury or illness to vulnerable employees;
- Extensive power outages;
- Reduction in water supply capacity;
- Damaged or destroyed structures and infrastructure;
- Employees unable to report for duty;
- Damages to power grid;
- Inadequate staffing for repair work;
- Decreased revenue;
- Dissatisfied customers.

Impacts to counties in the planning area that could indirectly impact GBRA:

- Individuals exposed to the storm can be struck by flying debris, falling limbs, or downed trees causing serious injury or death.
- Structures can be damaged or crushed by falling trees, which can result in physical harm to the occupants.
- Coastal communities may suffer substantial damage, requiring immediate shelter and long-term displacement assistance.
- Damaged bridges could prevent or delay emergency response, strand or prevent entry of tourists, commuters, supply delivery, or goods and services for extended periods.
- Driving conditions in all counties may be dangerous during a hurricane event, elevating the risk of injury and accidents during evacuations if not timed properly.
- Coastal erosion may dramatically prohibit rebuilding and recovery efforts.
- Emergency evacuations may be necessary prior to a hurricane landfall, requiring emergency responders, evacuation routing and temporary shelters.
- Significant debris and downed trees can result in emergency response vehicles being unable to access areas of the community.

[10] The GBRA was created in 1933. Events prior to that date do not represent direct damages to the GBRA.

[11] Estimated cost per event represents the average cost of elevated response, recovery and restoration per county event unless specific event damages were reported.

- Downed power lines may result in roadways being unsafe for use, which may prevent first responders from answering calls for assistance or rescue.
- During hurricane landfall, first responders may be prevented from responding to calls, as the winds may reach a speed in which their vehicles and equipment are unsafe to operate.
- Hurricane events often result in widespread power outages increasing the risk to more vulnerable portions of the population who rely on power for health and/or life safety.
- Extended power outage often results in an increase in structure fires and carbon monoxide poisoning, as individuals attempt to cook or heat their homes with alternate, unsafe cooking or heating devices, such as grills.
- Extreme hurricane events may rupture gas lines and down trees and power lines, increasing the risk of structure fires during and after a storm event.
- Extreme hurricane events may lead to prolonged evacuations during search and rescue, and immediate recovery efforts requiring additional emergency personnel and resources to prevent entry, and protect citizens and property.
- First responders are exposed to downed power lines, unstable and unusual debris, hazardous materials, and generally unsafe conditions.
- Emergency operations and services may be significantly impacted due to damaged facilities and/or loss of communications.
- Critical staff may be unable to report for duty, limiting response capabilities.
- City or county departments may be damaged, delaying response and recovery efforts for the entire community.
- Private sector entities that the City and its residents rely on, such as utility providers, financial institutions, and medical care providers may not be fully operational and may require assistance from neighboring communities until full services can be restored.
- Economic disruption negatively impacts the programs and services provided by the community due to short and long-term loss in revenue.
- Some businesses not directly damaged by the hurricane may be negatively impacted while roads are cleared and utilities are being restored, further slowing economic recovery.
- Older structures built to less stringent building codes may suffer greater damage as they are typically more vulnerable to hurricane damage.
- Large scale hurricanes can have significant economic impact on the affected area, as it must now fund expenses such as infrastructure repair and restoration, temporary services and facilities, overtime pay for responders, as well as normal day-to-day operating expenses.
- Businesses that are more reliant on utility infrastructure than others may suffer greater damages without a backup power source.

The economic and financial impacts of a hurricane on the area will depend entirely on the scale of the event, what is damaged, and how quickly repairs to critical components of the economy can be implemented. The level of preparedness and pre-event planning done by the GBRA in coordination with local government, businesses, and citizens will also contribute to the overall economic and financial conditions in the aftermath of any hurricane event.

SECTION 9: EXTREME HEAT

Hazard Description

Extreme heat is the condition whereby temperatures hover ten degrees or more above the average high temperature in a region for an extended period. Extreme heat during the summer months is a common occurrence throughout the State of Texas, and the GBRA planning area. Severe, excessive summer heat is characterized by a combination of exceptionally high temperatures and humidity. When these conditions persist over a period of time, it is defined as a heat wave. The GBRA typically experiences extended heat waves.

Although heat can damage buildings and facilities, it presents a more significant threat to the safety and welfare of citizens and animals. The major human risks associated with severe summer heat include: heat cramps, sunburn, dehydration, fatigue, heat exhaustion, and even heat stroke. The most vulnerable population to heat casualties are children and the elderly or infirmed, who may live on low fixed incomes and cannot afford to run air-conditioning on a regular basis. This population is sometimes isolated, with no immediate family or friends to look out for their well-being.

Location

Though injuries and deaths from extreme heat have been recorded in the GBRA planning area, there is no specific geographic scope to the extreme heat hazard. Extreme heat could occur in any area of the GBRA planning area.

Extent

The magnitude or intensity of an extreme heat event is measured according to temperature in relation to the percentage of humidity. According to the National Oceanic and Atmospheric Administration (NOAA), this relationship is referred to as the “Heat Index” and is depicted in Figure 9-1. The Heat Index measures how hot it feels outside when humidity is combined with high temperatures.

Figure 9-1. Extent Scale for Extreme Summer Heat[1]

Relative Humidity (%)	Temperatures (°F)	Temperatures (°F)	Temperatures (°F)	Temperatures (°F)
40	80 - 88: CAUTION	90 - 96: EXTREME CAUTION	98 - 106: DANGER	108 - 110: EXTREME DANGER
45	80 - 88: CAUTION	90 - 94: EXTREME CAUTION	96 - 104: DANGER	106 - 110: EXTREME DANGER
50	80 - 86: CAUTION	88 - 94: EXTREME CAUTION	96 - 102: DANGER	104 - 110: EXTREME DANGER
55	80 - 86: CAUTION	88 - 92: EXTREME CAUTION	94 - 100: DANGER	102 - 110: EXTREME DANGER
60	80 - 84: CAUTION	86 - 90: EXTREME CAUTION	92 - 98: DANGER	100 - 110: EXTREME DANGER
65	80 - 84: CAUTION	86 - 90: EXTREME CAUTION	92 - 96: DANGER	98 - 110: EXTREME DANGER
70	80 - 84: CAUTION	86 - 88: EXTREME CAUTION	90 - 94: DANGER	96 - 110: EXTREME DANGER
75	80 - 82: CAUTION	84 - 88: EXTREME CAUTION	90 - 94: DANGER	96 - 110: EXTREME DANGER
80	80 - 82: CAUTION	84 - 86: EXTREME CAUTION	88 - 92: DANGER	94- 110: EXTREME DANGER
85	80 - 82: CAUTION	84 - 86: EXTREME CAUTION	88 - 90: DANGER	92- 110: EXTREME DANGER
90	80: CAUTION	82 - 84: EXTREME CAUTION	86 - 90: DANGER	92- 110: EXTREME DANGER
95	80: CAUTION	82 - 84: EXTREME CAUTION	86 - 88: DANGER	90- 110: EXTREME DANGER
100	80: CAUTION	82 - 84: EXTREME CAUTION	86 - 88: DANGER	90- 110: EXTREME DANGER

**Likelihood of Heat Disorders with
Prolonged Exposure or Strenuous Activity**

The extent scale in Figure 9-1 displays varying degrees of caution depending on the relative humidity combined with the temperature. For example, when the temperature is at 90 degrees Fahrenheit (ºF) or lower, caution should be exercised if the humidity level is at or above 40 percent.

The shaded zones on the chart indicate varying symptoms or disorders that could occur depending on the magnitude or intensity of the event. "Caution," is the first level of intensity where fatigue due to heat exposure is possible. "Extreme Caution" indicates that sunstroke, muscle cramps, or heat exhaustion are possible, and a "Danger" level means that these symptoms are likely. "Extreme Danger" indicates that heat stroke is likely. The National Weather Service (NWS) initiates alerts based on the Heat Index as shown in Table 9-1.

Table 9-1. Heat Index and Warnings[2]

CATEGORY	HEAT INDEX	POSSIBLE HEAT DISORDERS	WARNING
Extreme Danger	130°F and higher	Heat stroke or sun stroke likely.	A heat advisory will be issued to warn that the Heat Index may exceed 105°F.
Danger	105 – 129°F	Sunstroke, muscle cramps, and/or heat exhaustion are likely. Heatstroke possible with prolonged exposure and/or physical activity.	
Extreme Caution	90 – 105°F	Sunstroke, muscle cramps, and/or heat exhaustion possible	An Excessive Heat Warning is issued if the Heat Index is

[1] Source: NOAA
[2] Source: http://www.nws.noaa.gov/om/heat/ww.shtml

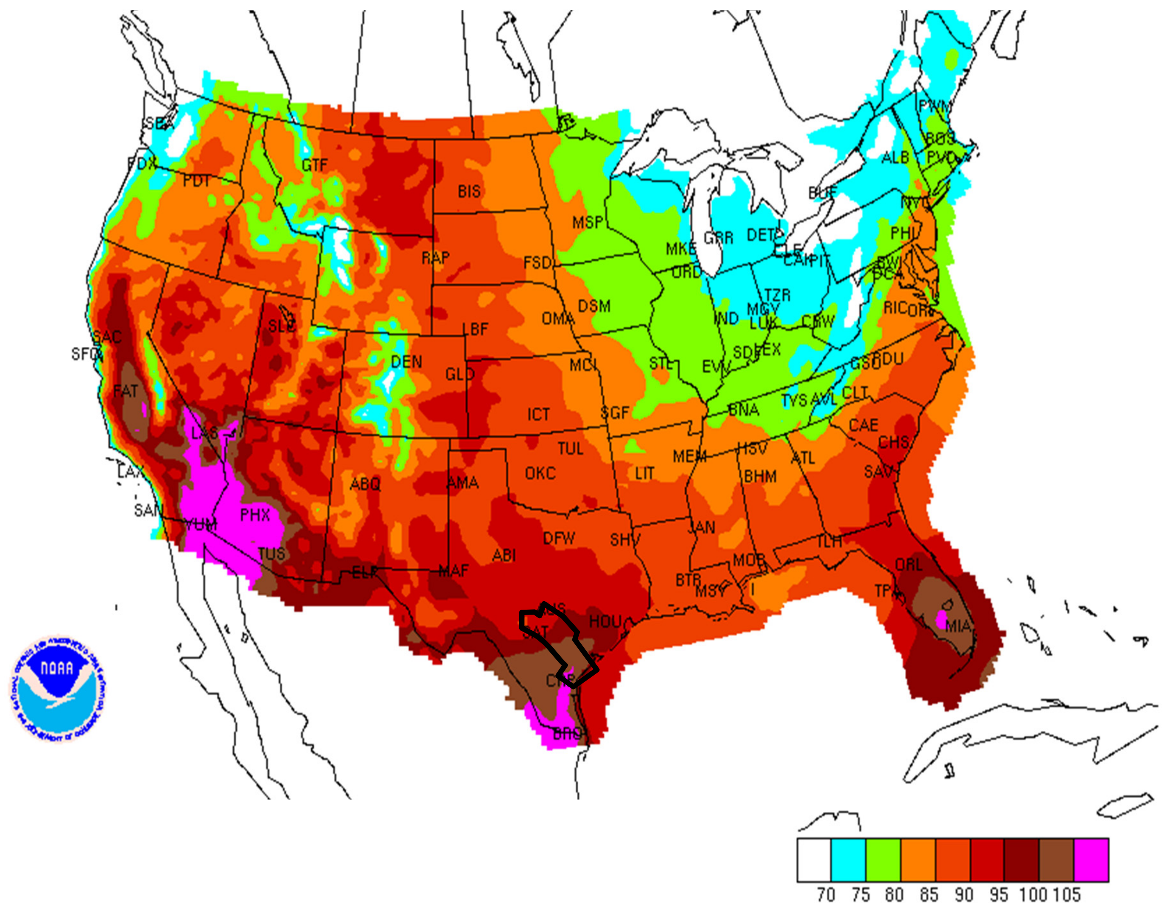
CATEGORY	HEAT INDEX	POSSIBLE HEAT DISORDERS	WARNING
		with prolonged exposure and/or physical activity.	expected to be 105°F or higher for at least 2 days and will not drop below 75°F at night.
Caution	80 – 90°F	Fatigue is possible with prolonged exposure and/or physical activity.	

Due to its multi-county location, some portion of the GBRA planning area can expect an extreme heat event each summer. The average probability for the entire planning area includes an extreme heat event every year. The GBRA monitors conditions throughout the planning area and takes additional precautions to protect employees when the heat index exceeds 105°F. In addition, the GBRA provides annual severe weather training to its employees.

Citizens, especially children and the elderly, should exercise caution by staying out of the heat for prolonged periods when a heat advisory or excessive heat warning is issued. Also at risk are those working or remaining outdoors for prolonged periods of time. Due to the abundance of concrete and metal infrastructure at many GBRA facilities, the effects of an extreme heat event can be intensified. Concrete and metal absorb heat energy and emit that energy at night, thereby trapping heat, and causing the temperature to feel as much as 10 degrees higher than surrounding areas. This is known as the “heat island” effect.

Figure 9-2 displays the daily maximum heat index as derived from NOAA based on data compiled from 1849 to 2014. The GBRA planning area has an average daily maximum heat index range between 90-110°F. Using the Heat Index, the GBRA planning area falls within the “Extreme Caution” to “Danger” category, meaning the average extent to mitigate for citizens in the planning area is sunstroke, muscle cramps, and heat exhaustion. The most extreme category the planning area has experienced and can anticipate in the future is the “Danger” category with temperatures between 105°F and 129°F. The highest temperature on record for the planning area was 113°F and occurred in DeWitt County in September 2000.

Figure 9-2. Average Daily Maximum Heat Index[3]



Historical Occurrences

Every summer, the hazard of heat-related illness becomes a significant public health issue throughout much of the US. Mortality from all causes increases during heat waves, and excessive heat is an important contributing factor to deaths from other causes, particularly among the elderly. Since 1996 eight deaths[4] were reported within the GBRA planning are including 2 deaths in Calhoun County, 1 in Comal, 1 in Gonzales, 1 in Guadalupe, 2 in Hays, and 1 in Victoria. Table 9-2 depicts historical occurrences of mortality in the State of Texas from heat from 1994 to 2004 from the Texas Department of State Health Services and 2005 to 2017 from the NCEI database.

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[3] Source: NOAA; the GBRA planning area in outlined in black

[4] Deaths reported in the GBRA planning area are not directly related to GBRA facilities, services or employees.

Table 9-2. Extreme Heat Related Deaths in Texas

YEAR	DEATHS
1994	1
1995	12
1996	10
1997	2
1998	66
1999	22
2000	71
2001	20
2002	1
2003	0
2004	3
2005	49
2006	2
2007	2
2008	7
2009	6
2010	5
2011	22
2012	2
2013	1
2014	0
2015	3
2016	6
2017	2

Section 9: Extreme Heat

According to heat related incidents located within the GBRA planning area there are 6 heat waves[5] on record. Historical extreme heat information, as provided by the NCEI, shows extreme heat activity across a multi-county forecast area for each event, the appropriate percentage of the total property damage reported for the entire forecast area has been allocated to each county impacted by the event. It is important to note historical extreme heat data for the GBRA planning area is provided on a County-wide basis per the NCEI databases and is reported by county. Only extreme heat events that have been reported have been factored into this Risk Assessment. It is likely that additional extreme heat occurrences have gone unreported before and during the recording period. Table 9-3 shows the historical events summary for each county within the GBRA planning area between 1996 and 2017.

Table 9-3. Historical Extreme Heat Events Summary, 1996-2017

COUNTY	NUMBER OF EVENTS	FATALITIES	INJURIES	PROPERTY DAMAGE (2017 DOLLARS)
Caldwell County	0	0	0	$0
Calhoun County	0	2	0	$0
Comal County	2	1	0	$0
DeWitt County	0	0	0	$0
Gonzales County	0	1	0	$0
Guadalupe County	2	1	0	$0
Hays County	0	2	0	$0
Kendall County	0	0	0	$0
Refugio County	1[6]	0	0	$0
Victoria County	2	1	0	$0
Total	**6**	**8**	**0**	**$0**

Based on the list of historical extreme heat events for the GBRA planning area (listed above), 3 of the events have occurred since the 2011 Plan.

[5] Even though the GBRA planning area experiences heat waves each summer, NCEI data only records events reported. Based on reports, only 6 events are on record. Heat wave events reported in multiple counties for the same time period are only counted as one event.

[6] This event is also reported during the same time frame in Victoria County. Heat wave events reported in multiple counties for the same time period are only counted as one event.

Significant Events

September 1, 2000

A record setting heat wave over south Texas through the first week of September 2000 saw record temperatures. Stagnant high pressure, light winds and several months of below normal rainfall, allowed temperatures to reach extreme levels for the first 5 days of September. High temperatures remained above 100 degrees for most locations. Aside from Corpus Christi and Victoria setting all-time record highs, 109 and 111 degrees respectively, on September 5th, Alice, Cotulla, Kingsville and Laredo reached 111, 112, 110 and 111 degrees respectively. Additional evidence that September 5th was the hottest day ever recorded for South Texas, coastal sites Rockport and Corpus Christi Naval Air Station reported 107 and 106 degrees respectively. Temperatures over southeast Texas began to cool on the 6th.

June 4, 2010

A ridge of high pressure was building over Texas after a mesoscale convective system had produced widespread rain across South Central Texas. This caused the low level winds to turn around to the southeast and brought a warm, moist air mass over the region. High temperatures climbed to near 90 degrees and the dew point temperatures near 70 degrees resulting in heat indices in the middle 90s. A three year old boy was found dead in a family vehicle in the Sand Hills area of Guadalupe County. The high temperature was around 90 degrees and the heat index was between 95 and 97.

March 8, 2011

Surface high pressure over the Gulf of Mexico caused southeasterly winds in South Central Texas which brought warm, moist air to the region. High temperatures were well above normal in the middle 80s. A 6 month old girl was found dead in a car in New Braunfels. News reports stated that she had been accidentally left in the car for nine hours before being discovered. The high temperature at the New Braunfels Airport was 84 degrees and the heat index was about the same.

Probability of Future Events

According to historical records combined with the average daily maximum heat index developed by NOAA, the GBRA typically experiences an extreme heat event every year in all ten counties of the planning area. Hence, the future probability of an excessive summer heat event in the GBRA planning area is highly likely.

Vulnerability and Impact

There is no defined geographic boudary for extreme heat events. While all of the GBRA planning area is exposed to extreme temperatures, existing buildings, infrastructure, and critical facilities are not likely to sustain significant damage from extreme heat events. Therefore, any estimated property losses associated with the extreme heat hazard are anticipated to be negligible across the area.

Extreme temperatures do however present a significant threat to life and safety for the population of the planning area as a whole. Heat casualties for example are typically caused by a lack of adequate air-conditioning or heat exhaustion. The most vulnerable population to heat casualties are the elderly or infirmed, who may live on low fixed incomes and cannot afford to run air-conditioning on a regular basis. This population is sometimes isolated, with no immediate family or friends to look out for their well-being.

The GBRA employees may be at risk during extreme heat events, particularly those whose jobs consist of strenuous labor outdoors or work at facilities with no air conditioning. The GBRA employs 174 people. Approximately 70 of these employees (40% of the total work force) engage in outdoor work-related tasks and could be at an elevated risk during extreme heat events.

Extreme high temperatures can have significant secondary impacts, leading to droughts, water shortages, increased fire danger, and prompt excessive demands for energy. The GBRA may not have the ability to meet hydroelectric energy demands, forcing the possibility of rolling blackouts in the GBRA service area with unseasonably high temperatures in what is a normally mild month with low power demands.

While structural damages from extreme heat are considered limited throughout the ten county planning area, the potential impact of excessive summer heat may be considered major as injuries and/or illnesses can result in permanent disability.

The GBRA does not attribute structure or infrastructure damages, or added labor costs to extreme heat events. The GBRA monitors conditions throughout the planning area and takes additional precautions to protect employees when the heat index exceeds 105°F. In addition, the GBRA provides annual severe weather training to its employees.

Typically, more than 12 hours of warning time would be given before the onset of an extreme heat event. The potential impact of extreme heat for the GBRA facilities, infrastructure and employees can be considered “Limited,” resulting in negligible damages and few injuries due to the mitigation measures regularly employed through GBRA standard operations. Based on historical records over a 22-year period, annualized losses for the GBRA planning area are negligible.

Assessment of Impacts

The greatest risk from extreme heat is to public health and safety.

The direct impacts to the GBRA facilities and services may include:

- Injury or illness to vulnerable employees;
- Potential rolling black-out;
- Increased water demands;
- Decreased revenue;
- Dissatisfied customers.

Impacts to local jurisdictions in the planning area that could indirectly impact GBRA:

- Vulnerable populations, particularly the elderly and infants, can face serious or life-threatening health problems from exposure to extreme heat including hyperthermia, heat cramps, heat exhaustion, and heat stroke (or sunstroke).
- Response personnel including utility workers, public works personnel, and any other professions where individuals are required to work outside, are more subject to extreme heat related illnesses since their exposure would typically be greater.
- High energy demand periods can outpace the supply of energy, potentially creating the need for rolling brownouts which would elevate the risk of illness to vulnerable residents.
- Highways and roads may be damaged by excessive heat causing asphalt roads to soften and concrete roads to shift or buckle.
- Vehicles engines and cooling systems typically run harder during extreme heat events resulting in increases in mechanical failures.
- Extreme heat events during times of drought can exacerbate the environmental impacts associated with drought, decreasing water and air quality and further degrading wildlife habitat.

- Extreme heat increases ground-level ozone (smog), increasing the risk of respiratory illnesses.
- Tourism and recreational activities may be negatively impacted during extreme heat events, reducing seasonal revenue.
- Food suppliers can anticipate an increase in food costs due to increases in production costs and crop and livestock losses.
- Fisheries may be negatively impacted by extreme heat, suffering damage to fish habitats (either natural or man-made) and a loss of fish and/or other aquatic organisms due to decreased water flows or availability.
- Negatively impacted water suppliers may face increased costs resulting from the transport water or develop supplemental water resources.

The economic and financial impacts of extreme heat on the GBRA planning area will depend on the duration of the event, demand for energy, drought associated with extreme heat, and many other factors. The level of preparedness and the amount of planning done by the GBRA in coordination with local government, businesses and citizens will impact the overall economic and financial conditions before, during, and after an extreme heat event.

SECTION 10: THUNDERSTORM WIND

Hazard Description

Thunderstorms create extreme wind events which include straight line winds. Wind is the horizontal motion of the air past a given point, beginning with differences in air pressures. Pressure that is higher at one place than another sets up a force pushing from the high toward the low pressure; the greater the difference in pressures, the stronger the force. The distance between the area of high pressure and the area of low pressure also determines how fast the moving air is accelerated.

Thunderstorms are created when heat and moisture near the Earth's surface are transported to the upper levels of the atmosphere. By-products of this process are the clouds, precipitation, and wind that become the thunderstorm. Sub-hazards of thunderstorms are hail and tornadoes, which are profiled separately in this Plan.

According to the National Weather Service (NWS), a thunderstorm occurs when thunder accompanies rainfall. Radar observers use the intensity of radar echoes to distinguish between rain showers and thunderstorms.

Straight line winds are responsible for most thunderstorm wind damages. One type of straight line wind, the downburst, is a small area of rapidly descending air beneath a thunderstorm. A downburst can cause damage equivalent to a strong tornado and make air travel extremely hazardous.

Straight line winds can have gusts of 100 miles per hour (mph) or more and are often accompanied by hail or rain. Unlike tornadoes, windstorms have a broader path that is several miles wide and can cover several counties. Straight line wind may down trees and power lines, overturn mobile homes, and cause damage to well-built structures.

Location

Severe thunderstorm winds are generally considered a common occurrence in the GBRA planning area. Typical thunderstorms are 15 miles in diameter and lasts an average of 30 minutes. Despite the short time span, thunderstorms can be extremely dangerous as they are often strong and fast in their approach and can be accompanied by flash flooding, hail, tornadoes, and high winds.

Thunderstorms occur randomly, and therefore it is impossible to predict where they will strike within the GBRA planning area. Thus, it is assumed that the entire GBRA planning area is uniformly exposed to the threat of thunderstorm winds.

Extent

The extent or magnitude of a thunderstorm wind event is measured by the Beaufort Wind Scale. Table 10-1 describes the different intensities of wind in terms of speed and effects, from calm to violent and destructive.

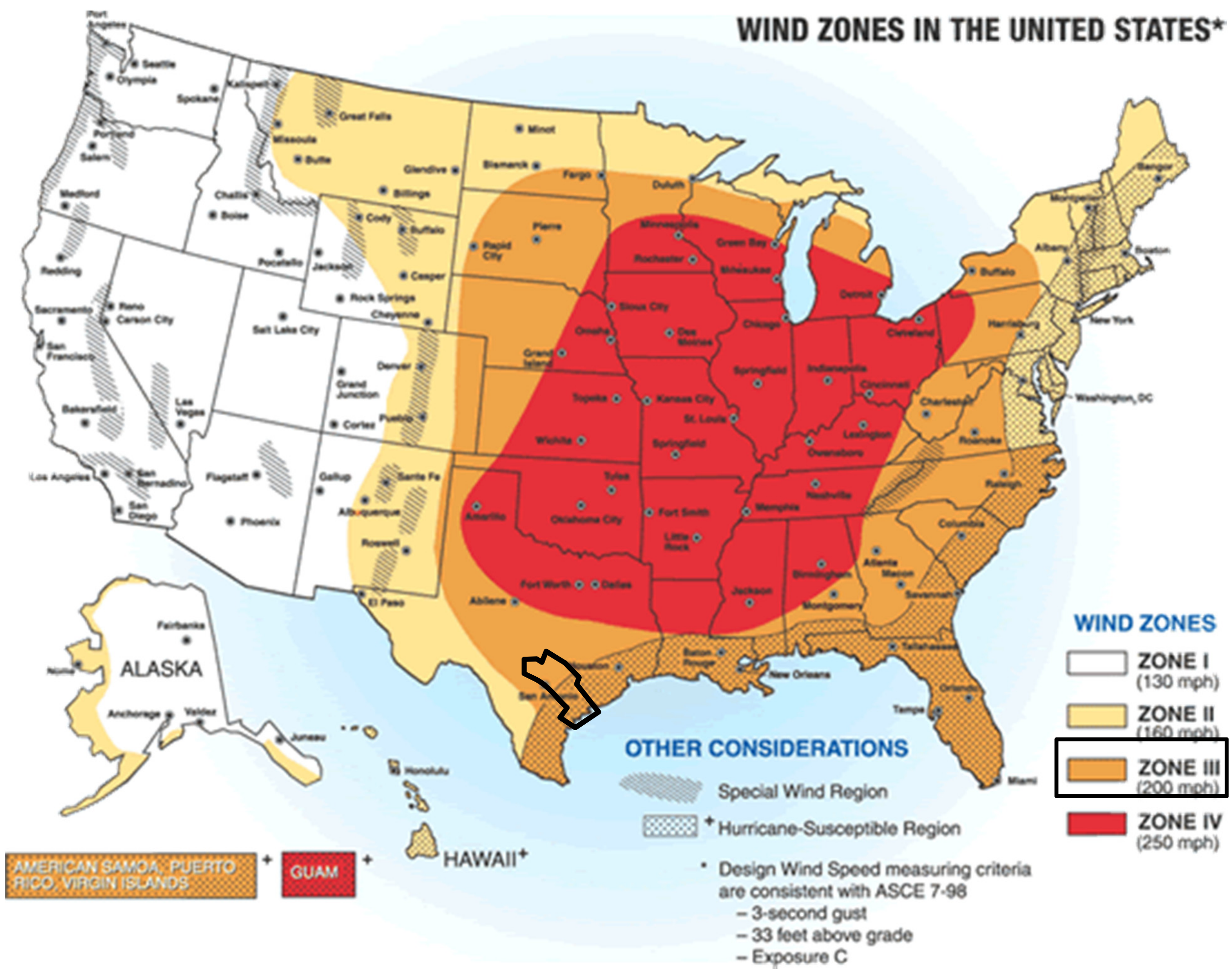
Table 10-1. Beaufort Wind Scale[1]

FORCE	WIND (KNOTS)	WMO CLASSIFICATION	APPEARANCE OF WIND EFFECTS
0	Less than 1	Calm	Calm, smoke rises vertically
1	1-3	Light Air	Smoke drift indicates wind direction, still wind vanes
2	4-7	Light Breeze	Wind felt on face, leaves rustle, vanes begin to move
3	8-12	Gentle Breeze	Leaves and small twigs constantly moving, light flags extended
4	13-18	Moderate Breeze	Dust, leaves and loose paper lifted, small tree branches move
5	111-24	Fresh Breeze	Small trees in leaf begin to sway
6	25-31	Strong Breeze	Larger tree branches moving, whistling in wires
7	32-38	Near Gale	Whole trees moving, resistance felt walking against wind
8	311-46	Gale	Whole trees in motion, resistance felt walking against wind
9	47-54	Strong Gale	Slight structural damage occurs, slate blows off roofs
10	55-63	Storm	Seldom experienced on land, trees broken or uprooted, "considerable structural damage"
11	64-72	Violent Storm	If experienced on land, widespread damage
12	73+	Hurricane	Violence and destruction

Figure 10-1 displays the wind zones as derived from NOAA.

[1] Source: World Meteorological Organization

Figure 10-1. Wind Zones in the United States[2]



On average, the ten county planning area experiences nine to ten thunderstorm wind events every year. According to the available data for previous occurrences, high winds are common to the planning area when accompanied by thunderstorms. The black outline in Figure 10-1 shows the GBRA planning area, which is located within Zone III, meaning they can experience winds up to 200 mph. The GBRA planning area has experienced a significant wind event, or an event with winds in the range of "Force 12" on the Beaufort Wind Scale, with the average measurement of severe thunderstorm winds above 73 knots. Therefore, the planning area on average could experience a range of wind speeds where widespread destruction is possible.

Historical Occurrences

Table 10-2 below lists a summary of historical occurrences of thunderstorm events for the GBRA planning area according to the National Centers for Environmental Information (NCEI) data. Between

[2] The black outline indicates the GBRA planning area.

1955 and 2017 the number of thunderstorm wind events impacting the GBRA planning area range from 27 in Refugio County to 118 in Victoria County, based upon NCEI records. The table presents a summary of historical events, by location, known to have specifically impacted the GBRA planning area. It is important to note that high wind events associated with other hazards, such as tornadoes, are not accounted for in this section.

Only thunderstorm events that have been reported have been factored into this Risk Assessment. It is likely that additional thunderstorm occurrences have gone unreported before and during the recording period. Table 10-2 shows a summary of historical incident information for the planning area with property damage totals from 1955 to 2017.[3] Table 10-3 provides the direct GBRA estimated costs of response and repair per thunderstorm wind event.

Table 10-2. Historical Thunderstorm Wind Events Summary, 1955-2017

COUNTY	NUMBER OF EVENTS	MAGNITUDE (maximum knots)	PROPERTY DAMAGE (2017 DOLLARS)
Caldwell County	63	95	$21,002,224
Calhoun County	47	87	$491,473
Comal County	57	70	$9,140,363
DeWitt County	64	70	$11,419,461
Gonzales County	40	90	$1,943,734
Guadalupe County	82	70	$10,550,305
Hays County	74	70	$19,289,581
Kendall County	34	78	$843,968
Refugio County	27	61	$337,183
Victoria County	118	87	$513,152
GBRA Planning Area Losses	**606**		**$75,531,444**

Table 10-3. Estimated GBRA Response, Recovery and Restoration Damages, 1955-2017

ESTIMATED COST PER EVENT[4]	NUMBER OF EVENTS	TOTAL GBRA COSTS
$10,037	606	$6,082,422

Based on the list of historical thunderstorm wind events for the GBRA planning area (listed above), 139 of the events have occurred since the 2011 Plan.

[3] Comprehensive list of historical events available upon request.

[4] Estimated cost per event represents the average cost of response, recovery and restoration per county event.

Significant Events

March 27, 1994 – Caldwell County, Comal County, Guadalupe County
A line of thunderstorms moved eastward from Bexar County into Comal and Guadalupe Counties shortly after midnight, producing damaging wind at New Braunfels and large hail at Schertz and Cibolo. They reached the city of Seguin within an hour. The Guadalupe County Sheriff reported 0.50- to 1-inch hail in Seguin. Damaging winds occurred at the same time, uprooting several trees and knocking down numerous large tree limbs. This thunderstorm system caused extensive property damage and cut off electric service to 11,000 homes. Eleven power lines that had been built to withstand over 100 mph winds were twisted and toppled by the storm. Damage was the most severe from the New Braunfels and Schertz area eastward to Staples. Twenty-one residences in Schertz, Cibolo, and Marion were damaged, with four mobile homes destroyed and four with major damage. Winds were estimated at 50 to 60 mph, with golf ball-size hail. One woman at a flea market on the Interstate 35 portion of Schertz was hit by flying debris and was taken to a hospital. Damage in region was estimated at more than $10 million. Barns and storage areas were blown over or damaged. Other damage was mainly to roofs and windows of houses and to windows of automobiles.

June 2, 2003 – Caldwell County
A severe thunderstorm crossed portions of southwest Texas on June 2, 2003. As the downburst crossed the Hays County line into Caldwell County, it struck the San Marcos Airport located in extreme western Caldwell County. The severe winds caused nearly $7 million in damages to hangars and to between 25 and 30 general aviation aircraft. As it exited the airport, the downburst moved across the Gary Job Corps Center, damaging buildings and knocking over trees. An additional $5 million damage was estimated at the campus. The downburst moved past the campus, across open country and through the town of Martindale. Amateur Radio operators reported trees blown down and damage to numerous roofs, vehicles and fences from west of Martindale and throughout the town. Winds in the event at the airport were estimated at between 80 and 90 knots.

April 22, 2015 – Refugio County
Several supercells developed and tracked east-southeast along a nearly stationary front stretching from the Hill Country to South Texas into the central Gulf of Mexico. These storms contained very large hail, up to tennis ball size near Austwell, and very strong winds greater than 60 mph. Wind damage and flash flooding occurred with these severe thunderstorms also. A metal garage was blown over. Large trees were blown down along with numerous power lines through much of the community of Austwell.

Probability of Future Events

Most thunderstorms occur during the spring in the months of March, April, and May and in the fall, during the month of September. Even though the intensity of thunderstorm winds is not always damaging for the entire planning area, the frequency of occurrence for a thunderstorm wind event is highly likely, meaning that multiple events are probable every year for some portion of the GBRA facilities and infrastructure.

Vulnerability and Impact

Vulnerability is difficult to evaluate since thunderstorm wind events can occur at different strength levels, in random locations, and can create relatively narrow paths of destruction. Due to the randomness of these events, all existing and future GBRA structures, and facilities could potentially be impacted and remain vulnerable to possible injury and property loss from strong winds.

Trees, power lines and poles, signage, manufactured housing, radio towers, concrete block walls, storage barns, windows, garbage receptacles, brick facades, and vehicles, unless reinforced, are vulnerable to thunderstorm wind events. More severe damage involves windborne debris. Items have been reported to have been blown around by wind and, very commonly, debris from damaged structures in turn have caused damage to other buildings not directly impacted by the event. In numerous instances roofs have been reported as having been torn off of buildings. Portable buildings used at GBRA facilities would be more vulnerable to thunderstorm wind events than typical site built structures and could potentially pose a greater risk for wind-blown debris. While some facilities and infrastructure are more susceptible, all GBRA assets are vulnerable to thunderstorms.

Table 10-4 includes the total GBRA assets at risk by county.[5]

Table 10-4. GBRA Assets at Risk[6]

COUNTY	EMPLOYEES	ASSETS	MARKET VALUE	ACREAGE
Caldwell County	0	2 Structures, Acreage	$2,238,594	281
Calhoun County	0	Acreage	$610,370	620
Comal County	0	6 Structures, Meter Station, Acreage	$6,686,026	61
DeWitt County	0	2 Structures, Infrastructure	$5,785,030	44
Gonzales County	0	10 Structures, Infrastructure, Acreage	$1,154,710	46
Guadalupe County	174	15 Structures, Lift Station,17 Substations, Infrastructure, Acreage	$64,993,426	199
Hays County	0	Acreage	$35,800	3
Kendall County	0	1 Structure, Acreage	$60,010	1
Refugio County	0	Acreage	$13,360	10
Victoria County	0	Infrastructure	$510,180	0
GBRA Total	**174**	**36 Structures, 17 Substations, Lift Station, Meter Stations, Infrastructure, Acreage**	**$82,087,506**	**1,265**

[5] GBRA assets include land and improvements including buildings, power substations, dams, radio tower sites, gas storage facilities, electric generating complexes, and support infrastructure.
[6] Source: County Central Appraisal Districts

The GBRA elevates the response level for thunderstorm wind events resulting in increases in labor and maintenance costs. The GBRA employees typically engaged in outdoor work related tasks could be at an elevated risk during thunderstorm wind events, including approximately 70 employees (40% of the total work force).

A thunderstorm wind event can also result in damage to the hydroelectric power stations, resulting in repair costs and lost revenue. Impact of thunderstorms experienced in the GBRA planning area has resulted in 6 injuries and 1 fatality (none directly related to the GBRA facilities or employees). The structural impact of thunderstorm wind events experienced on the GBRA planning area would be "Limited", meaning facilities would be shut down for 24 hours or less and less than 10 percent of GBRA assets destroyed or with major damage. However, historical injuries and fatalities in the planning area indicate a potential "Major" impact, meaning potential loss of life and injuries and/or illness that result in permanent disability.

GBRA direct response and repair costs as a result of thunderstorm wind events are estimated at $6,082,422, having an approximate annual loss estimate of $96,546 (Table 10-6).

Table 10-5. Historic Thunderstorm Wind Event Summary and Annualized Loss

COUNTY	NUMBER OF EVENTS	PROPERTY LOSS (2017 DOLLARS)	ANNUAL LOSS ESTIMATE (2017 DOLLARS)
Caldwell County	63	$21,002,224	$333,369
Calhoun County	47	$491,473	$7,801
Comal County	57	$9,140,363	$145,085
DeWitt County	64	$11,419,461	$181,261
Gonzales County	40	$1,942,732	$30,837
Guadalupe County	82	$10,550,305	$167,465
Hays County	74	$19,289,581	$306,184
Kendall County	34	$843,968	$13,396
Refugio County	27	$337,183	$5,352
Victoria County	118	$513,152	$8,145

Table 10-6. GBRA Historic Thunderstorm Wind Event Summary and Direct Annualized Losses, 1955-2017

ESTIMATED COST PER EVENT[7]	NUMBER OF EVENTS	TOTAL GBRA COSTS	ANNUAL LOSS ESTIMATE (2017 DOLLARS)
$10,037	606	$6,082,422	$96,546

[7] Estimated cost per event represents the average cost of response, recovery and restoration per county event.

Assessment of Impacts

Thunderstorm wind events have the potential to pose a significant risk to people and can create dangerous and difficult situations for public health and safety officials.

The direct impacts to the GBRA facilities and services may include:

- Injury to vulnerable employees;
- Extensive power outages;
- Damaged or destroyed structures and infrastructure;
- Employees unable to report for duty;
- Impassable roads, delaying repairs and restoration work;
- Damages to power grid and hydroelectric power infrastructure;
- Inadequate staffing for repair work;
- Decreased revenue;
- Dissatisfied customers.

Impacts to counties in the planning area that could indirectly impact GBRA:

- Individuals exposed to the storm can be struck by flying debris, falling limbs, or downed trees causing serious injury or death.
- Structures can be damaged or crushed by falling trees, which can result in physical harm to the occupants.
- Significant debris and downed trees can result in emergency response vehicles being unable to access areas of the community.
- Downed power lines may result in roadways being unsafe for use, which may prevent first responders from answering calls for assistance or rescue.
- During exceptionally heavy thunderstorm events, first responders may be prevented from responding to calls, as the winds may reach a speed in which their vehicles and equipment are unsafe to operate.
- Thunderstorm events often result in widespread power outages increasing the risk to more vulnerable portions of the population who rely on power for health and/or life safety.
- Extended power outage often results in an increase in structure fires and carbon monoxide poisoning, as individuals attempt to cook or heat their homes with alternate, unsafe cooking or heating devices, such as grills.
- First responders are exposed to downed power lines, unstable and unusual debris, hazardous materials, and generally unsafe conditions.
- Emergency operations and services may be significantly impacted due to damaged facilities and/or loss of communications.
- Critical staff may be unable to report for duty, limiting response capabilities.
- City or county departments may be damaged, delaying response and recovery efforts for the entire community.
- Private sector entities that the City and its residents rely on, such as utility providers, financial institutions, and medical care providers, may not be fully operational and may require assistance from neighboring communities until full services can be restored.
- Economic disruption negatively impacts the programs and services provided by the community due to short and long-term loss in revenue.
- Some businesses not directly damaged by thunderstorm events may be negatively impacted while roads are cleared and utilities are being restored, further slowing economic recovery.
- Older structures built to less stringent building codes may suffer greater damage as they are typically more vulnerable to thunderstorm winds.

- Large scale thunderstorm events can have significant economic impact on the affected area, as it must now fund expenses such as infrastructure repair and restoration, temporary services and facilities, overtime pay for responders, as well as normal day-to-day operating expenses.
- Businesses that are more reliant on utility infrastructure than others may suffer greater damages without a backup power source.

The economic and financial impacts of thunderstorms will depend entirely on the scale of the event, what is damaged, and how quickly repairs to critical components of the economy can be implemented. The level of preparedness and pre-event planning conducted by the GBRA in coordination with local government, businesses, and citizens will contribute to the overall economic and financial conditions in the aftermath of any thunderstorm wind event.

SECTION 11: TORNADO

Hazard Description

Tornadoes are among the most violent storms on the planet. A tornado is a violently rotating column of air extending between, and in contact with, a cloud and the surface of the earth. The most violent tornadoes are capable of tremendous destruction, with wind speeds of 250 miles per hour or more. In extreme cases, winds may approach 300 miles per hour. Damage paths can be in excess of one mile wide and 50 miles long.

The most powerful tornadoes are produced by "super cell thunderstorms." Super-cell thunderstorms are created when horizontal wind shears (winds moving in different directions at different altitudes) begin to rotate the storm. This horizontal rotation can be tilted vertically by violent updrafts and the rotation radius can shrink, forming a vertical column of very quickly swirling air. This rotating air can eventually reach the ground, forming a tornado.

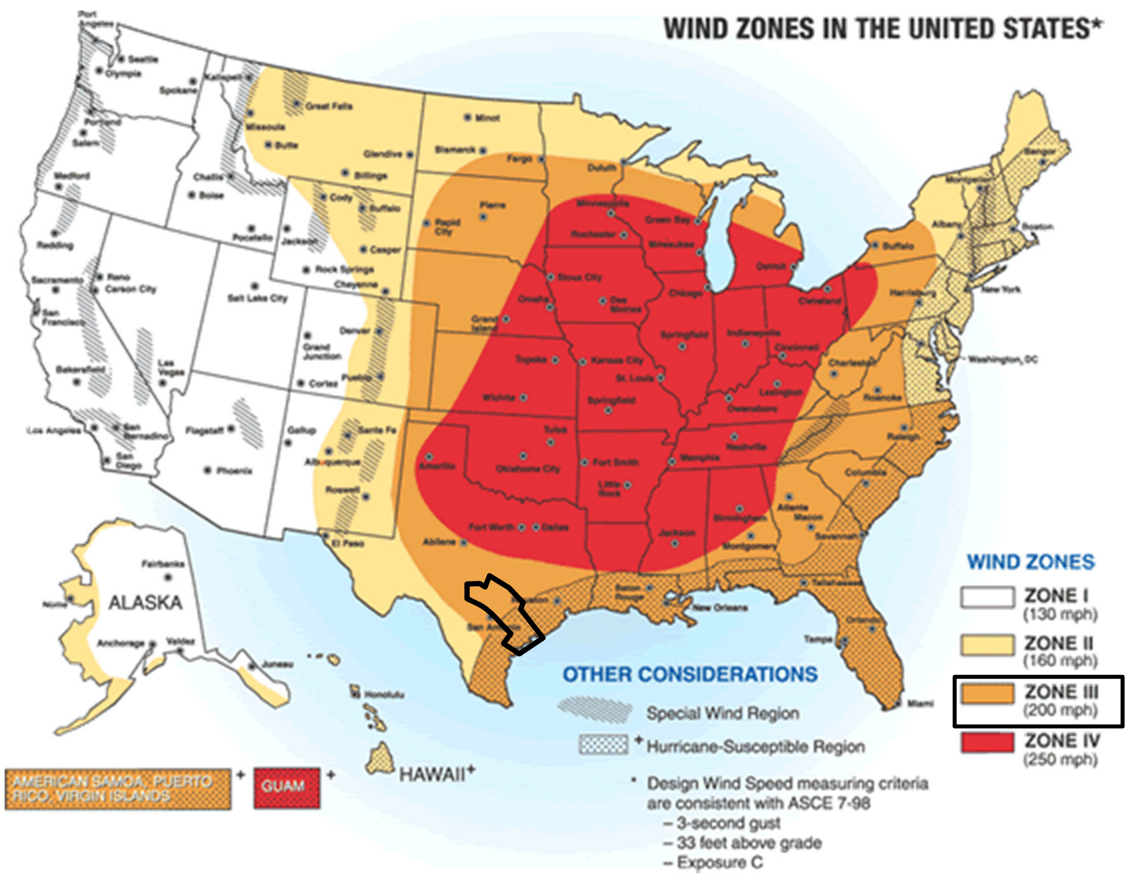
Table 11-1. Tornado Variations

WEAK TORNADOES	STRONG TORNADOES	VIOLENT TORNADOES
• 69% of all tornadoes • Less than 5% of tornado deaths • Lifetime 1-10+ minutes • Winds less than 110 mph	• 29% of all tornadoes • Nearly 30% of all tornado deaths • Lifetime 20+ minutes • Winds 110 – 205 mph	• 2% of all tornadoes • 70% of all tornado deaths • Lifetime can exceed one hour • Winds greater than 205 mph

Location

As with thunderstorms, tornadoes do not have any specific geographic boundary and can occur throughout the GBRA planning area. It is assumed that the GBRA planning area is uniformly exposed to tornado activity. The GBRA planning area is located in Wind Zone III, meaning tornado winds can be as high as 200 mph.

Figure 11-1. FEMA Wind Zones in the United States[1]



Extent

The destruction caused by tornadoes ranges from light to devastating depending on the intensity, size, and duration of the storm. Typically, tornadoes cause the greatest damage to structures of light construction, such as residential homes and particularly mobile homes or portable buildings.

Tornado magnitudes prior to 2005 were determined using the traditional version of the Fujita Scale (Table 11-2). Since February 2007, the Fujita Scale (FS) has been replaced by the Enhanced Fujita Scale (EFS) (Table 11-3), which retains the same basic design as its predecessor with six strength categories. The newer scale reflects more refined assessments of tornado damage surveys, standardization, and damage consideration to a wider range of structures.

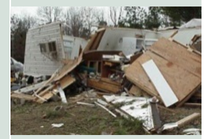
[1] The GBRA planning area indicated in the black outline.

Table 11-2. The Fujita Tornado Scale[2]

F-SCALE NUMBER	INTENSITY	WIND SPEED (MPH)	TYPE OF DAMAGE DONE	PERCENT OF APPRAISED STRUCTURE VALUE LOST DUE TO DAMAGE
F0	Gale Tornado	40 – 72	Some damage to chimneys; breaks branches off trees; pushes over shallow-rooted trees; and damages sign boards.	None Estimated
F1	Moderate Tornado	73 – 112	The lower wind speed is the beginning of hurricane wind speed; peels surface off roofs; mobile homes pushed off foundations or overturned; moving autos pushed off roads; and attached garages may be destroyed.	0% – 20%
F2	Significant Tornado	113 – 157	Considerable damage; roofs torn off frame houses; mobile homes demolished; boxcars pushed over; large trees snapped or uprooted; and light object missiles generated.	50% – 100%
F3	Severe Tornado	158 – 206	Roofs and some walls torn off well-constructed houses; trains overturned; and most trees in forest uprooted.	100%
F4	Devastating Tornado	207 – 260	Well-constructed homes leveled; structures with weak foundations blown off some distance; cars thrown; and large missiles generated.	100%
F5	Incredible Tornado	261 – 318	Strong frame houses lifted off foundations and carried considerable distances to disintegrate; automobile sized missiles flying through the air in excess of 330 yards; trees debarked; and steel reinforced concrete badly damaged.	100%

[2] Source: http://www.tornadoproject.com/fscale/fscale.htm

Table 11-3. Enhanced Fujita Scale for Tornadoes

STORM CATEGORY	DAMAGE LEVEL	3 SECOND GUST (MPH)	DESCRIPTION OF DAMAGES	PHOTO EXAMPLE
EF0	Gale	65 – 85	Some damage to chimneys; breaks branches off trees; pushes over shallow-rooted trees; and damages sign boards.	
EF1	Weak	86 – 110	The lower wind speed is the beginning of hurricane wind speed; peels surface off roofs; mobile homes pushed off foundations or overturned; moving autos pushed off roads; and attached garages may be destroyed.	
EF2	Strong	111 – 135	Considerable damage; roofs torn off frame houses; mobile homes demolished; boxcars pushed over; large trees snapped or uprooted; and light object missiles generated.	
EF3	Severe	136 – 165	Roof and some walls torn off well-constructed houses; trains overturned; and most trees in forest uprooted.	
EF4	Devastating	166 – 200	Well-constructed homes leveled; structures with weak foundations blown off some distance; and cars thrown and large missiles generated.	
EF5	Incredible	200+	Strong frame houses lifted off foundations and carried considerable distances to disintegrate; automobile sized missiles flying through the air in excess of 330 yards; trees debarked; and steel reinforced concrete badly damaged.	

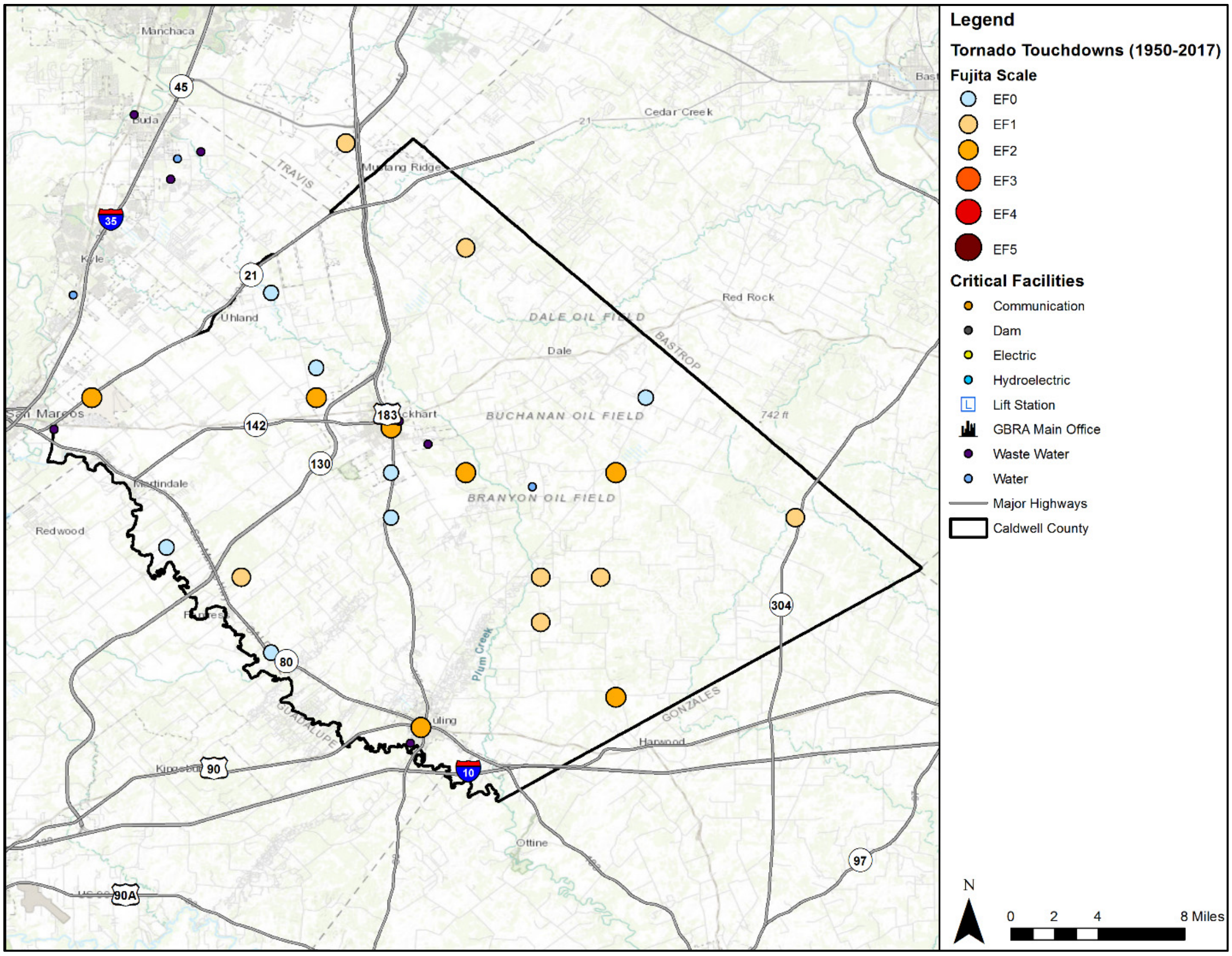
Both the Fujita Scale and Enhanced Fujita Scale are referenced in reviewing previous occurrences as tornado events prior to 2007 follow the Fujita Scale. The largest tornado magnitude reported within the GBRA planning area was an F3 on the Fujita Scale, or a severe tornado.

Although the planning area could experience a storm with a category up to an EF3 depending on the wind speed, the majority of storms only rise to a level of EF0 to an EF2 (Table 11-4). Therefore, the range of intensity that the GBRA planning area would be expected to mitigate for a tornado event would be a “low” to “severe” risk, or an EF0 to an EF3.

Historical Occurrences

A total of 260 tornado events have been recorded for the GBRA planning area from 1950 to 2017 as shown in Figure 11-2 ranging in strength from F0 to F3. The events shown in Figure 11-2 and listed in Table 11-4 represent only those that were reported to NCEI and NOAA databases and resulted in injury or damages, and may not represent all tornado events that have occurred since 1950. Only those events with latitude and longitude available were plotted on the map (Figures 11-2 through 11-11).

Figure 11-2. Spatial Historical Tornado Events Caldwell County, 1950-2017[3]



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3 Source: NOAA Records

Figure 11-3. Spatial Historical Tornado Events Calhoun County, 1950-2017

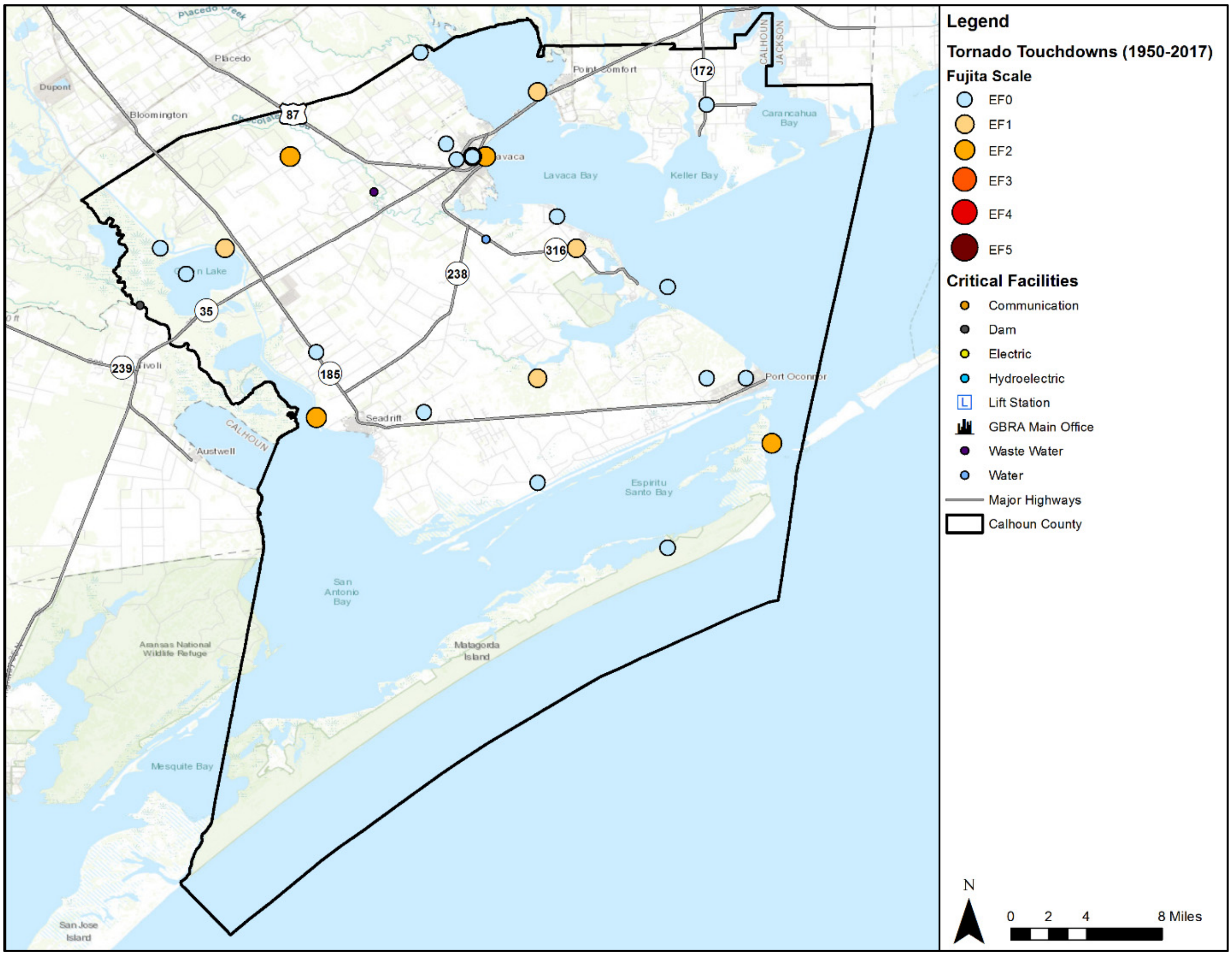


Figure 11-4. Spatial Historical Tornado Events Comal County, 1950-2017

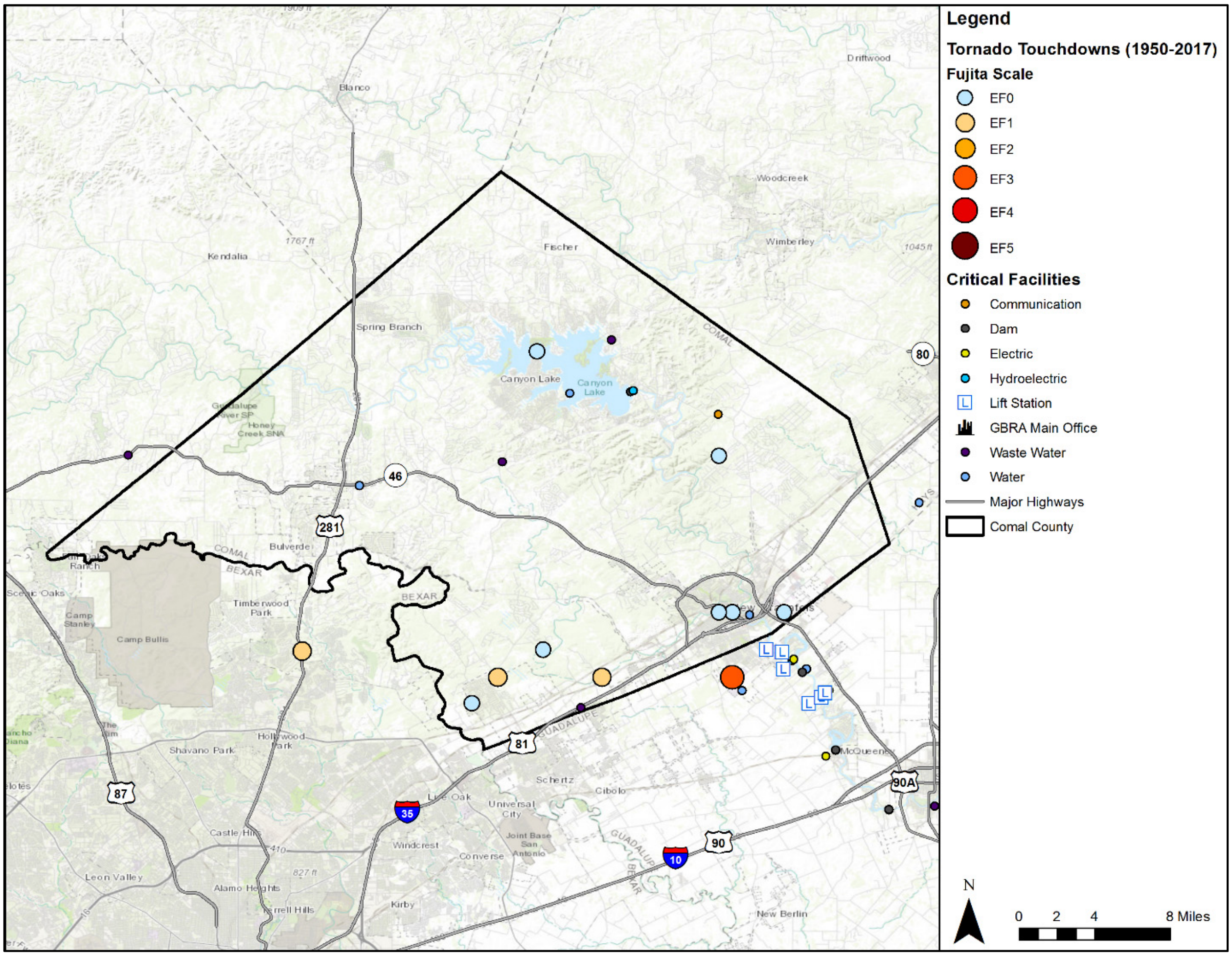


Figure 11-5. Spatial Historical Tornado Events DeWitt County, 1950-2017

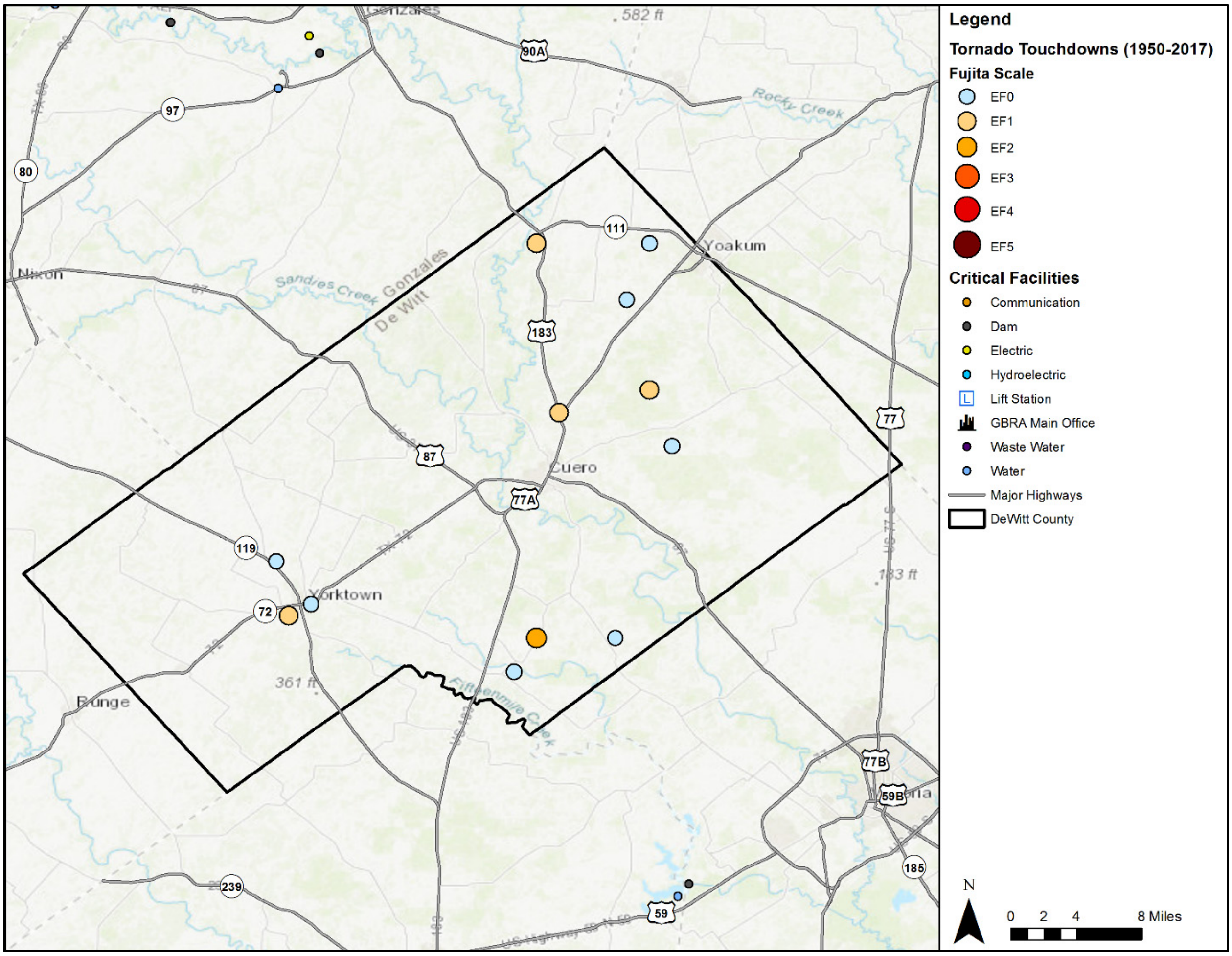


Figure 11-6. Spatial Historical Tornado Events Gonzales County, 1950-2017

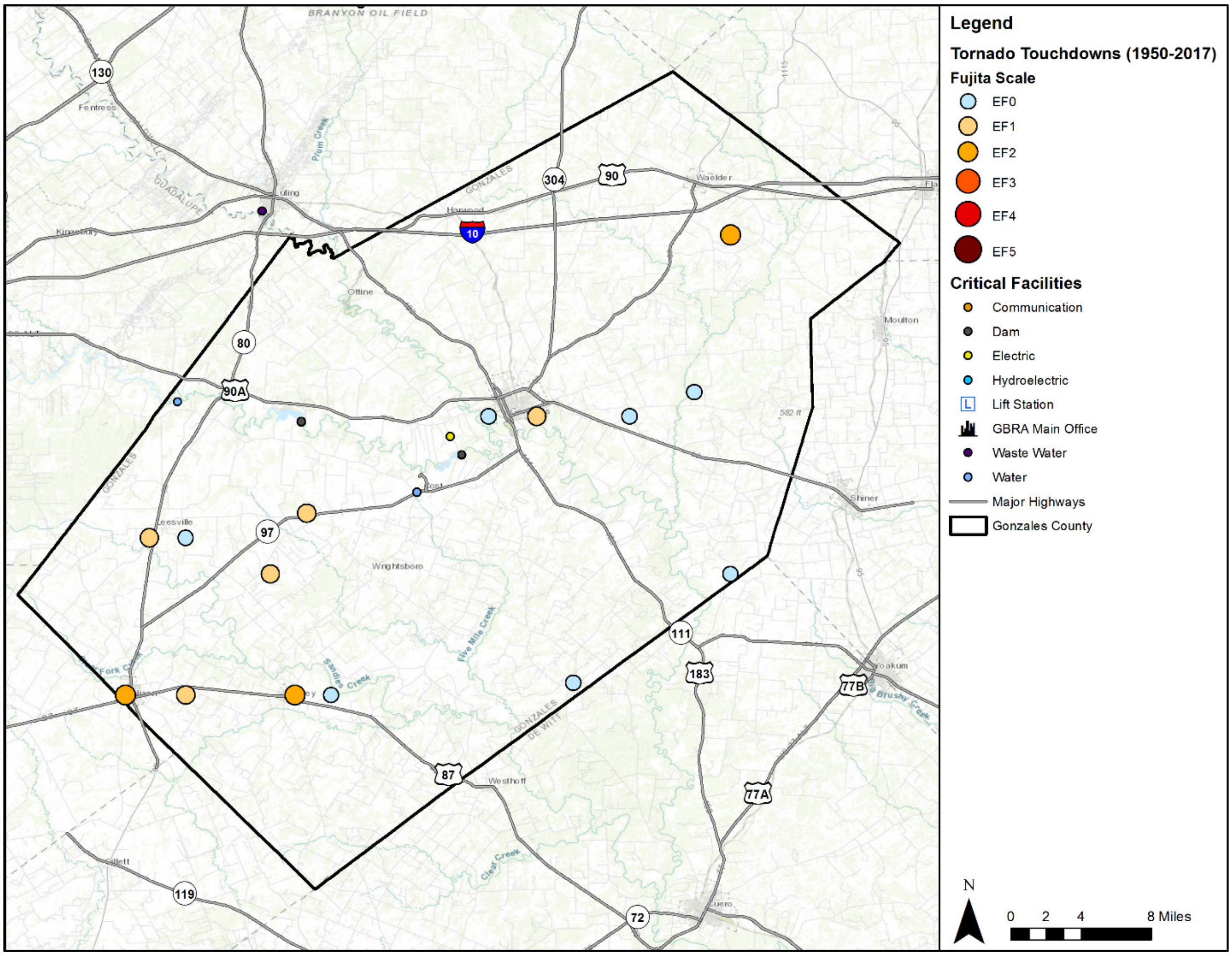


Figure 11-7. Spatial Historical Tornado Events Guadalupe County, 1950-2017

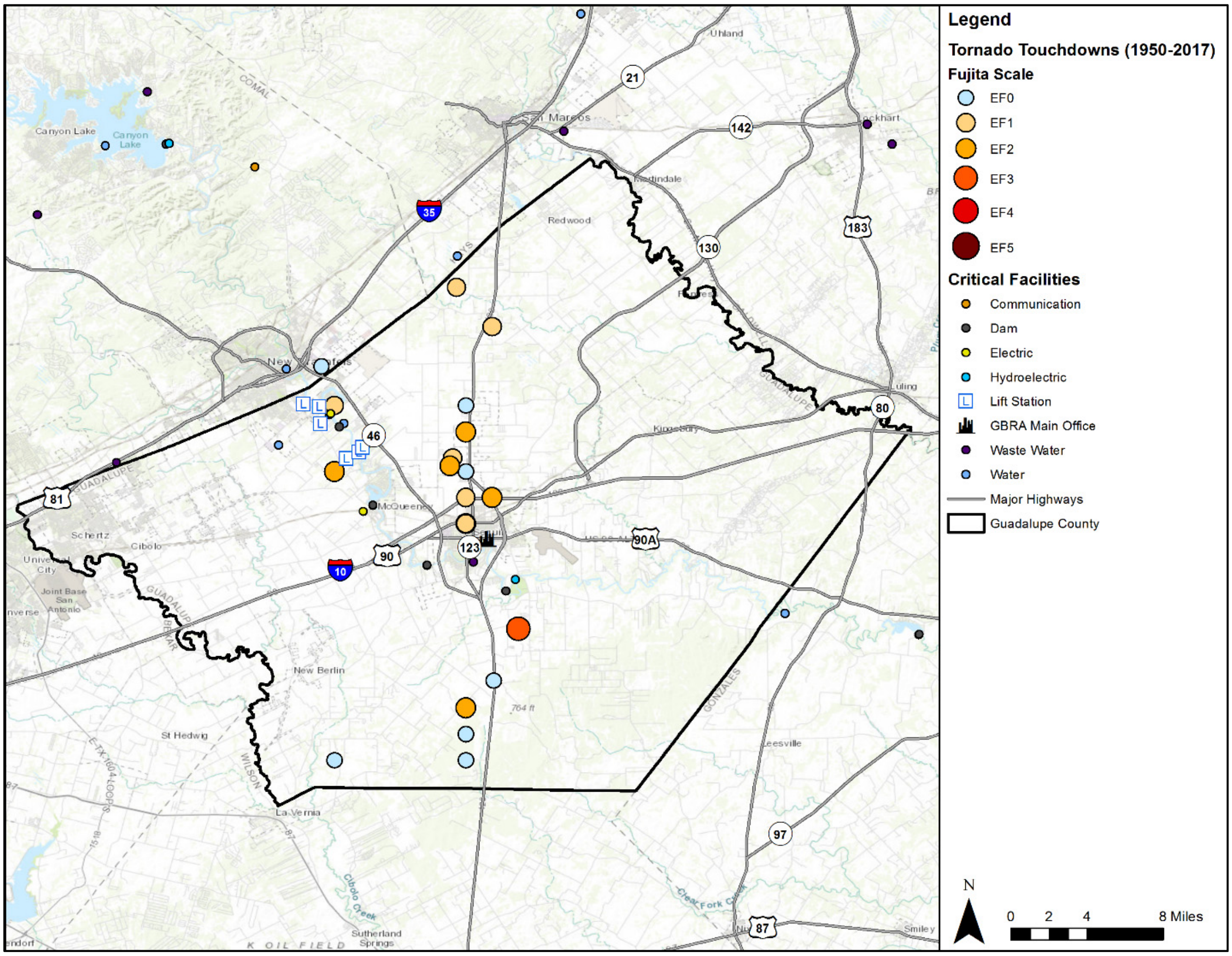


Figure 11-8. Spatial Historical Tornado Events Hays County, 1950-2017

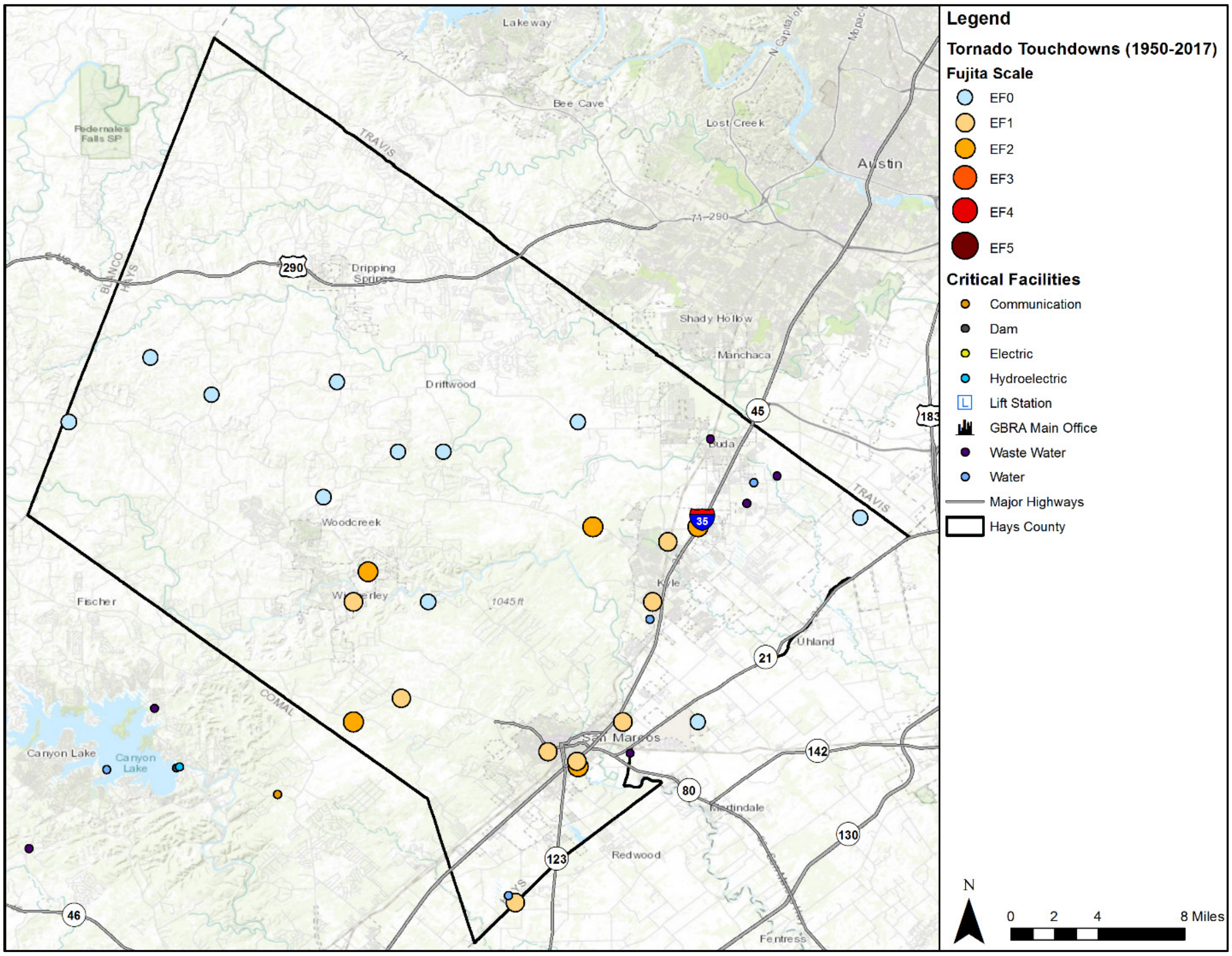


Figure 11-9. Spatial Historical Tornado Events Kendall County, 1950-2017

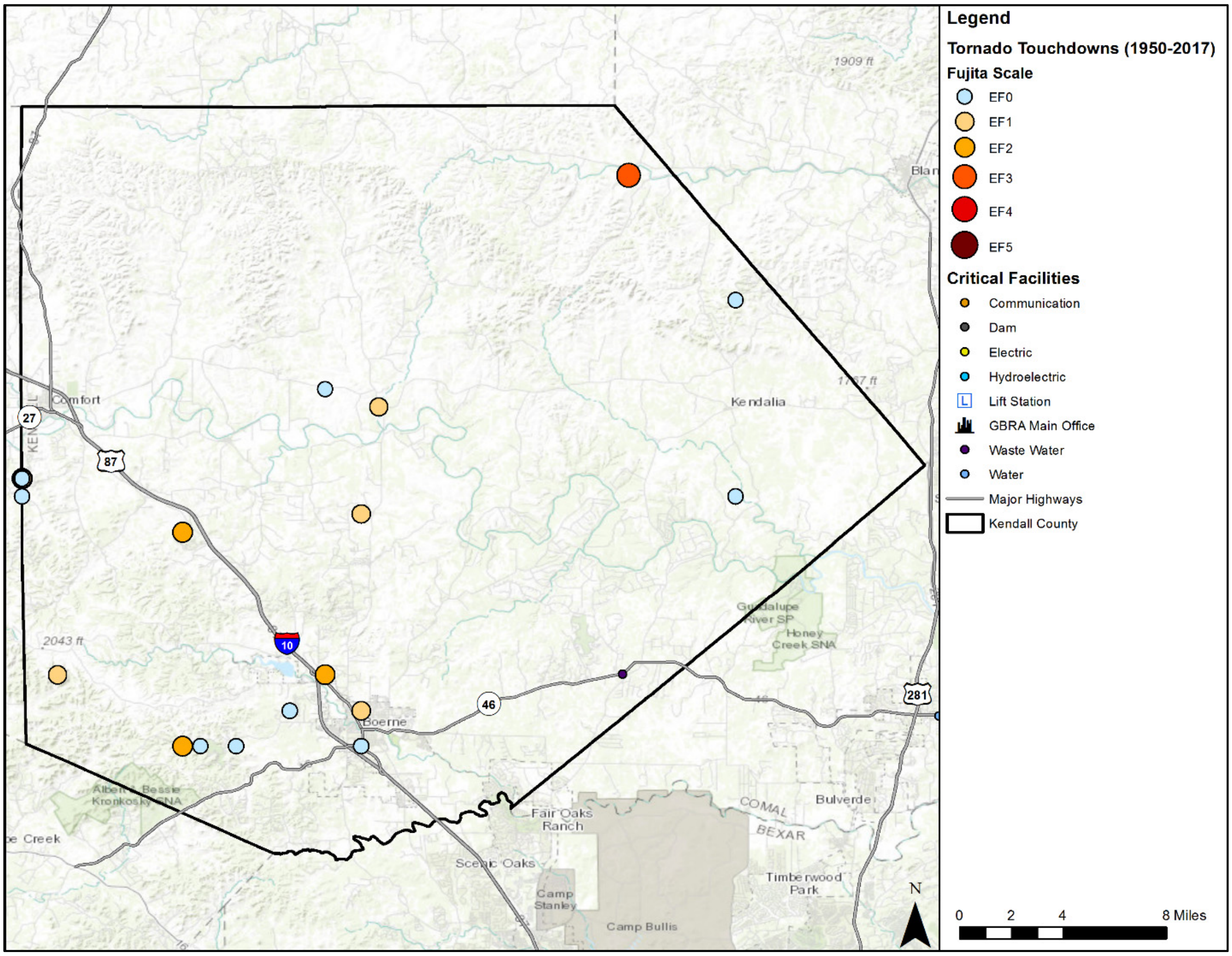


Figure 11-10. Spatial Historical Tornado Events Refugio County, 1950-2017

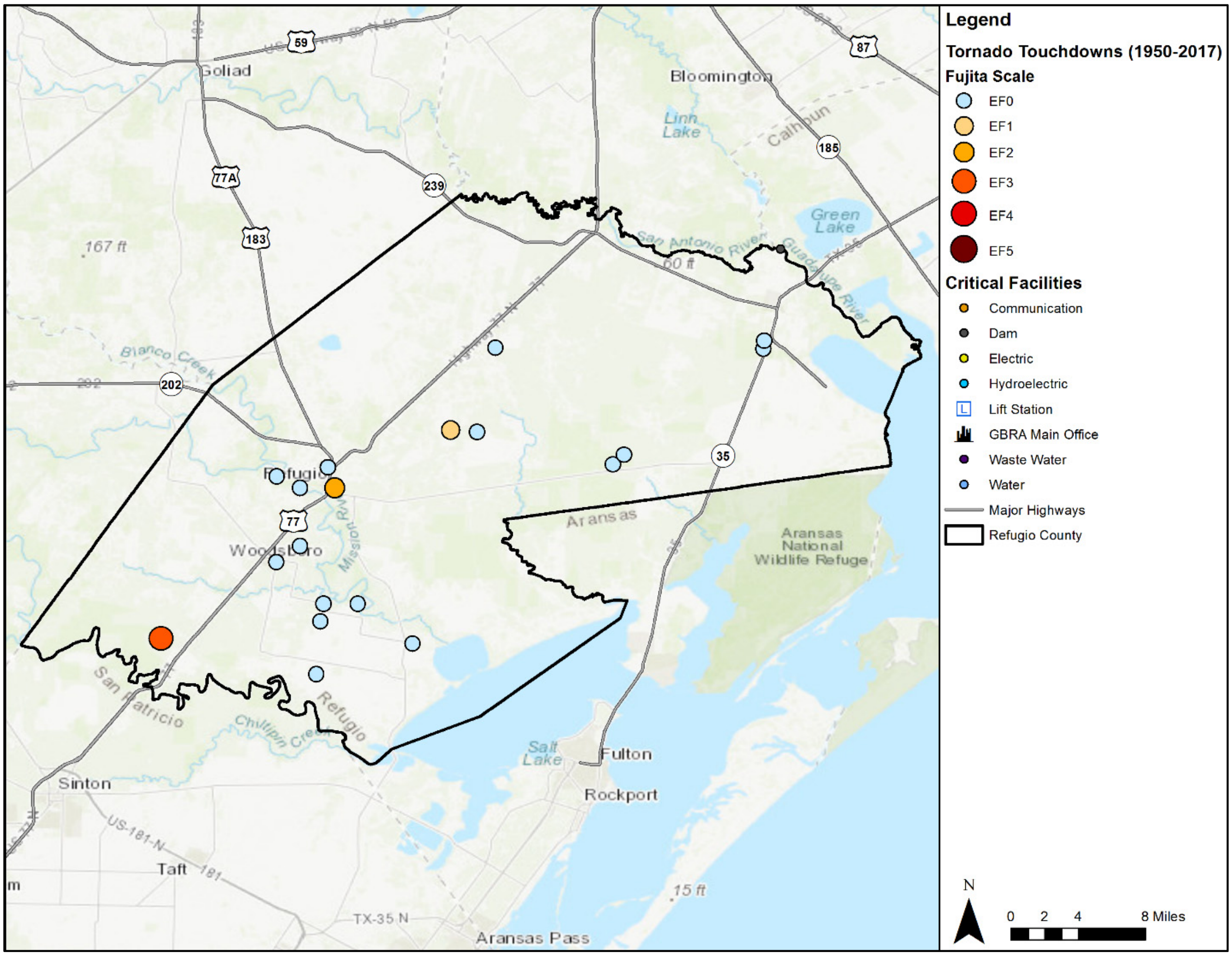


Figure 11-11. Spatial Historical Tornado Events Victoria County, 1950-2017

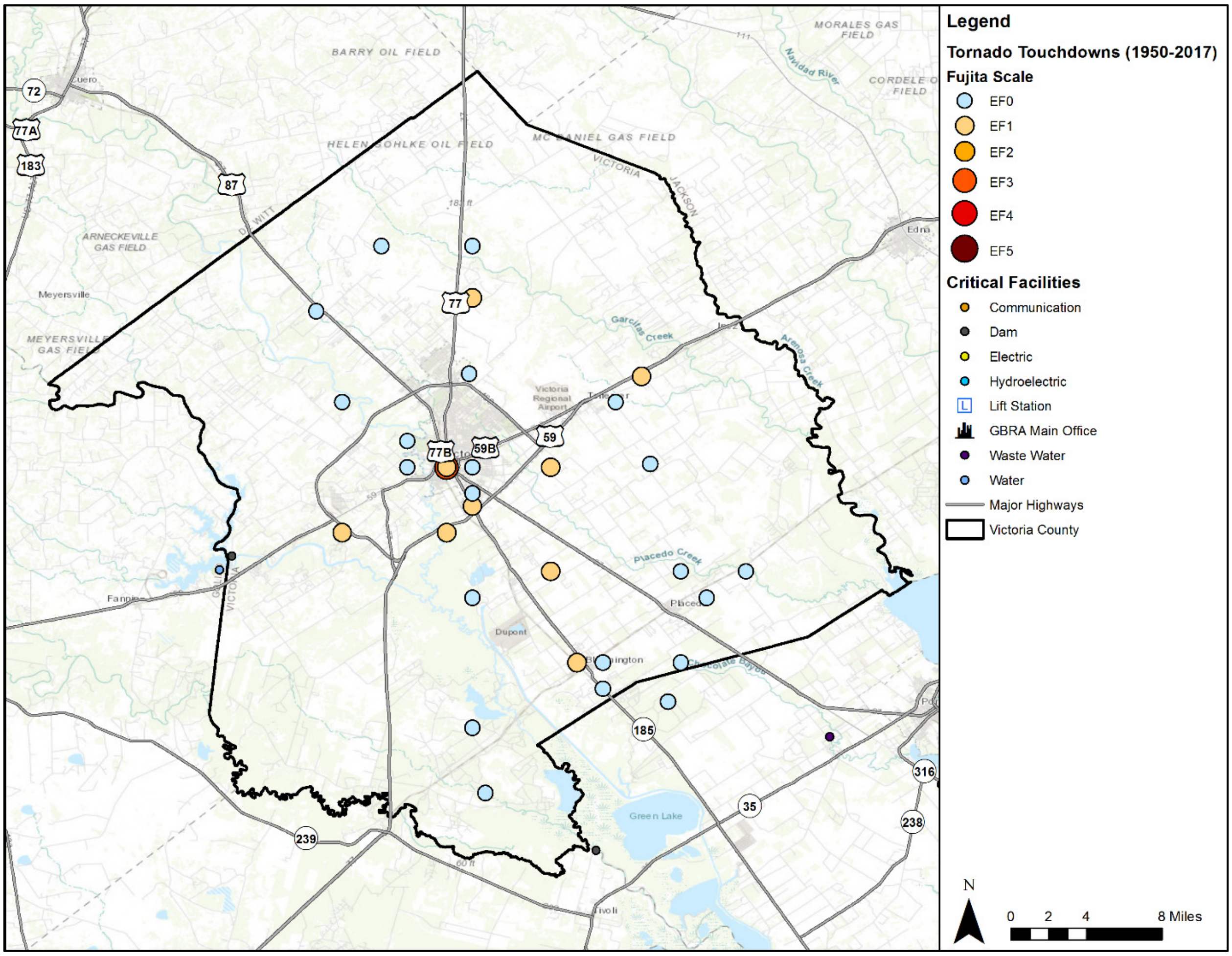


Table 11-4 shows a summary of historical incident information for the planning area with property damage totals from 1950 to 2017.[4] Table 11-5 provides the direct GBRA estimated costs of response and repair per tornado event.

Table 11-4. Historical Tornado Event Summary, 1950-2017

COUNTY	NUMBER OF EVENTS	MAGNITUDE (Fujita-Max Extent)	FATALITIES	INJURIES	PROPERTY DAMAGE (2017 Dollars)
Caldwell County	22	F2	0	23	$74,542,839
Calhoun County	35	F2	0	5	$1,704,970
Comal County	14	F3	0	0	$2,731,993
DeWitt County	17	F2	0	0	$293,886
Gonzales County	26	F2	0	4	$9,395,876

[4] Comprehensive list of historical events available upon request.

COUNTY	NUMBER OF EVENTS	MAGNITUDE (Fujita-Max Extent)	FATALITIES	INJURIES	PROPERTY DAMAGE (2017 Dollars)
Guadalupe County	25	F3	0	11	$3,011,312
Hays County	32	F3	1	13	$81,562,051
Kendall County	20	F3	0	3	$12,344,160
Refugio County	23	F3	0	2	$498,075
Victoria County	46	F3	0	5	$3,342,923
GBRA Planning Area Losses	**260**		**1**	**66**	**$189,428,085**

Table 11-5. Estimated GBRA Response, Recovery and Restoration Damages, 1950-2017

ESTIMATED COST PER EVENT[5]	NUMBER OF EVENTS	TOTAL GBRA COSTS
$5,572	260	$1,448,720

Based on the list of historical tornado events for the GBRA planning area (listed above), 36 of the events have occurred since the 2011 Plan.

Significant Events

August 10, 1980 – Caldwell and Hays County
A tornado touched down near the San Marcus airport just after 4:00 PM on August 10. The tornado was 200 yards wide and stayed on the ground for more than 13 miles. Damages exceeded $73 million (2017 dollars). There were no fatalities and 20 injuries as a direct result of the event.

May 6, 1982 – Gonzales County
A tornado touched down near Leesville just after 3:00 AM on May 6. The tornado was 40 yards wide and stayed on the ground for approximately 7 miles. Damages exceeded $6 million (2017 dollars). There were no fatalities or injuries as a direct result of the event.

November 11, 2001 – Kendall County
A large tornado was observed by the Kendall County Sheriff's Department 4 miles west of Boerne along SH46. This tornado moved toward the northeast, causing extensive damage to mobile homes, trees, fences, and roofs. The tornado was 200 yards wide and stayed on the ground for approximately 4 miles. Two injuries were reported as a direct result of the event.

September 29, 2012 – Calhoun County
A National Weather Service storm survey concluded a tornado briefly touched down just west of Highway 35 at Farm to Market Road 3084. A Tractor Supply store experienced damage which included

[5] Estimated cost per event represents the average cost of response, recovery and restoration per county event.

losing gutters off the building and a rooftop air conditioning unit being flipped. Winds were estimated at 65 mph.

Probability of Future Events

Tornadic storms can occur at any time of year and at any time of day, but they are typically more common in the spring months during the late afternoon and evening hours. A smaller, high frequency storm period can also emerge in the fall during the brief transition between the warm and cold seasons. According to historical records, a tornado event is a highly likely occurrence for the GBRA planning area, and several events are considered probable in the next year for some portion of the GBRA facilities and infrastructure. Hence, the probability of future tornado occurrences affecting some portion of the GBRA planning area is highly likely.

Vulnerability and Impact

Because tornadoes often cross jurisdictional boundaries, all existing and future buildings, facilities, and populations in the GBRA planning area are considered to be exposed to this hazard and could potentially be impacted. The damage caused by a tornado is typically a result of high wind velocity, wind-blown debris, and large hail.

The average tornado moves from southwest to northeast. However, tornadoes have been known to move in any direction at different strengths, in random locations, and typically create relatively narrow paths of destruction. Thus, it is difficult to evaluate the vulnerability of people and property to the impacts of a tornado. Although tornadoes strike at random, making all buildings vulnerable, three types of structures are more likely to suffer damage:

- Manufactured Homes,
- Homes on crawlspaces (more susceptible to lift), and
- Buildings that span a large area, such as shopping malls, gymnasiums, and factories.

Utility systems on roofs at GBRA facilities would be vulnerable and could be damaged by debris and high winds. The portable buildings used at GBRA facilities would be more vulnerable to tornado damage than typical site built structures. Tornadoes can possibly cause a significant threat to people as they could be struck by flying debris, falling trees/branches, utility lines, and poles. Employees that work outdoors would be more vulnerable to tornado events. Tornadoes commonly cause power outages which could cause health and safety risks to GBRA employees as well as to residents in the planning area. While some facilities and infrastructure are more susceptible, all GBRA assets are vulnerable to tornadoes.

Table 11-6 includes the total GBRA assets at risk by county.[6]

[6] GBRA assets include land and improvements including buildings, power substations, dams, radio tower sites, gas storage facilities, electric generating complexes, and support infrastructure.

Table 11-6. GBRA Assets at Risk[7]

COUNTY	EMPLOYEES	ASSETS	MARKET VALUE	ACREAGE
Caldwell County	0	2 Structures, Acreage	$2,238,594	281
Calhoun County	0	Acreage	$610,370	620
Comal County	0	6 Structures, Meter Station, Acreage	$6,686,026	61
DeWitt County	0	2 Structures, Infrastructure	$5,785,030	44
Gonzales County	0	10 Structures, Infrastructure, Acreage	$1,154,710	46
Guadalupe County	174	15 Structures, Lift Station,17 Substations, Infrastructure, Acreage	$64,993,426	199
Hays County	0	Acreage	$35,800	3
Kendall County	0	1 Structure, Acreage	$60,010	1
Refugio County	0	Acreage	$13,360	10
Victoria County	0	Infrastructure	$510,180	0
GBRA Total	**174**	**36 Structures, 17 Substations, Lift Station, Meter Stations, Infrastructure, Acreage**	**$82,087,506**	**1,265**

The GBRA elevates the response level when tornado events occur resulting in increases in labor, maintenance, and repair costs. GBRA direct response and repair costs as a result of tornado events are estimated at $1,448,720, having an approximate annual loss estimate of $21,305 (Table 11-9). Based on historic loss and damages, the impact of tornado on the GBRA facilities and infrastructure throughout the ten-county planning area can be considered “Limited”, with less than 10 percent of property expected to be destroyed, and critical facilities shut down for 24 hours or less.

Historic loss estimates due to tornados are presented in Table 11-7 and 11-8 below and include an estimate of annualized loss for the GBRA planning area by county as well as direct GBRA damages[8]

Table 11-7. Historic Tornado Event Summary and Annualized Loss

COUNTY	NUMBER OF EVENTS	PROPERTY LOSS (2017 DOLLARS)	ANNUAL LOSS ESTIMATE (2017 DOLLARS)
Caldwell County	22	$74,542,839	$1,096,218

[7] Source: County Central Appraisal Districts

[8] GBRA loss estimates were developed as an average cost per elevated response unless specific event damages were reported.

COUNTY	NUMBER OF EVENTS	PROPERTY LOSS (2017 DOLLARS)	ANNUAL LOSS ESTIMATE (2017 DOLLARS)
Calhoun County	35	$1,704,970	$25,073
Comal County	14	$2,731,993	$40,176
DeWitt County	17	$293,886	$4,322
Gonzales County	26	$9,395,876	$138,175
Guadalupe County	25	$3,011,312	$44,284
Hays County	32	$81,562,051	$1,199,442
Kendall County	20	$12,344,160	$181,532
Refugio County	23	$498,075	$7,325
Victoria County	46	$3,342,923	$49,161
Planning Area Totals	**260**	**$189,428,085**	**$2,785,707**

Table 11-8. GBRA Historic Tornado Event Summary and Direct Annualized Loss

ESTIMATED COST PER EVENT[9]	NUMBER OF EVENTS	TOTAL GBRA COSTS	ANNUAL LOSS ESTIMATE (2017 DOLLARS)
$5,572	260	$1,448,720	$21,305

Assessment of Impacts

Tornadoes have the potential to pose a significant risk to the population and can create dangerous situations. Providing and preserving public health and safety is often difficult.

The direct impacts to the GBRA facilities and services may include:

- Injury to vulnerable employees;
- Extensive power outages;
- Damaged or destroyed structures and infrastructure;
- Decreased hydroelectric power generation;
- Employees unable to report for duty;
- Inadequate staffing for repair work;
- Decreased revenue;
- Dissatisfied customers.

Impacts to counties in the planning area that could indirectly impact GBRA:

- Individuals exposed to the storm can be struck by flying debris, falling limbs, or downed trees causing serious injury or death.

[9] Estimated cost per event represents the average cost of response, recovery and restoration per county event.

- Structures can be damaged or crushed by falling trees, which can result in physical harm to the occupants.
- Significant debris and downed trees can result in emergency response vehicles being unable to access areas of the community.
- Downed power lines may result in roadways being unsafe for use, which may prevent first responders from answering calls for assistance or rescue.
- Tornadoes often result in widespread power outages increasing the risk to more vulnerable portions of the population who rely on power for health and/or life safety.
- Extended power outage can result in an increase in structure fires and/or carbon monoxide poisoning, as individuals attempt to cook or heat their home with alternate, unsafe cooking or heating devices, such as grills.
- Tornadoes can destroy or make residential structures uninhabitable, requiring shelter or relocation of residents in the aftermath of the event.
- First responders are exposed to downed power lines, unstable and unusual debris, hazardous materials, and generally unsafe conditions, elevating the risk of injury to first responders and potentially diminishing emergency response capabilities.
- Emergency operations and services may be significantly impacted due to damaged facilities, loss of communications, and damaged emergency vehicles and equipment.
- Downed power lines and large debris, such as downed trees, can result in the inability of emergency response vehicles to access areas of the community.
- Critical staff may be personally injured or otherwise impacted by a tornado and unable to report for duty, limiting response capabilities.
- City or county departments may be damaged or destroyed, delaying response and recovery efforts for the entire community.
- Private sector entities that the City and its residents rely on, such as utility providers, financial institutions, and medical care providers may not be fully operational and may require assistance from neighboring communities until full services can be restored.
- Economic disruption negatively impacts the programs and services provided by the community due to short and long-term loss in revenue.
- Damage to infrastructure may slow economic recovery since repairs may be extensive and lengthy.
- Some businesses not directly damaged by the tornado may be negatively impacted while roads and utilities are being restored, further slowing economic recovery.
- When the community is affected by significant property damage it is anticipated that funding would be required for infrastructure repair and restoration, temporary services and facilities, overtime pay for responders, as well as normal day-to-day operating expenses.
- Displaced residents may not be able to immediately return to work, further slowing economic recovery.
- Residential structures destroyed by a tornado may not be rebuilt for years, reducing the tax base for the community.
- Large or intense tornadoes may result in a dramatic population fluctuation, as people are unable to return to their homes or jobs and must seek shelter and/or work outside of the affected area.
- Businesses that are uninsured or underinsured may have difficulty reopening, which results in a net loss of jobs for the community and a potential increase in the unemployment rate.
- Recreation activities may be unavailable and tourism can be unappealing for years following a large tornado, devastating directly related local businesses.

The economic and financial impacts of a tornado event will depend entirely on the scale of the event, what is damaged, and how quickly repairs to critical components of the economy can be implemented.

Section 11: Tornado

The level of preparedness and pre-event planning conducted by the GBRA in coordination with local government, businesses, and citizens will contribute to the overall economic and financial conditions in the aftermath of any tornado event.

SECTION 12: HAIL

Hazard Description

Hailstorms are a potentially damaging outgrowth of severe thunderstorms. Early in the developmental stages of a hailstorm, ice crystals form within a low pressure front due to the rapid rising of warm air into the upper atmosphere and the subsequent cooling of the air mass. Frozen droplets gradually accumulate into ice crystals until they fall as precipitation that are round or irregularly shaped masses of ice greater than 0.75 inches in diameter. The size of hailstones is a direct result of the size and severity of the storm. High velocity updraft winds are required to keep hail in suspension in thunderclouds. The strength of the updraft is a byproduct of heating on the Earth's surface. Higher temperature gradients above Earth's surface result in increased suspension time and hailstone size.

Location

Hailstorms are not confined to any specific geographic location and can vary greatly in terms of size, location, intensity, and duration. The entire GBRA planning area is considered to be exposed to this hazard equally.

Extent

The National Weather Service (NWS) classifies a storm as "Severe" if hail of three-quarters of an inch in diameter (approximately the size of a penny) or greater is present. The size determination is based on radar intensity or seen by observers. The intensity category of a hailstorm depends on its size and the potential damage it could cause, as depicted in the National Centers for Environmental Information (NCEI) Intensity Scale in Table 12-1.

Table 12-1. Hail Intensity and Magnitude[1]

SIZE CODE	INTENSITY CATEGORY	SIZE (Diameter Inches)	DESCRIPTIVE TERM	TYPICAL DAMAGE
H0	Hard Hail	Up to 0.33	Pea	No damage
H1	Potentially Damaging	0.33 – 0.60	Marble	Slight damage to plants and crops
H2	Potentially Damaging	0.60 – 0.80	Dime	Significant damage to plants and crops
H3	Severe	0.80 – 1.20	Nickel	Severe damage to plants and crops
H4	Severe	1.2 – 1.6	Quarter	Widespread glass and auto damage
H5	Destructive	1.6 – 2.0	Half Dollar	Widespread destruction of glass, roofs, and risk of injuries
H6	Destructive	2.0 – 2.4	Ping Pong Ball	Aircraft bodywork dented and brick walls pitted
H7	Very Destructive	2.4 – 3.0	Golf Ball	Severe roof damage and risk of serious injuries
H8	Very Destructive	3.0 – 3.5	Hen Egg	Severe damage to all structures
H9	Super Hailstorms	3.5 – 4.0	Tennis Ball	Extensive structural damage, could cause fatal injuries
H10	Super Hailstorms	4.0 +	Baseball	Extensive structural damage, could cause fatal injuries

The scale in Table 12-1 extends from H0 to H10 with increments of intensity or damage potential related to hail size (distribution and maximum), texture, fall speed, speed of storm translation, and strength of the accompanying wind. Based on available data regarding the previous occurrences for the area, the GBRA planning area may experience hailstorms ranging from an H0 to an H10. The planning area can mitigate a storm from low risk or hard hail to a severe, super hailstorm with baseball size hail that leads to extensive structural damage and could cause fatal injuries.

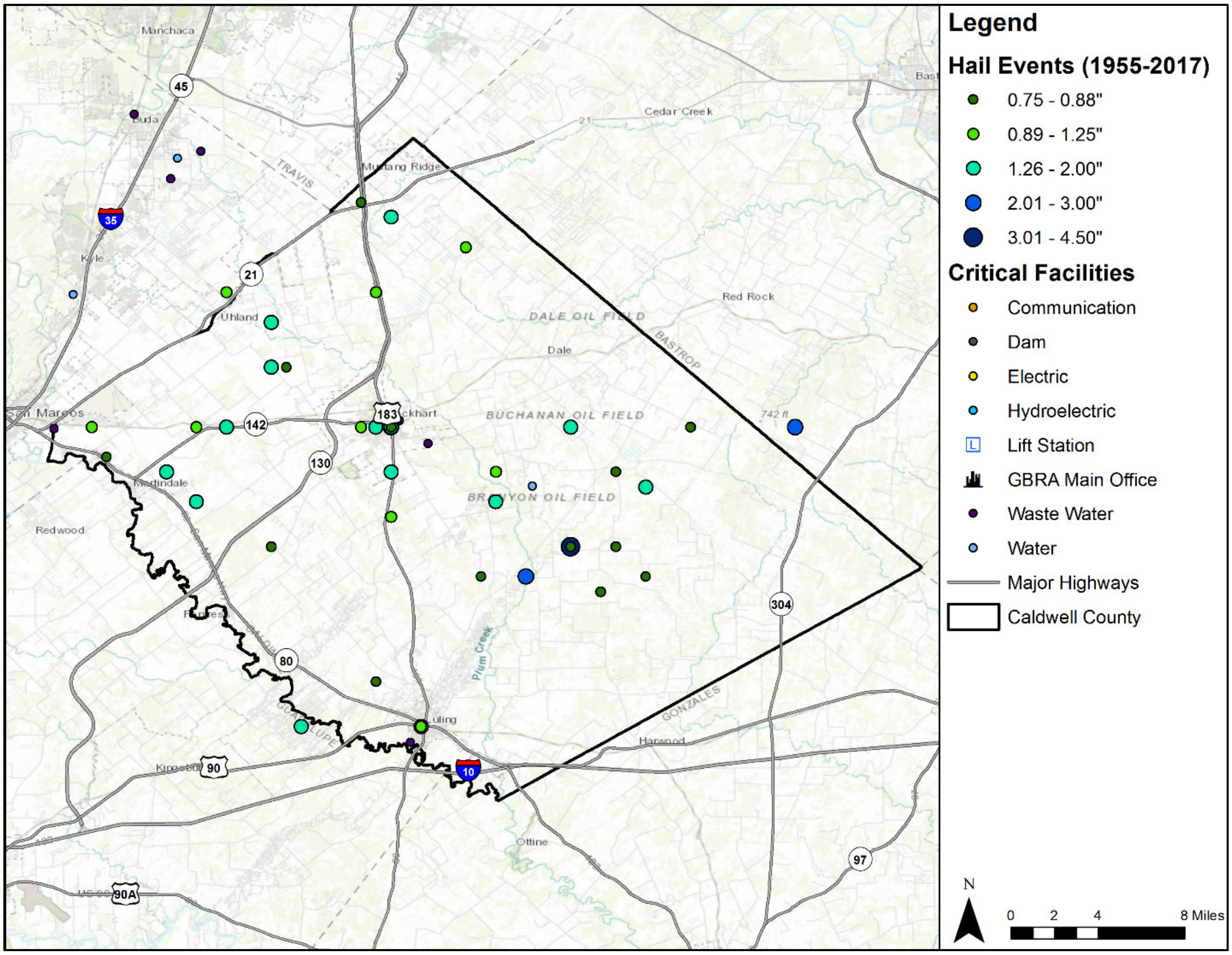
Historical Occurrences

Historical evidence shown in Figure 12-1 shows that the planning area is vulnerable to hail events overall, which typically result from severe thunderstorm activity. The number of reported hail events in the planning area varies by county. Between 1955 and 2017 the number of hail events range from 18 in Calhoun County to 131 in Hays County. Table 12-2 depicts historical summary of hail events

[1] NCEI Intensity Scale, based on the TORRO Hailstorm Intensity Scale.

known to have impacted the GBRA planning area by county[2]. These hail events represent only those that were reported to NCEI, National Oceanic and Atmospheric Administration (NOAA), and may not represent all hail events to have occurred during the past 63 years. Only those events for the GBRA planning area with latitude and longitude available were plotted on the maps in Figures 12-1 through 12-10.

Figure 12-1. Spatial Historical Hail Events Caldwell County, 1955-2017[3]



2 Comprehensive list of historical events available upon request.
3 Source: NOAA/NCEI Records

Figure 12-2. Spatial Historical Hail Events Calhoun County, 1955-2017

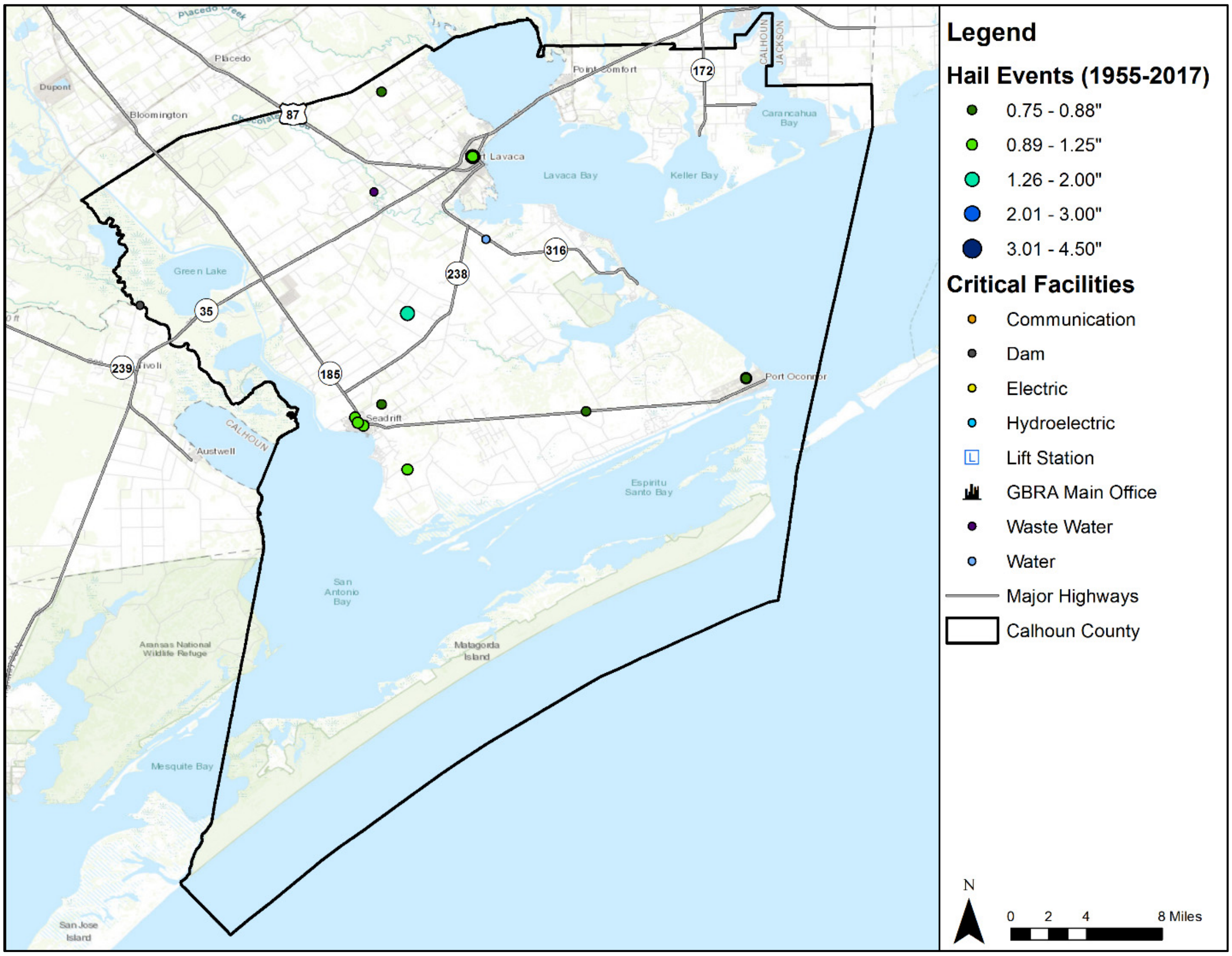


Figure 12-3. Spatial Historical Hail Events Comal County, 1955-2017

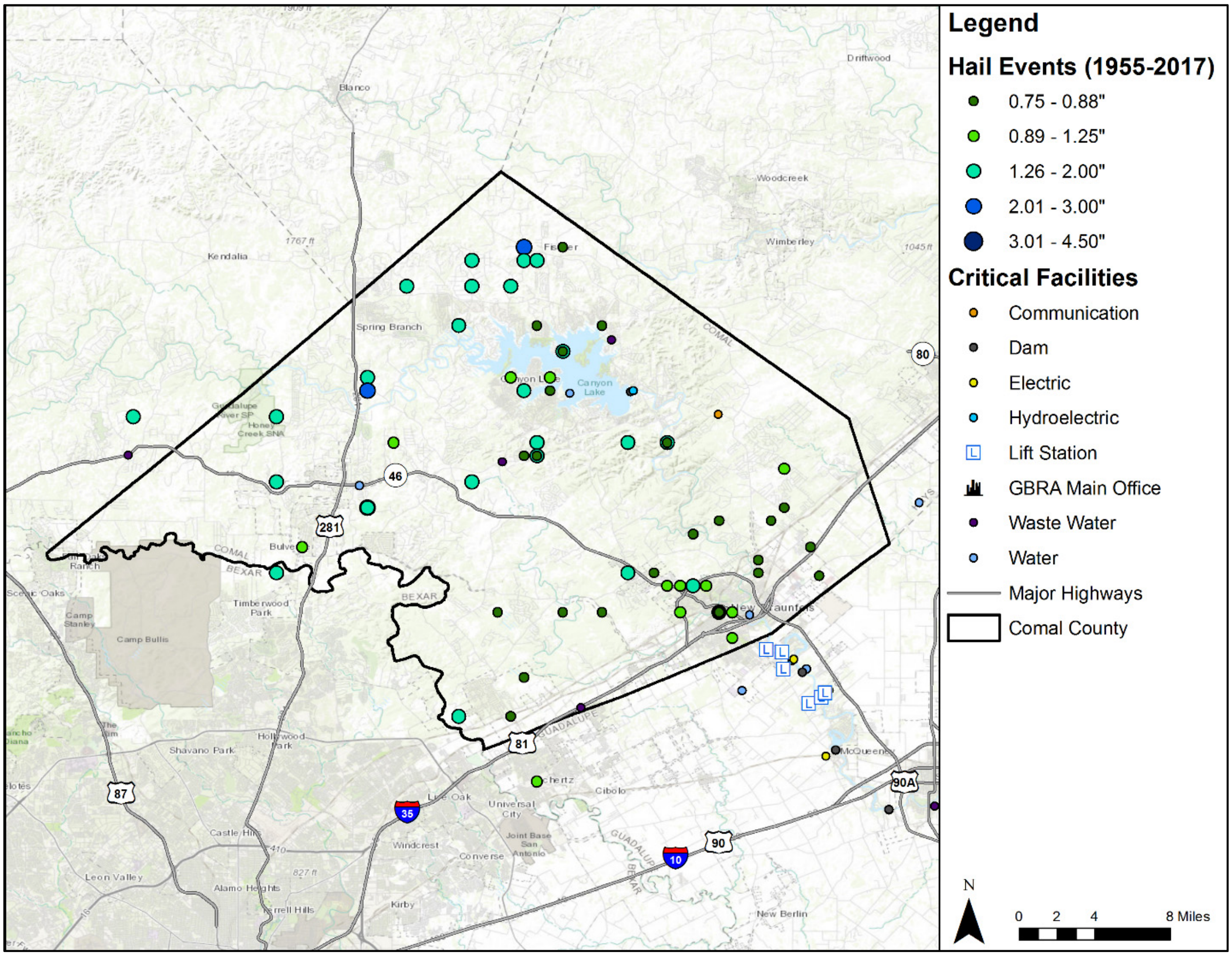


Figure 12-4. Spatial Historical Hail Events DeWitt County, 1955-2017

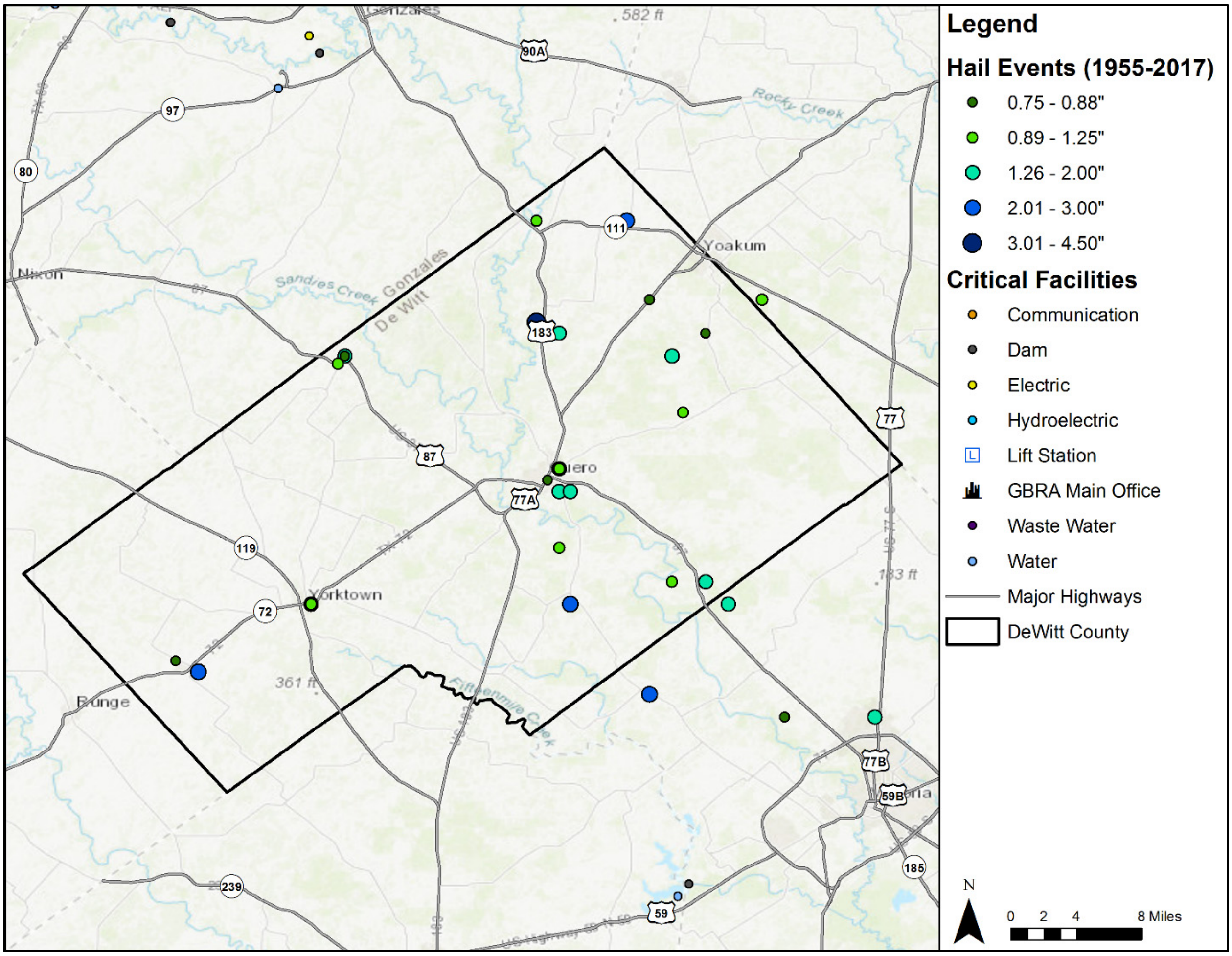


Figure 12-5. Spatial Historical Hail Events Gonzales County, 1955-2017

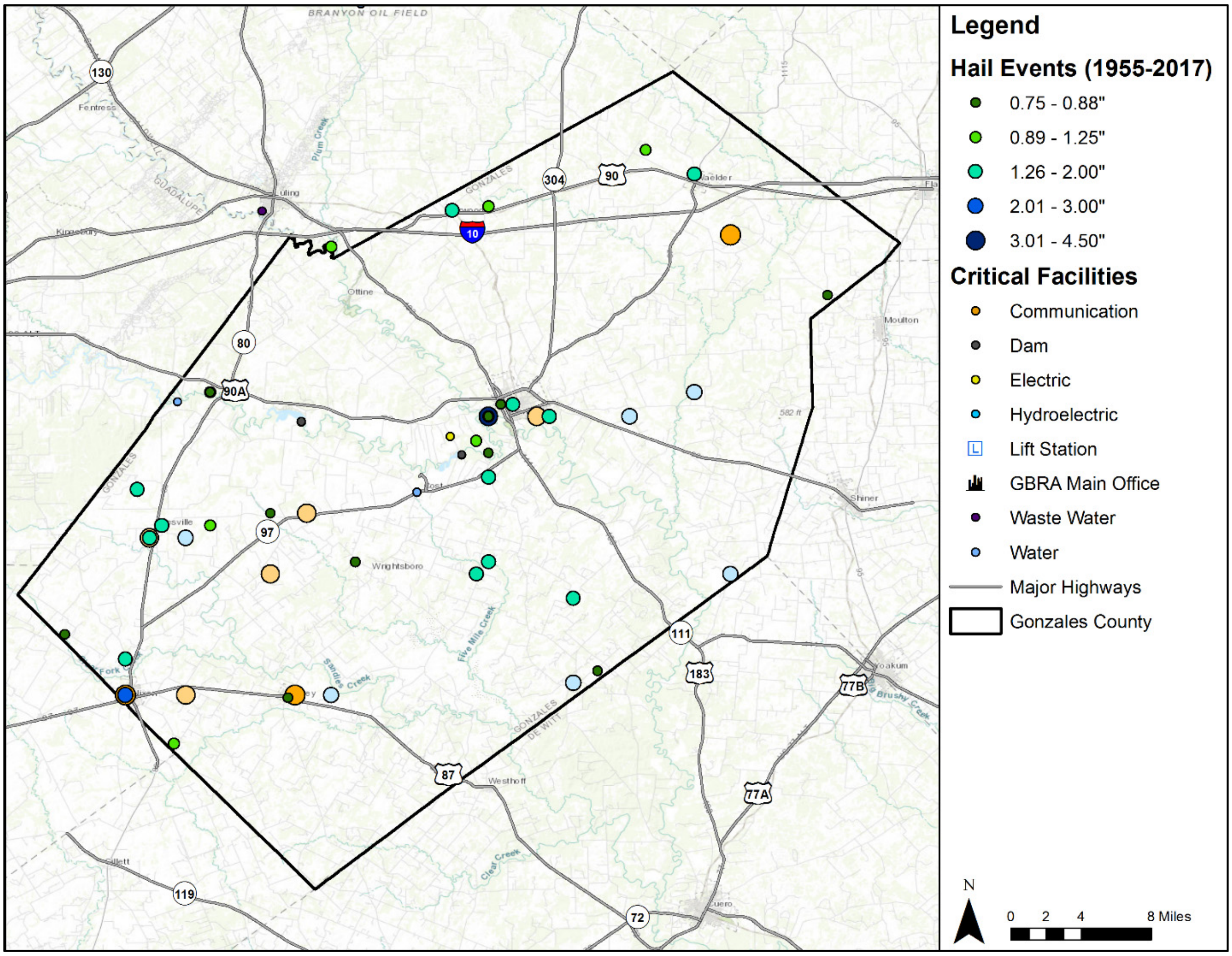


Figure 12-6. Spatial Historical Hail Events Guadalupe County, 1955-2017

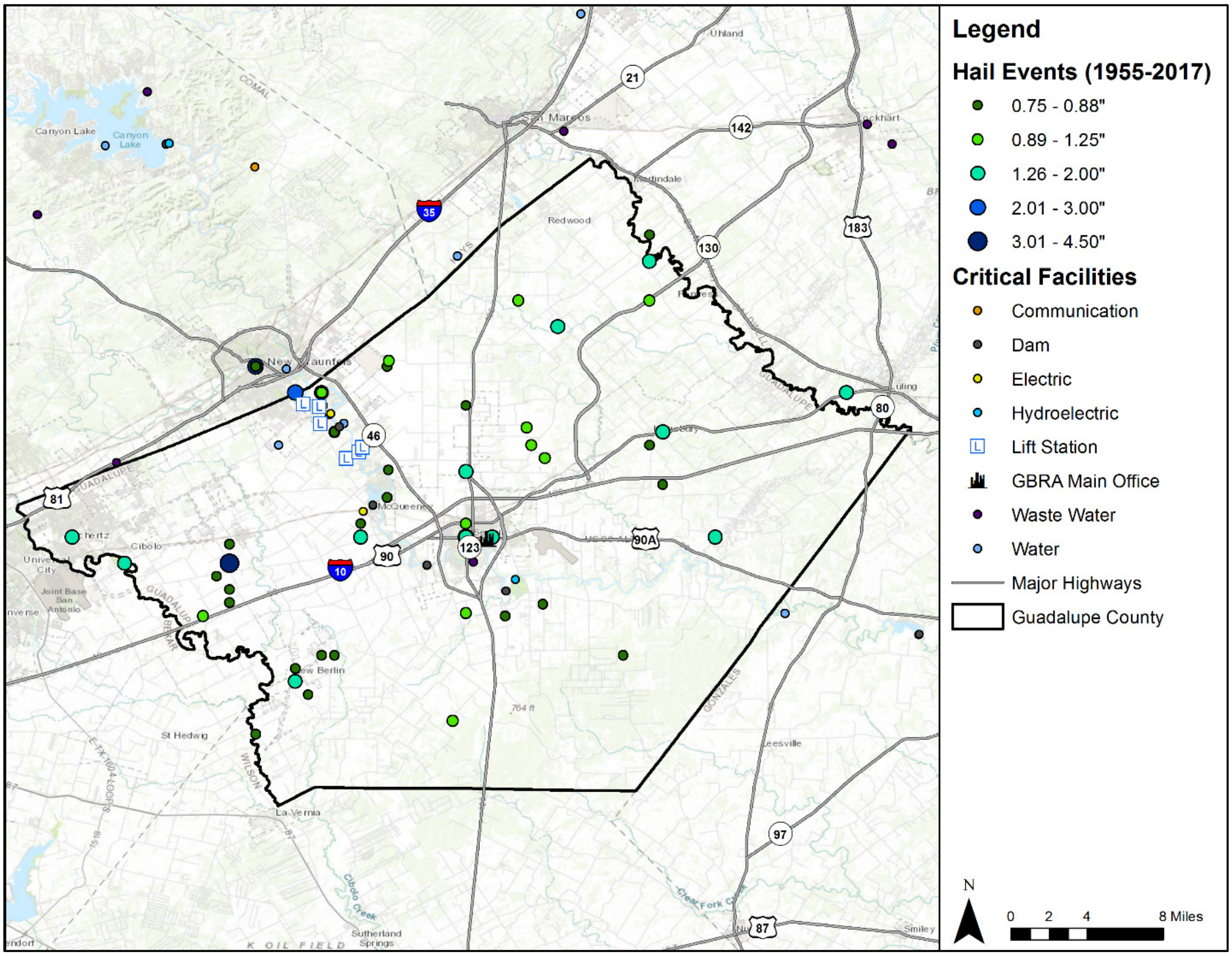


Figure 12-7. Spatial Historical Hail Events Hays County, 1955-2017

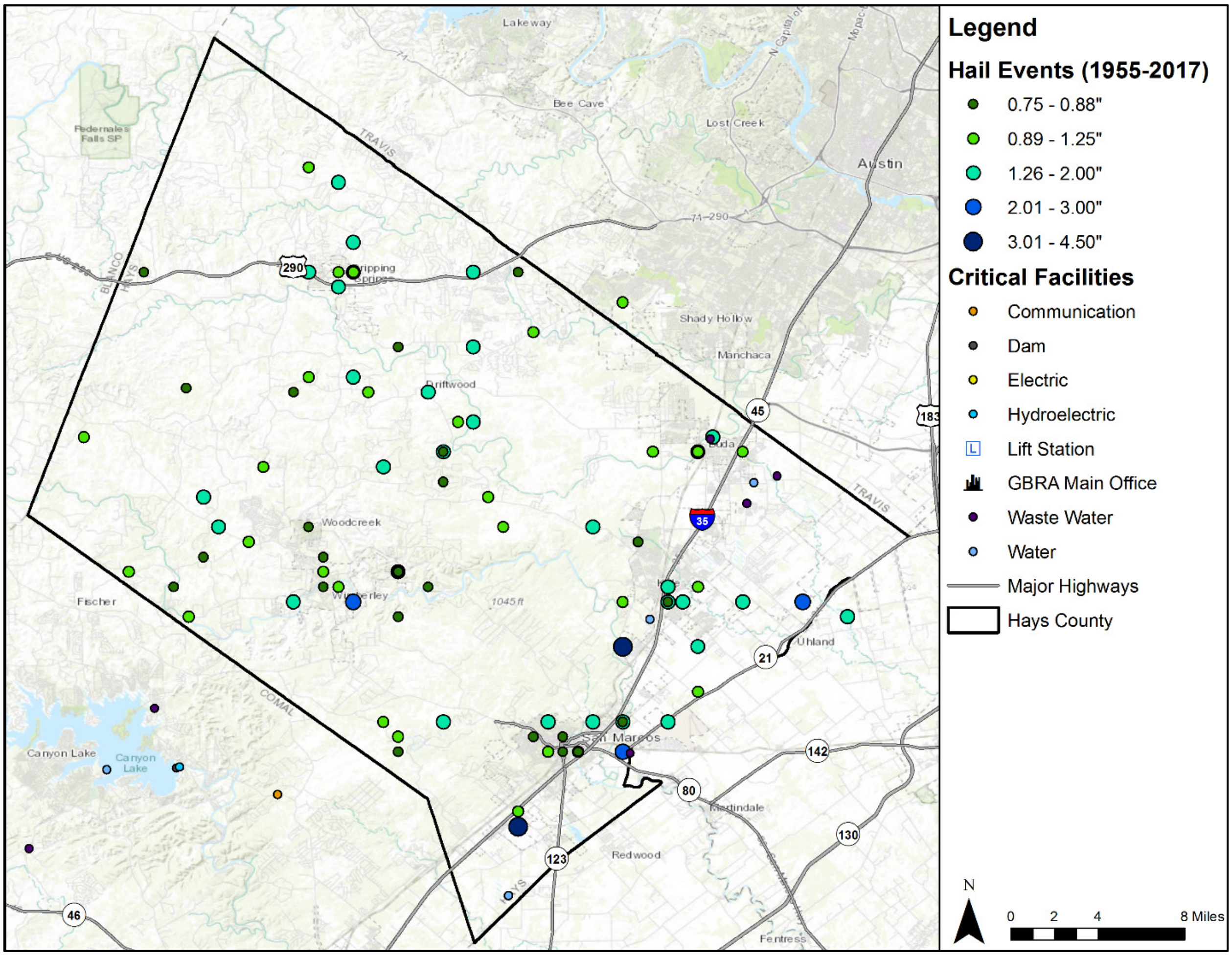


Figure 12-8. Spatial Historical Hail Events Kendall County, 1955-2017

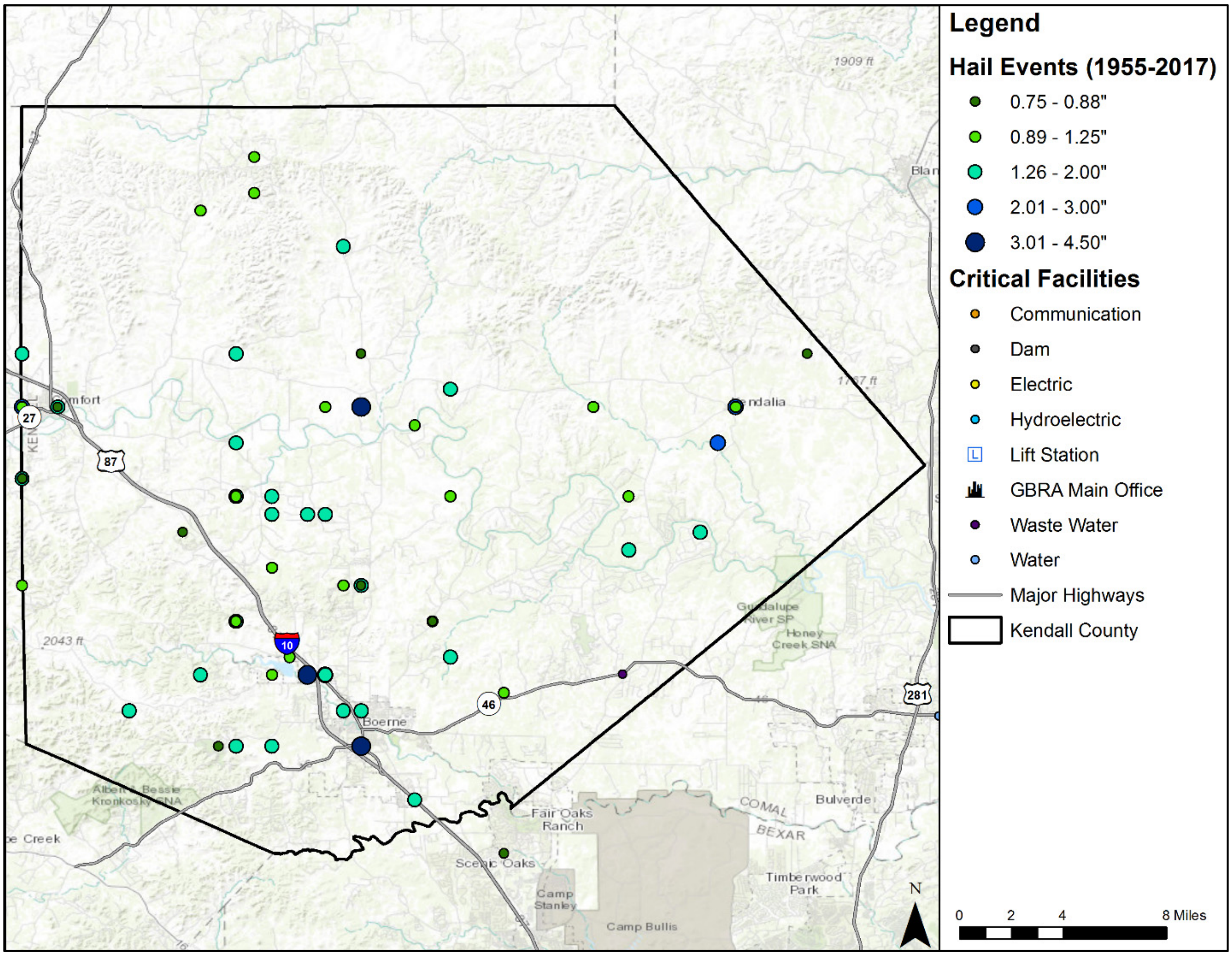


Figure 12-9. Spatial Historical Hail Events Refugio County, 1955-2017

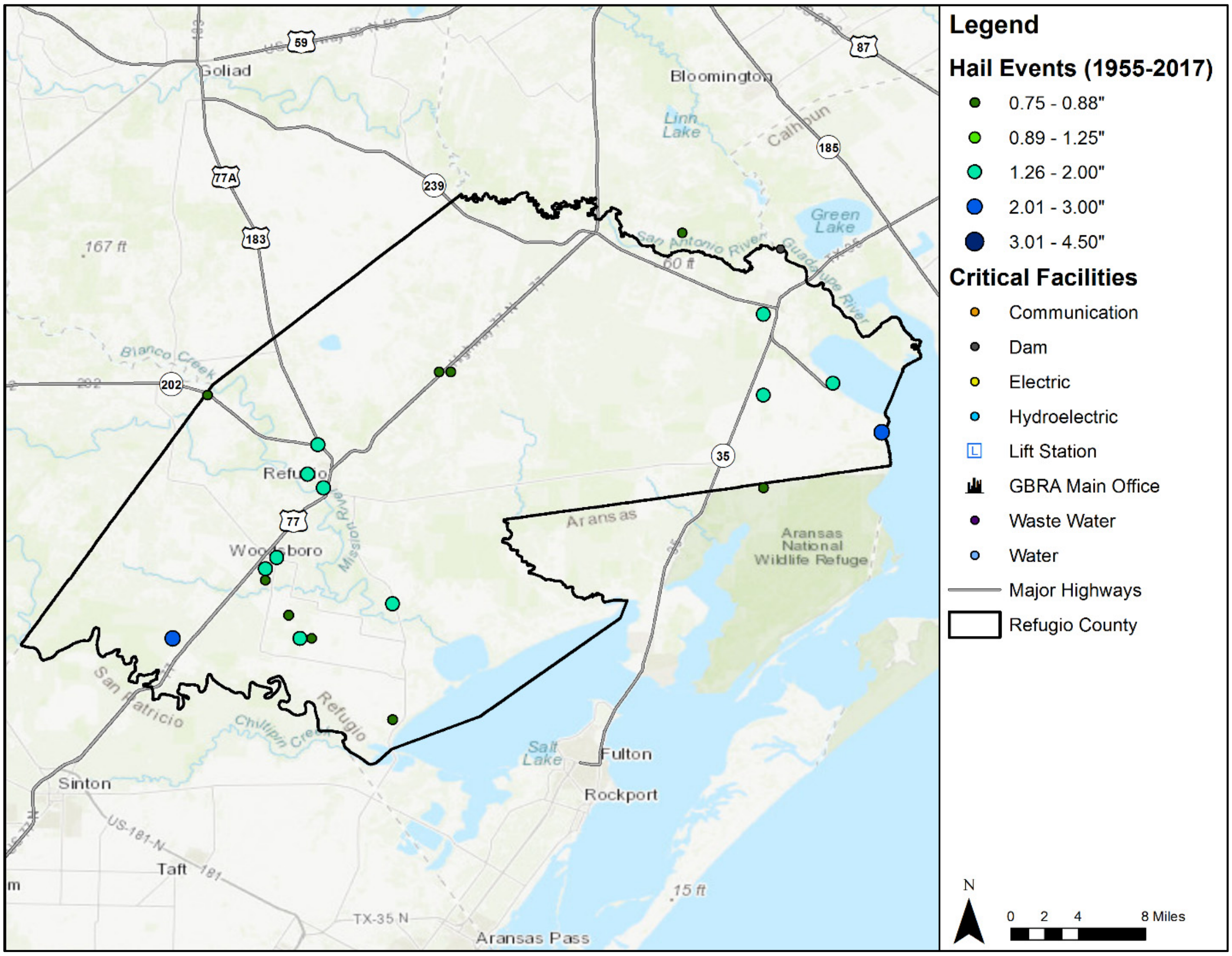
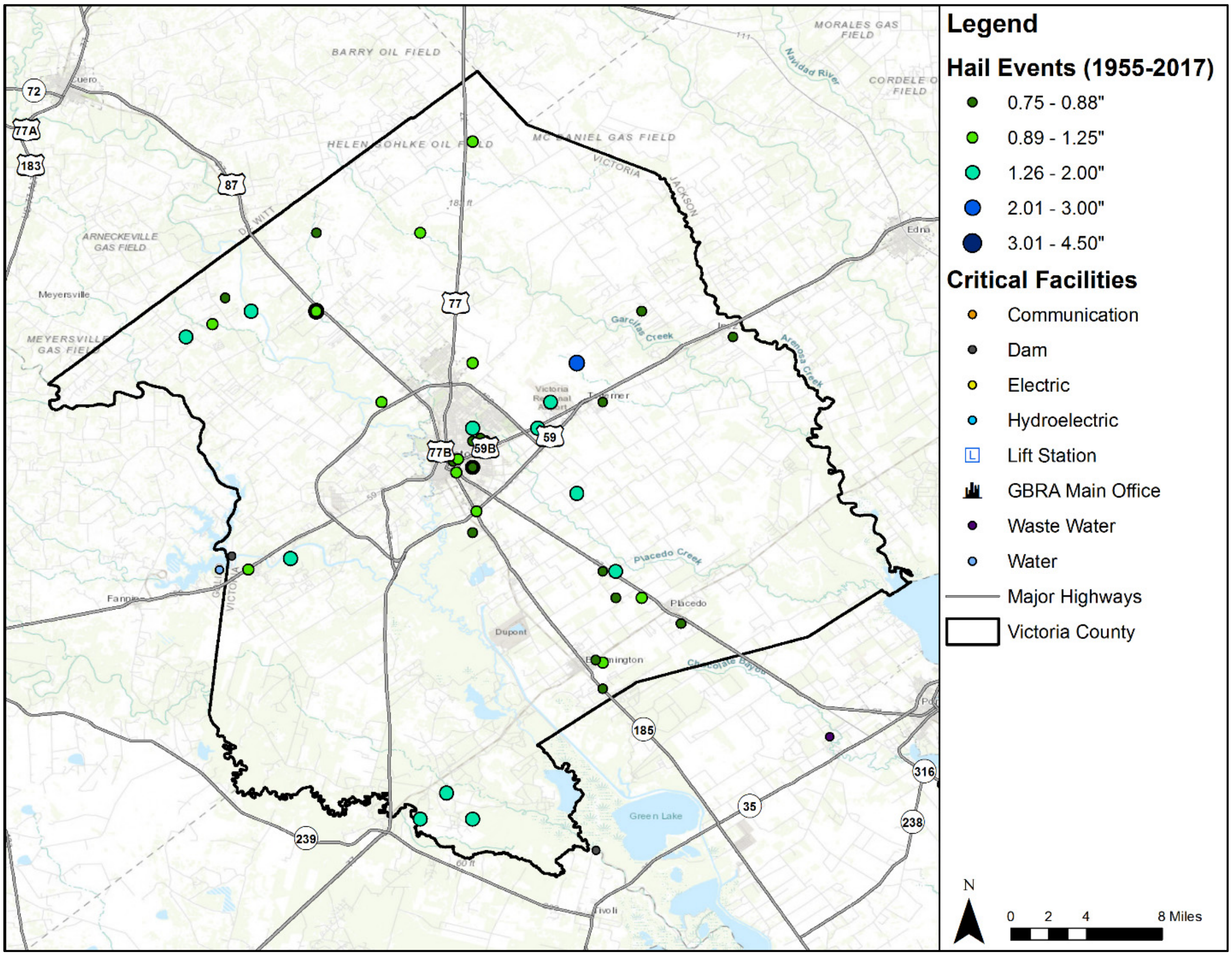


Figure 12-10. Spatial Historical Hail Events Victoria County, 1955-2017



Only hail events that have been reported have been factored into this Risk Assessment. It is likely that additional hail occurrences have gone unreported before and during the recording period. Table 12-2 shows historical incident information for the planning area which resulted in property damage. Table 12-3 provides the direct GBRA estimated costs of response and repair per hail event.

Table 12-2. Historical Hail Events Summary, 1955-2017

COUNTY	NUMBER OF EVENTS	MAGNITUDE	PROPERTY DAMAGE (2017 DOLLARS)
Caldwell County	67	3.5	$318,638
Calhoun County	18	4.5	$15,942
Comal County	114	2.75	$387,795
DeWitt County	52	4.5	$8,709,246
Gonzales County	39	4.5	$5,609

COUNTY	NUMBER OF EVENTS	MAGNITUDE	PROPERTY DAMAGE (2017 DOLLARS)
Guadalupe County	77	4.0	$16,756,756
Hays County	131	4.5	$124,017,501
Kendall County	92	4.25	$243,194
Refugio County	35	2.75	$900,475
Victoria County	96	2.75	$184,809
GBRA Planning Area Losses	**721**		**$151,539,965**

Table 12-3. Estimated GBRA Response, Recovery and Restoration Damages, 1955-2017

ESTIMATED COST PER EVENT[4]	NUMBER OF EVENTS	TOTAL GBRA COSTS
$5,572	721	$4,017,412

Based on the list of historical hail events for the GBRA planning area (listed above), 147 of the events have occurred since the 2011 Plan.

Significant Events

March 27, 1994 – Guadalupe County

Thunderstorms moved through Bexar County, Comal and Guadalupe Counties shortly after 1:00 AM CST, producing damaging wind at New Braunfels and large hail at Schertz and Cibolo. The Guadalupe County Sheriff reported 0.50- to 1-inch hail at Seguin. Damaging winds occurred at the same time, uprooting several trees and knocking down numerous large tree limbs. This thunderstorm system caused extensive property damage and cut off electric service to 11,000 homes. Eleven power lines that had been built to withstand over 100 mph winds were twisted and toppled by the storm. Damage was the most severe from the New Braunfels and Schertz area eastward to Staples. Twenty-one residences in Schertz, Cibolo, and Marion were damaged, with four mobile homes destroyed and four with major damage. Winds were estimated at 50 to 60 mph, with golf ball-size hail. One woman at a flea market on the Interstate 35 portion of Schertz was hit by flying debris and was taken to a hospital. Damage in the Schertz-Cibolo region was estimated at well over $2 million. Barns and storage areas were blown over or damaged. Other damage was mainly to roofs and windows of houses and to windows of automobiles.

April 15, 1994 – DeWitt County

The combination of damaging wind and marble- to dime-sized hail caused extensive damage to homes, trees, and crops between Nordheim, Yorktown, and Arneckville. Several trees were knocked over by the winds which were estimated at over 58 mph. Vegetation was completely stripped from

[4] Estimated cost per event represents the average cost of response, recovery and restoration per county event.

trees and shrubs across the area. Birds and poultry were killed by the storm. Widespread damage was reported to vehicle windows and bodies. Many fields were reported to have been stripped of all vegetation by the storm. Heavy rain accompanied the storm, with up to 3.5 inch accumulations reported.

April 20, 2006 – Hays County

A large hail storm struck the Hays County area on April 20, 2006. Damage was caused by a combination of large hail and winds gusting 40 to 50 mph. Parking lot surfaces were covered with dents and impressions produced by the wind and hail. Hundreds of vehicles had been damaged in this event. Most of these had all of the window glass broken out with hundreds of hail dents in the car bodies. Dents in some vehicles were 4.25 inches in diameter, indicating that at some of the hail stones were as large as grapefruits. Wind speeds were estimated to be between 60 and 70 mph in some areas. Severe wind and hail had caused the worst damage in an area enclosed by Wonder World Drive, Posey Road, Hunter Road, and FM266 which is also known as Old Bastrop Highway. Other areas of large hail and damaging winds were reported to the NWS, but the level of damage was generally more isolated and less severe. Damages from this storm were estimated at $100M with up to 17,000 vehicles damaged. Losses to businesses as a result of closing the following day were estimated at $500,000.

Probability of Future Events

Based on the historical events over the last 63 years (1955 – 2017), a hail event is a highly likely occurrence for the GBRA planning area and multiple events are considered probable in the next year for some portion of the GBRA facilities and infrastructure. Most hailstorms occur during the spring (March, April and May) and in the fall during the month of September. Warning time for a hailstorm is generally minimal, or there is no warning.

Vulnerability and Impact

Damage from hail approaches $1 billion in the U.S. each year. Much of the damage inflicted by hail is to crops. Even relatively small hail can shred plants to ribbons in a matter of minutes. Vehicles, roofs of buildings, homes, and landscaping are the other things most commonly damaged by hail.

Utility systems on roofs at GBRA facilities would be vulnerable and could be damaged. Hail can cause significant threat to people as they could be struck by hail and falling trees and branches. Employees that work outdoors part or full time will be at greater risk to hail events which includes approximately 70 of the 174 GBRA employees. Portable buildings at GBRA facilities would be more vulnerable to hail events than the typical site built structures. Also, hail can cause power outages which could cause health and safety risks to employees and disrupt services provided by the GBRA. While some facilities and infrastructure are more susceptible, all GBRA assets are vulnerable to hail.

Table 12-4 includes the total GBRA assets at risk by county.[5]

[5] GBRA assets include land and improvements including buildings, power substations, dams, radio tower sites, gas storage facilities, electric generating complexes, and support infrastructure.

Table 12-4. GBRA Assets at Risk[6]

COUNTY	EMPLOYEES	ASSETS	MARKET VALUE	ACREAGE
Caldwell County	0	2 Structures, Acreage	$2,238,594	281
Calhoun County	0	Acreage	$610,370	620
Comal County	0	6 Structures, Meter Station, Acreage	$6,686,026	61
DeWitt County	0	2 Structures, Infrastructure	$5,785,030	44
Gonzales County	0	10 Structures, Infrastructure, Acreage	$1,154,710	46
Guadalupe County	174	15 Structures, Lift Station,17 Substations, Infrastructure, Acreage	$64,993,426	199
Hays County	0	Acreage	$35,800	3
Kendall County	0	1 Structure, Acreage	$60,010	1
Refugio County	0	Acreage	$13,360	10
Victoria County	0	Infrastructure	$510,180	0
GBRA Total	**174**	**36 Structures, 17 Substations, Lift Station, Meter Stations, Infrastructure, Acreage**	**$82,087,506**	**1,265**

Hail has been known to cause injury to humans and occasionally has been fatal. The GBRA elevates the response level when hail events occur, resulting in increases in labor, maintenance, and repair costs. GBRA direct response and repair costs as a result of hail events are estimated at $4,017,412, having an approximate annual loss estimate of $63,768 (Table 12-6). Based on historic loss and damages, the impact of hail damages on the GBRA planning area can be considered "Limited" severity of impact, meaning a minor disruption to the quality of life, shutdown of facilities and services for 24 hours or less, and less than ten percent of property is destroyed or experiences major damage.

Historic loss estimates due to hail are presented in Table 12-5 below including an estimate of annualized loss for the GBRA planning area by county. GBRA direct response, recovery and repair damages and annualized losses are presented in Table 12-6.[7]

[6] Source: County Central Appraisal Districts

[7] GBRA loss estimates were developed as an average cost per elevated response unless specific event damages were reported.

Table 12-5. Historic Hail Event Summary and Annualized Loss

COUNTY	NUMBER OF EVENTS	PROPERTY DAMAGES (2017 DOLLARS)	ANNUAL LOSS ESTIMATE (2017 DOLLARS)
Caldwell County	67	$318,638	$5,058
Calhoun County	18	$15,942	$253
Comal County	114	$387,795	$6,155
DeWitt County	52	$8,709,246	$138,242
Gonzales County	39	$5,609	$89
Guadalupe County	77	$16,756,756	$265,980
Hays County	131	$124,017,501	$1,968,532
Kendall County	92	$243,194	$3,860
Refugio County	35	$900,475	$14,293
Victoria County	96	$184,809	$2,933

Table 12-6. GBRA Historic Hail Event Summary and Direct Annualized Loss, 1955-2017

ESTIMATED COST PER EVENT[8]	NUMBER OF EVENTS	TOTAL GBRA COSTS	ANNUAL LOSS ESTIMATE (2017 DOLLARS)
$5,572	721	$4,017,412	$63,768

Assessment of Impacts

Hail events have the potential to pose a significant risk to people, and can create dangerous situations.

The direct impacts to the GBRA facilities and services may include:

- Injury to vulnerable employees;
- Extensive power outages;
- Damaged or destroyed structures and infrastructure;
- Damages to power grid;
- Inadequate staffing for repair work;
- Decreased revenue;
- Dissatisfied customers.

Impacts to counties in the planning area that could indirectly impact GBRA:

- Hail may create hazardous road conditions during and immediately following an event, delaying first responders from providing for or preserving public health and safety.

[8] Estimated cost per event represents the average cost of response, recovery and restoration per county event.

- Individuals and first responders who are exposed to the storm may be struck by hail, falling branches, or downed trees resulting in injuries or possible fatalities.
- Residential structures can be damaged by falling trees, which can result in physical harm to occupants.
- Large hail events will likely cause extensive roof damage to residential structures along with siding damage and broken windows, creating a spike in insurance claims and a rise in premiums.
- Automobile damage may be extensive depending on the size of the hail and length of the storm.
- Hail events can result in power outages over widespread areas increasing the risk to more vulnerable portions of the population who rely on power for health and/or life safety.
- Extended power outage can result in an increase in structure fires and/or carbon monoxide poisoning as individuals attempt to cook or heat their home with alternate, unsafe cooking or heating devices, such as grills.
- First responders are exposed to downed power lines, damaged structures, hazardous spills, and debris that often accompany hail events, elevating the risk of injury to first responders and potentially diminishing emergency response capabilities.
- Downed power lines and large debris, such as downed trees, can result in the inability of emergency response vehicles to access areas of the community.
- Hazardous road conditions may prevent critical staff from reporting for duty, limiting response capabilities.
- Economic disruption negatively impacts the programs and services provided by the community due to short and long-term loss in revenue.
- Some businesses not directly damaged by the hail event may be negatively impacted while roads are cleared and utilities are being restored, further slowing economic recovery.
- Businesses that are more reliant on utility infrastructure than others may suffer greater damages without a backup power source.
- Hazardous road conditions will likely lead to increases in automobile accidents, further straining emergency response capabilities.
- Depending on the severity and scale of damage caused by large hail events, damage to power transmission and distribution infrastructure can require days or weeks to repair.
- A significant hail event could significantly damage agricultural crops, resulting in extensive economic losses for the community and surrounding area.
- Hail events may injure or kill livestock and wildlife.

The economic and financial impacts of hail will depend entirely on the scale of the event, what is damaged, and how quickly repairs to critical components of the economy can be implemented. The level of preparedness and pre-event planning conducted by the GBRA in coordination with local government, businesses, and citizens will contribute to the overall economic and financial conditions in the aftermath of any hail event.

SECTION 13: WINTER STORM

Hazard Description


Source: http://kxan.com/blog/2014/11/12/today-is-texas-winter-weather-awareness-day/

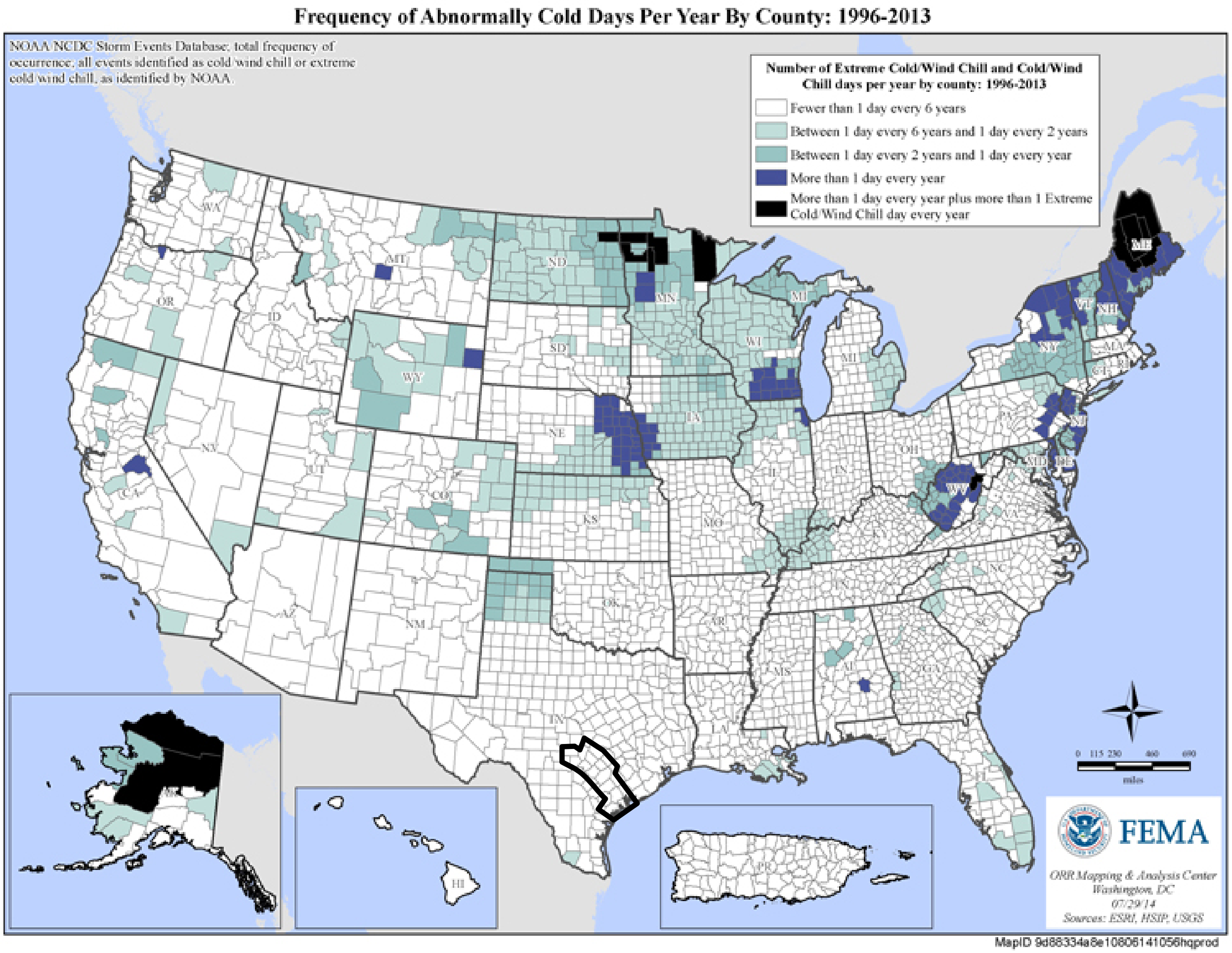
Winter storms can cause significant problems for area residents. A severe winter storm event is identified as a storm with snow and ice or freezing rain. Winter storms are associated with freezing or frozen precipitation such as freezing rain, sleet, snow, and the combined effects of winter precipitation and strong winds. Wind chill is a function of temperature and wind. Low wind chill is a product of high winds and freezing temperatures.

Winter storms that threaten the GBRA planning area usually begin as powerful cold fronts that push south from central Canada. Although the planning area is at risk to ice hazards, snow, and extremely cold temperatures, the effects and frequency of winter storm events are generally mild and short-lived.

Data from the National Oceanic and Atmospheric Administration (NOAA) and National Centers for Environmental Information (NCEI) Storm Events Database shows the total frequency of occurrence of all events identified as blizzards, heavy snow, ice storm, lake-effect snow, and winter storm or winter weather. As indicated in Figure 13-1, on average, the GBRA planning area experiences less than one extreme cold day every six years. Figure 13-2 indicates that on average, the planning area experiences one or fewer of the listed winter storm types per year.[1] Figure 13-3 indicates that the planning area could expect a snow accumulation of 0-3.0 inches a year. During times of ice and snow accumulation, public safety response times can increase until major roads become passable.

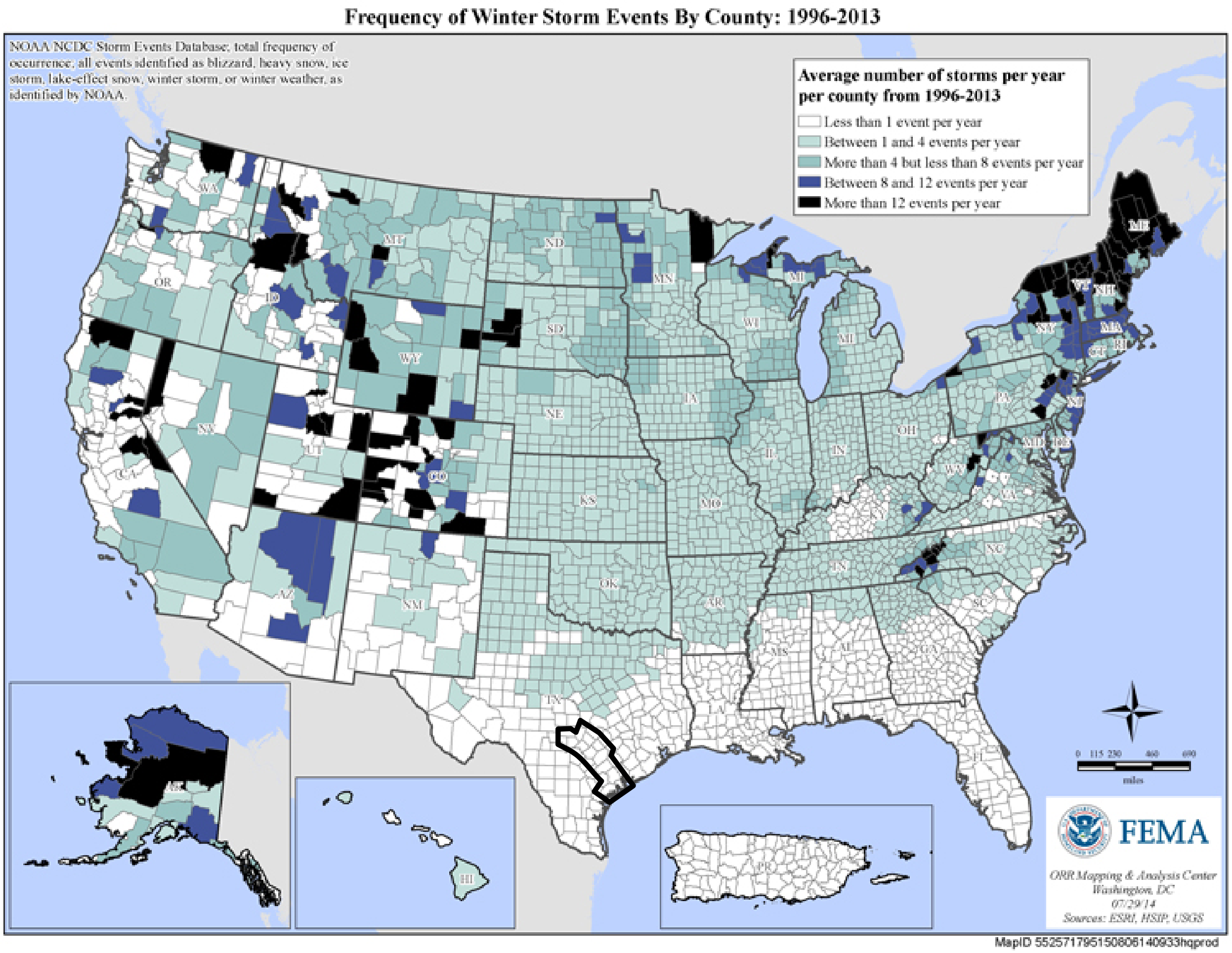
[1] Source: http://community.fema.gov/hazard/winter-storm/be-smart

Figure 13-1. Extreme Cold Days, 1996-2013[2]



[2] The GBRA planning area indicated by the black outline.

Figure 13-2. Frequency of Winter Storm Events, 1996-2013[3]



3 GBRA planning area is indicated by the black outline.

Figure 13-3. Annual Mean Snowfall for Texas[4]

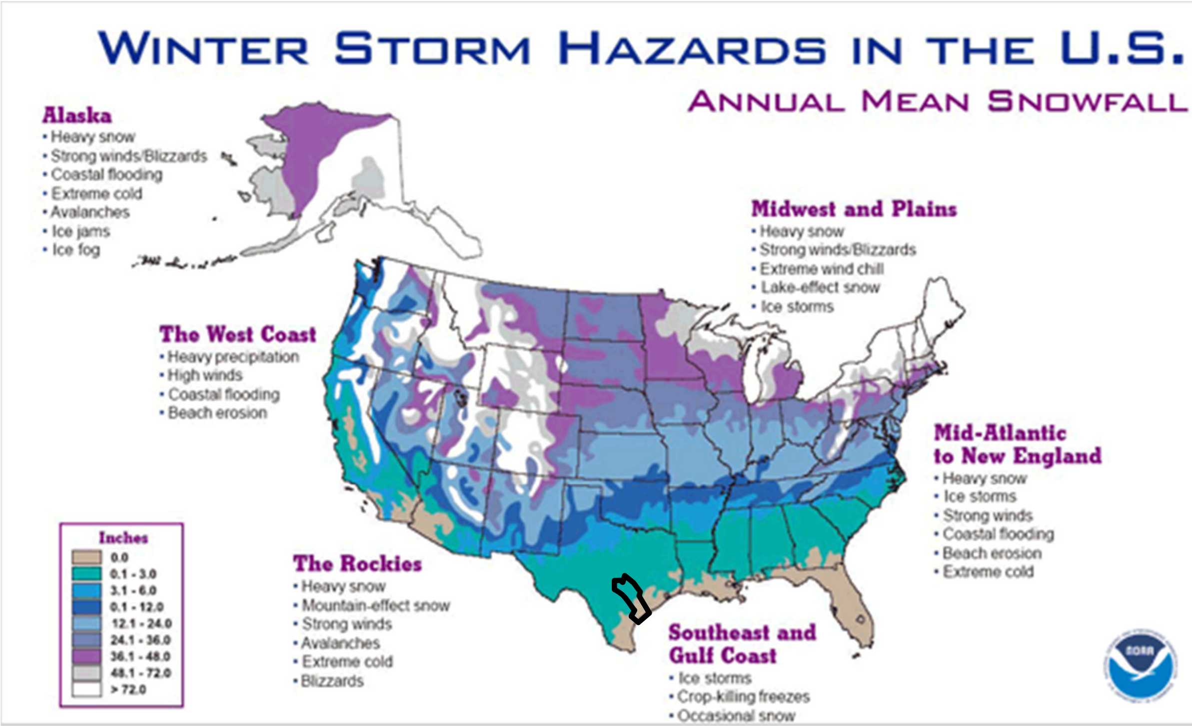


Table 13-1 describes the types of winter storms possible to occur in the GBRA planning area.

Table 13-1. Types of Winter Storms

TYPE OF WINTER STORM	DESCRIPTION
Winter Weather Advisory	Weather advisories may be announced for snow, blowing or drifting snow, freezing drizzle, freezing rain, or a combination of weather events.
Winter Storm Watch	Severe winter weather conditions may include freezing rain, sleet or heavy snow, and conditions may occur separately or in combination.
Winter Storm Warning	Severe winter weather conditions are imminent.
Freezing Rain or Freezing Drizzle	Rain or drizzle is likely to freeze upon impact, resulting in a coating of ice glaze on roads and all other exposed objects.
Sleet	Small particles of ice usually mixed with rain. If enough sleet accumulates on the ground, it makes travel hazardous.
Blizzard Warning	Sustained wind speeds of at least 35 mph are accompanied by considerable falling or blowing snow. These are the most perilous winter storm conditions with visibility dangerously restricted.
Frost/Freeze Warning	Below freezing temperatures are expected and may cause significant damage to plants, crops and fruit trees.
Wind Chill	A strong wind combined with a temperature slightly below freezing can have the same chilling effect as a temperature nearly 50 degrees lower in a calm

[4] GBRA planning area is indicated by the black rectangle

TYPE OF WINTER STORM	DESCRIPTION
	atmosphere. The combined cooling power of the wind and temperature on exposed flesh is called the wind-chill factor.

Location

Because winter storm events are not confined to specific geographic boundaries, all existing and future buildings, facilities, and populations within the GBRA planning area are considered to be exposed to this hazard and could potentially be impacted.

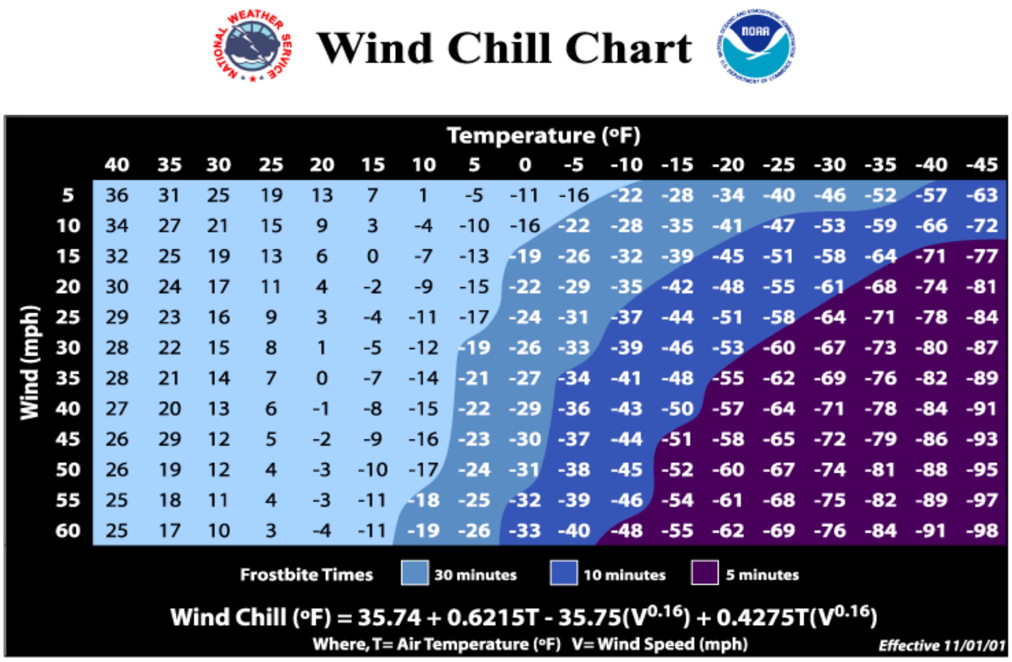
Extent

The extent or magnitude of severe winter storms is measured in intensity based on the temperature and level of accumulations as shown in Table 13-2. The intensity index was developed by the National Weather Service. Table 13-2 is not applicable when temperatures are over 50° or winds are calm, and can be read in conjunction with the wind chill factor described in Figure 13-4.

Table 13-2. Magnitude of Severe Winter Storms

INTENSITY	TEMPERATURE RANGE	EXTENT DESCRIPTION
Mild	40° – 50°	Winds less than 10 mph and freezing rain or light snow falling for short durations with little or no accumulations.
Moderate	30° – 40°	Winds between 10 and 15 mph with sleet and snow up to 4 inches.
Significant	25° – 30°	Intense snow showers accompanied with strong gust winds, between 15 and 20 mph, and significant snow accumulation.
Extreme	20° – 25°	Wind driven snow that reduces visibility, heavy winds between 20 to 30 mph, and sleet or ice up to 5 millimeters in diameter.
Severe	Below 20°	Winds of 35 mph or more, and snow and sleet accumulation greater than 4 inches.

Figure 13-4. Wind Chill Chart



Wind Chill Chart

Wind (mph) \ Temperature (°F)	40	35	30	25	20	15	10	5	0	-5	-10	-15	-20	-25	-30	-35	-40	-45
5	36	31	25	19	13	7	1	-5	-11	-16	-22	-28	-34	-40	-46	-52	-57	-63
10	34	27	21	15	9	3	-4	-10	-16	-22	-28	-35	-41	-47	-53	-59	-66	-72
15	32	25	19	13	6	0	-7	-13	-19	-26	-32	-39	-45	-51	-58	-64	-71	-77
20	30	24	17	11	4	-2	-9	-15	-22	-29	-35	-42	-48	-55	-61	-68	-74	-81
25	29	23	16	9	3	-4	-11	-17	-24	-31	-37	-44	-51	-58	-64	-71	-78	-84
30	28	22	15	8	1	-5	-12	-19	-26	-33	-39	-46	-53	-60	-67	-73	-80	-87
35	28	21	14	7	0	-7	-14	-21	-27	-34	-41	-48	-55	-62	-69	-76	-82	-89
40	27	20	13	6	-1	-8	-15	-22	-29	-36	-43	-50	-57	-64	-71	-78	-84	-91
45	26	29	12	5	-2	-9	-16	-23	-30	-37	-44	-51	-58	-65	-72	-79	-86	-93
50	26	19	12	4	-3	-10	-17	-24	-31	-38	-45	-52	-60	-67	-74	-81	-88	-95
55	25	18	11	4	-3	-11	-18	-25	-32	-39	-46	-54	-61	-68	-75	-82	-89	-97
60	25	17	10	3	-4	-11	-19	-26	-33	-40	-48	-55	-62	-69	-76	-84	-91	-98

Frostbite Times: 30 minutes, 10 minutes, 5 minutes

Wind Chill (°F) = $35.74 + 0.6215T - 35.75(V^{0.16}) + 0.4275T(V^{0.16})$

Where, T= Air Temperature (°F) V= Wind Speed (mph)

Effective 11/01/01

Wind chill temperature is a measure of how cold the wind makes real air temperature feel to the human body. Since wind can dramatically accelerate heat loss from the body, a blustery 30° day would feel just as cold as a calm day with 0° temperatures. The GBRA planning area has never experienced a blizzard, but based on 93 previous occurrences across ten counties recorded from 1996 to 2017, the planning area has been subject to winter storm watches, warnings, freezing rain, snow, and wind chill.

Based on the data for historical occurrences and the planning area location, the average event for the planning area to mitigate would be mild to moderate winter storm. The GBRA planning area can expect anywhere between 0 to 4.0 inches of ice and snow during a winter storm event and temperatures between 30 and 50 degrees with winds ranging from 0 to 15 mph.

Historical Occurrences

Table 13-3 shows the summary of historical occurrence of winter storm events for each county in the GBRA planning area from 1996 to 2017, provided by the NCEI database. There have been 93 recorded winter storm events across the ten-county planning area. Only winter storm events that have been reported have been factored into this Risk Assessment. It is likely that additional winter storm occurrences have gone unreported before and during the recording period. Historical winter storm information, as provided by the NCEI, shows winter storm activity across a multi-county forecast area for each event. The appropriate percentage of the total property damage reported for the entire forecast area has been allocated to each county impacted by the event. Table 13-3 shows the historical incident information summary by county for the planning area.[5] Table 13-4 provides the direct GBRA estimated costs of response and repair per winter storm event.

[5] Comprehensive list of historical events available upon request.

Table 13-3. Historical Winter Storm Events Summary, 1996-2017

COUNTY	NUMBER OF EVENTS	FATALITIES	INJURIES	PROPERTY DAMAGE (2017 DOLLARS)
Caldwell County	12	0	0	$0
Calhoun County	5	0	0	$0
Comal County	15	0	0	$0
DeWitt County	5	0	0	$0
Gonzales County	5	0	0	$0
Guadalupe County	9	0	0	$0
Hays County	13	0	0	$151,003
Kendall County	16	0	0	$0
Refugio County	5	0	0	$0
Victoria County	8	0	0	$52,267
GBRA Planning Area Losses	**93**	**0**	**0**	**$203,270**

Table 13-4. Estimated GBRA Response, Recovery and Restoration Damages, 1996-2017

ESTIMATED COST PER EVENT[6]	NUMBER OF EVENTS	TOTAL GBRA COSTS
$2,009	93	$186,837

Based on the list of historical winter storm events for the GBRA planning area (listed above), 38 of the events have occurred since the 2011 Plan.

Significant Events

January 15, 2007 – All GBRA Counties

Cold air poured into South Central Texas on January 14 and 15 in the wake of a strong cold front, with temperatures ranging from the mid-thirties to just below freezing early on the morning of January 15. At the same time, an upper level disturbance began to approach South Texas from the southwest. Light precipitation from the upper level system began falling through the cold air and freezing over the northwest counties first. With time, the event spread to the west and southeast, including all but the extreme southern tier of counties, by January 16. Spotty 1 to 2 inch snowfalls were common over the Hill Country and Edwards Plateau. The serious problems were associated with coatings of freezing rain and drizzle that varied from one-half inch to three-quarters of an inch in thickness. In many locations, schools and businesses and local offices were already closed on January 15 due to the Martin Luther King Holiday and simply did not re-open until Wednesday, January 16, or Thursday, January 17. Hundreds of accidents were reported on interstate highways as well as city and rural

[6] Estimated cost per event represents the average cost of response, recovery and restoration per county event.

roads, causing additional closures and problems. Most area schools were closed on January 16 as a result of the storm. The only reported damages occurred in the City of San Marcos in Hays County.

January 24, 2014 – Victoria County
During the afternoon on January 23rd, 2014, a strong Arctic cold front moved through South Texas. Temperatures dropped around 20 degrees in 3 hours and around 30 degrees in 6 hours after the front had passed. Maximum wind gusts behind the front across most of South Texas averaged between 35 and 40 mph. Bob Hall Pier recorded a peak wind gust of 49 mph, the Naval Air Station in Corpus Christi recorded a peak wind gust of 48 mph, and the Corpus Christi International Airport recorded a peak wind gust of 46 mph during the evening of the 23rd.

Overrunning moisture along with an upper level disturbance aided in the development of precipitation behind the cold front. As temperatures plummeted into the 30s, a wintry mix of precipitation began to develop as early as 8:00 PM CST on the 23rd across the northern Brush Country. As the Arctic air mass became more entrenched across South Texas during the late evening and overnight hours, freezing rain and freezing drizzle sometimes mixed with sleet became the more dominant precipitation type across much of South Texas. The wintry precipitation ended around 900 AM CST on the 24th along the coast. Ice accumulations averaged from less than a tenth of an inch to around an eighth of an inch for most of South Texas except for portions along the Middle Texas Coast where no ice accumulation occurred since the temperatures within this area remained just above freezing. Ice accumulations around an eighth of an inch occurred across portions of Jim Wells, Live Oak, Bee, Goliad, and Victoria counties.

Multiple vehicle accidents occurred across South Texas due to the icy roads and bridges. Even portions of Interstate 35, Interstate 37, and US Highway 181 along with the Harbor Bridge were closed briefly during the morning of the 24th. Most roads were re-opened by 10:00 AM CST on the 24th as the temperatures slowly rose above freezing. Many schools either delayed or canceled classes. Flights were delayed for several hours at the Victoria Regional Airport. Power outages were also reported.

Probability of Future Events

Based on the historical events over the last 22 years (1996 – 2017), a winter storm event is a highly likely occurrence for the GBRA planning area and multiple events are considered probable in the next year for some portion of the GBRA facilities and infrastructure.

Vulnerability and Impact

During periods of extreme cold and freezing temperatures, water pipes can freeze and crack, and ice can build up on power lines, causing them to break under the weight or causing tree limbs to fall on the lines. These events can disrupt electric service for long periods.

An economic impact may occur due to increased consumption of heating fuel, which can lead to energy shortages and higher prices. House fires and resulting deaths tend to occur more frequently from increased and improper use of alternate heating sources. Fires during winter storms also present a greater danger because water supplies may freeze and impede firefighting efforts.

All populations, buildings, critical facilities, and infrastructure in the entire GBRA planning area are vulnerable to severe winter events. Table 13-5 includes the total GBRA assets at risk by county.[7]

Table 13-5. GBRA Assets at Risk[8]

COUNTY	EMPLOYEES	ASSETS	MARKET VALUE	ACREAGE
Caldwell County	0	2 Structures, Acreage	$2,238,594	281
Calhoun County	0	Acreage	$610,370	620
Comal County	0	6 Structures, Meter Station, Acreage	$6,686,026	61
DeWitt County	0	2 Structures, Infrastructure	$5,785,030	44
Gonzales County	0	10 Structures, Infrastructure, Acreage	$1,154,710	46
Guadalupe County	174	15 Structures, Lift Station,17 Substations, Infrastructure, Acreage	$64,993,426	199
Hays County	0	Acreage	$35,800	3
Kendall County	0	1 Structure, Acreage	$60,010	1
Refugio County	0	Acreage	$13,360	10
Victoria County	0	Infrastructure	$510,180	0
GBRA Total	**174**	**36 Structures, 17 Substations, Lift Station, Meter Stations, Infrastructure, Acreage**	**$82,087,506**	**1,265**

People and animals are subject to health risks from extended exposure to cold air. Elderly people are at greater risk of death from hypothermia during these events, especially in the rural areas of the county where populations are sparse, icy roads may impede travel, and there are fewer neighbors to check in on the elderly. According to the U.S. Center for Disease Control, every year hypothermia kills about 600 Americans, half of whom are 65 years of age or older. Employees that work outdoors part or full time will be at greater risk to winter storm events which includes approximately 70 of the 174 GBRA employees (approximately 40% of the work force).

The GBRA elevates the response level when winter storm events occur resulting in increases in labor, maintenance and repair costs. GBRA direct response and repair costs as a result of winter storm events are estimated at $186,837, having an approximate annual loss estimate of $8,493. The potential severity of impact is limited meaning injuries are treatable with first aid, shutdown of facilities and services for 24 hours or less, and less than 10% of property destroyed or with major damage. Loss estimates were based on 22 years of statistical data from the NCEI. Only winter storm events that have been reported have been factored into this Risk Assessment. It is likely that additional winter

[7] GBRA assets include land and improvements including buildings, power substations, dams, radio tower sites, gas storage facilities, electric generating complexes, and support infrastructure.
[8] Source: County Central Appraisal Districts

storm occurrences have gone unreported before and during the recording period. Table 13-6 shows the annualized losses by county. Table 13-7 shows the direct response and repair costs estimated for the GBRA facilities and assets[9].

Table 13-6. Historic Winter Storm Event Summary and Annualized Loss, 1996-2017

COUNTY	NUMBER OF EVENTS	PROPERTY DAMAGES (2017 DOLLARS)	ANNUALIZED LOSS ESTIMATE (2017 DOLLARS)
Caldwell County	12	$0	$0
Calhoun County	5	$0	$0
Comal County	15	$0	$0
DeWitt County	5	$0	$0
Gonzales County	5	$0	$0
Guadalupe County	9	$0	$0
Hays County	13	$151,003	$6,864
Kendall County	16	$0	$0
Refugio County	5	$0	$0
Victoria County	8	$52,267	$2,376
GBRA Total	**93**	**$203,270**	**$9,240**

Table 13-7. GBRA Historic Winter Storm Event Summary and Direct Annualized Losses, 1996-2017

ESTIMATED COST PER EVENT[10]	NUMBER OF EVENTS	TOTAL GBRA COSTS	ANNUAL L OSS ESTIMATE (2017 DOLLARS)
$2,009	93	$186,837	$8,493

Assessment of Impacts

The greatest risk from a winter storm hazard is to public health and safety.

The direct impacts to the GBRA facilities and services may include:

- Injury to vulnerable employees;
- Extensive power outages;
- Damaged or destroyed structures and infrastructure;
- Employees unable to report for duty;

[9] GBRA loss estimates were developed as an average cost per elevated response unless specific event damages were reported.

[10] Estimated cost per event represents the average cost of response, recovery and restoration per county event.

- Damages to power grid and substations;
- Inadequate staffing for repair work;
- Decreased revenue;
- Dissatisfied customers.

Impacts to counties in the planning area that could indirectly impact GBRA:

- Vulnerable populations, particularly the elderly and infants, can face serious or life-threatening health problems from exposure to extreme cold including hypothermia and frostbite.
- Loss of electric power or other heat source can result in increased potential for fire injuries or hazardous gas inhalation because residents burn candles for light or use fires or generators to stay warm.
- Response personnel, including utility workers, public works personnel, debris removal staff, tow truck operators, and other first responders are subject to injury or illness resulting from exposure to extreme cold temperatures.
- Response personnel would be required to travel in potentially hazardous conditions, elevating the life safety risk due to accidents, and potential contact with downed power lines.
- Operations or service delivery may experience impacts from electricity blackouts due to winter storms.
- Power outages are possible throughout the planning area due to downed trees and power lines and/or rolling blackouts.
- Critical facilities without emergency backup power may not be operational during power outages.
- Emergency response and service operations may be impacted by limitations on access and mobility if roadways are closed, unsafe, or obstructed.
- Hazardous road conditions will likely lead to increases in automobile accidents, further straining emergency response capabilities.
- Depending on the severity and scale of damage caused by ice and snow events, damage to power transmission and distribution infrastructure can require days or weeks to repair.
- A winter storm event could lead to tree, shrub, and plant damage or death.
- Schools may be forced to close early due to deteriorating road conditions.
- Severe cold and ice could significantly damage agricultural crops.
- Exposed water pipes may be damaged by severe or late season winter storms at both residential and commercial structures, causing significant damages.

The economic and financial impacts of winter storms will depend entirely on the scale of the event, what is damaged, and how quickly repairs to critical components of the economy can be implemented. The level of preparedness and pre-event planning conducted by the GBRA in coordination with local government, businesses, and citizens will contribute to the overall economic and financial conditions in the aftermath of any winter storm event.

SECTION 14: WILDFIRE

Hazard Description

A wildfire event can be a potentially damaging consequence of drought. A wildfire event can rapidly spread out of control and occurs most often in the summer, when the brush is dry and flames can move unchecked through a highly vegetative area. Wildfires can start as a slow burning fire along the forest floor, killing and damaging trees. The fires often spread more rapidly as they reach the tops of trees, with wind carrying the flames from tree to tree. Usually, dense smoke is the first indication of a wildfire.

A wildfire event often begins unnoticed and spreads quickly, lighting brush, trees and homes on fire. For example, a wildfire may be started by a campfire that was not doused properly, a tossed cigarette, burning debris, or arson.

Texas has seen a significant increase in the number of wildfires in the past 30 years, which included wildland, interface, or intermix fires. Wildland Urban Interface or Intermix (WUI) fires occur in areas where structures and other human improvements meet or intermingle with undeveloped wildland or vegetative fuels.

Location

Wildfires can vary greatly in terms of size, location, intensity, and duration. While wildfires are not confined to any specific geographic location, they are most likely to occur in open grasslands. The threat to people and property from a wildfire event is greater in the fringe areas where developed areas meet open grass lands, such as the WUI (Figures 14-1 through 14-10). GBRA primary facilities are identified by county under each figure below. However, it should be noted that GBRA infrastructure is located throughout each county in the planning area. It is estimated that 91 percent of the GBRA facilities are located within the WUI. However, the entire GBRA planning area is at risk for wildfires.

Figure 14-1. GBRA Wildland Urban Interface Map – Caldwell County

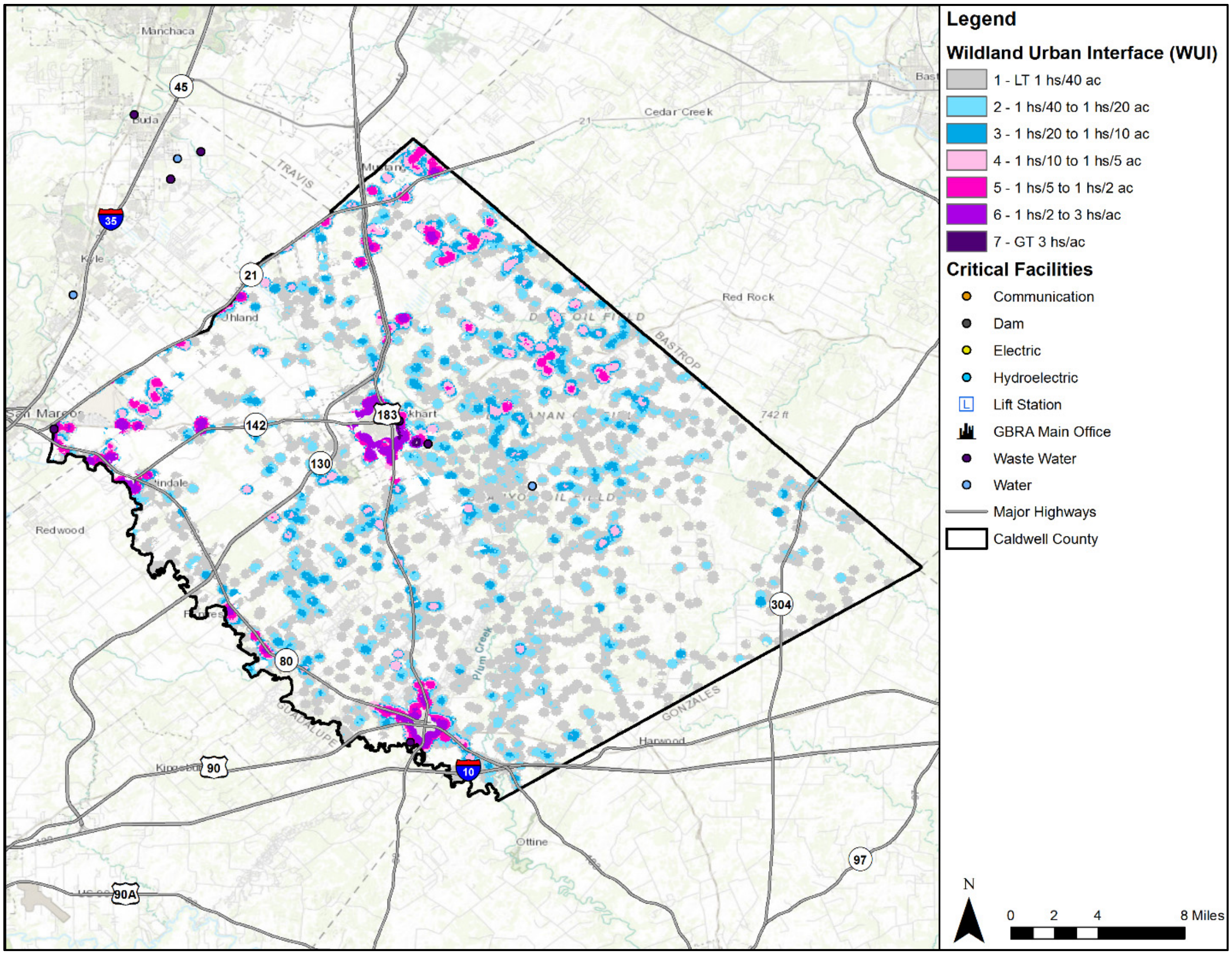


Figure 14-2. GBRA Wildland Urban Interface Map – Calhoun County

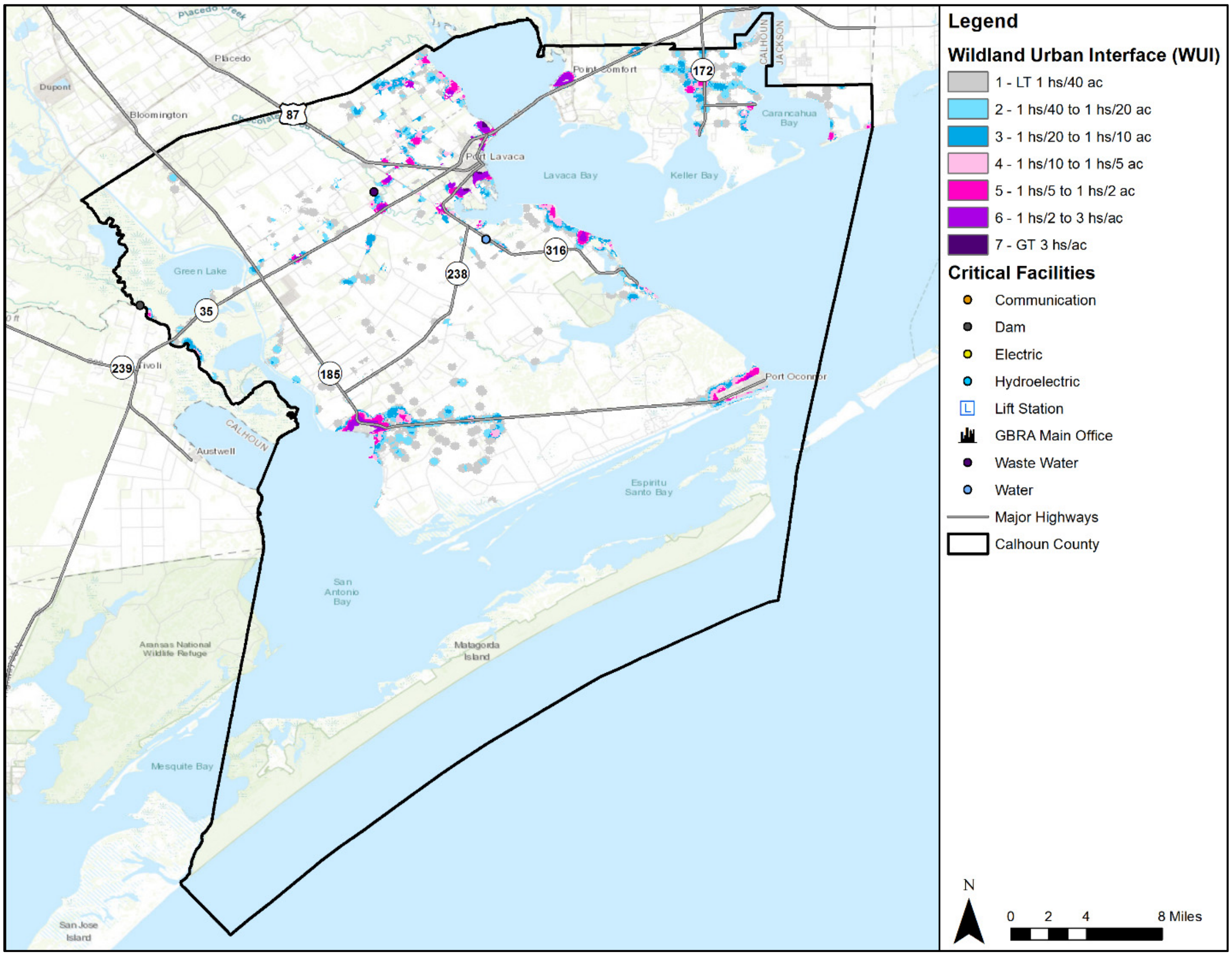


Figure 14-3. GBRA Wildland Urban Interface Map – Comal County

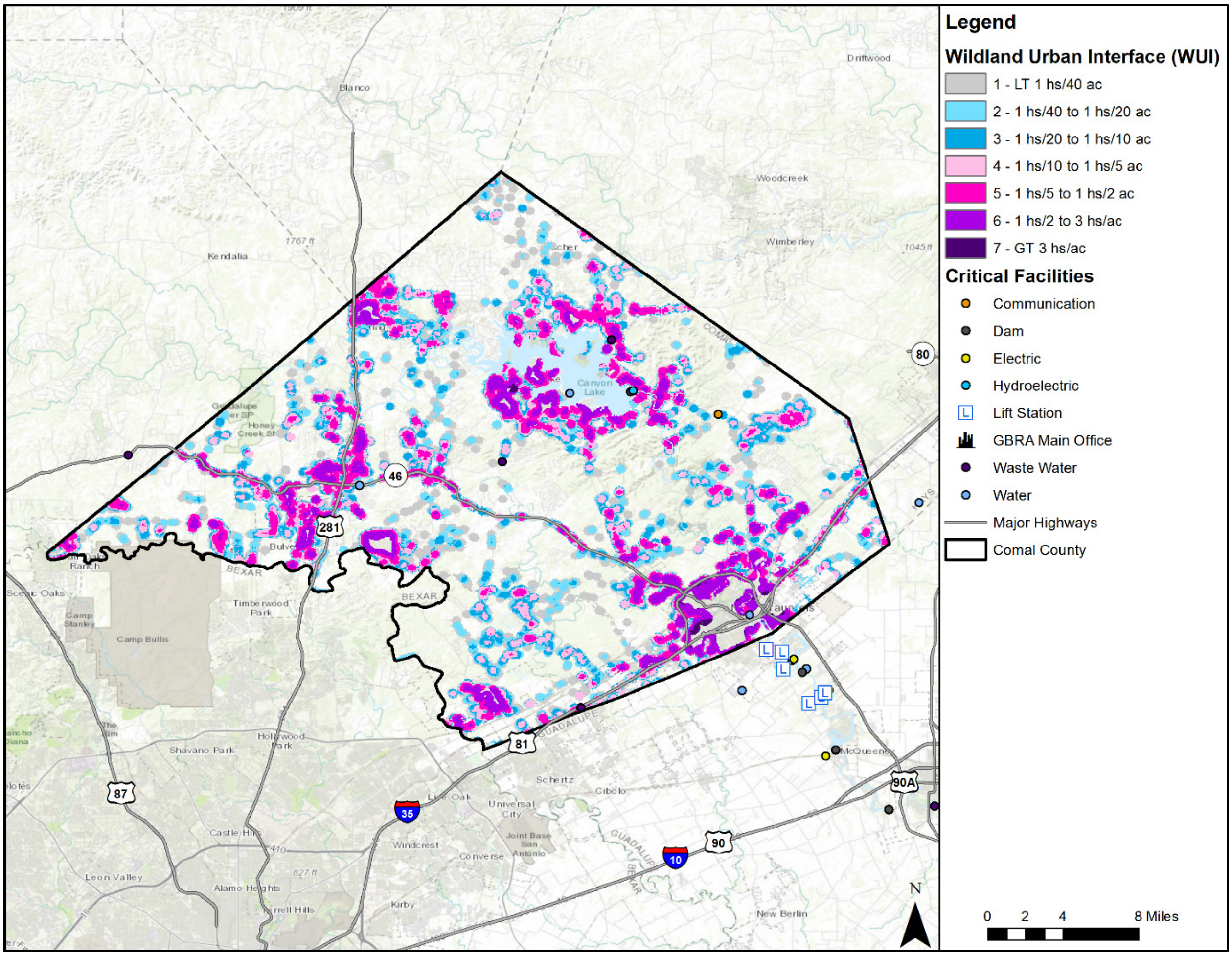


Figure 14-4. GBRA Wildland Urban Interface Map – DeWitt County

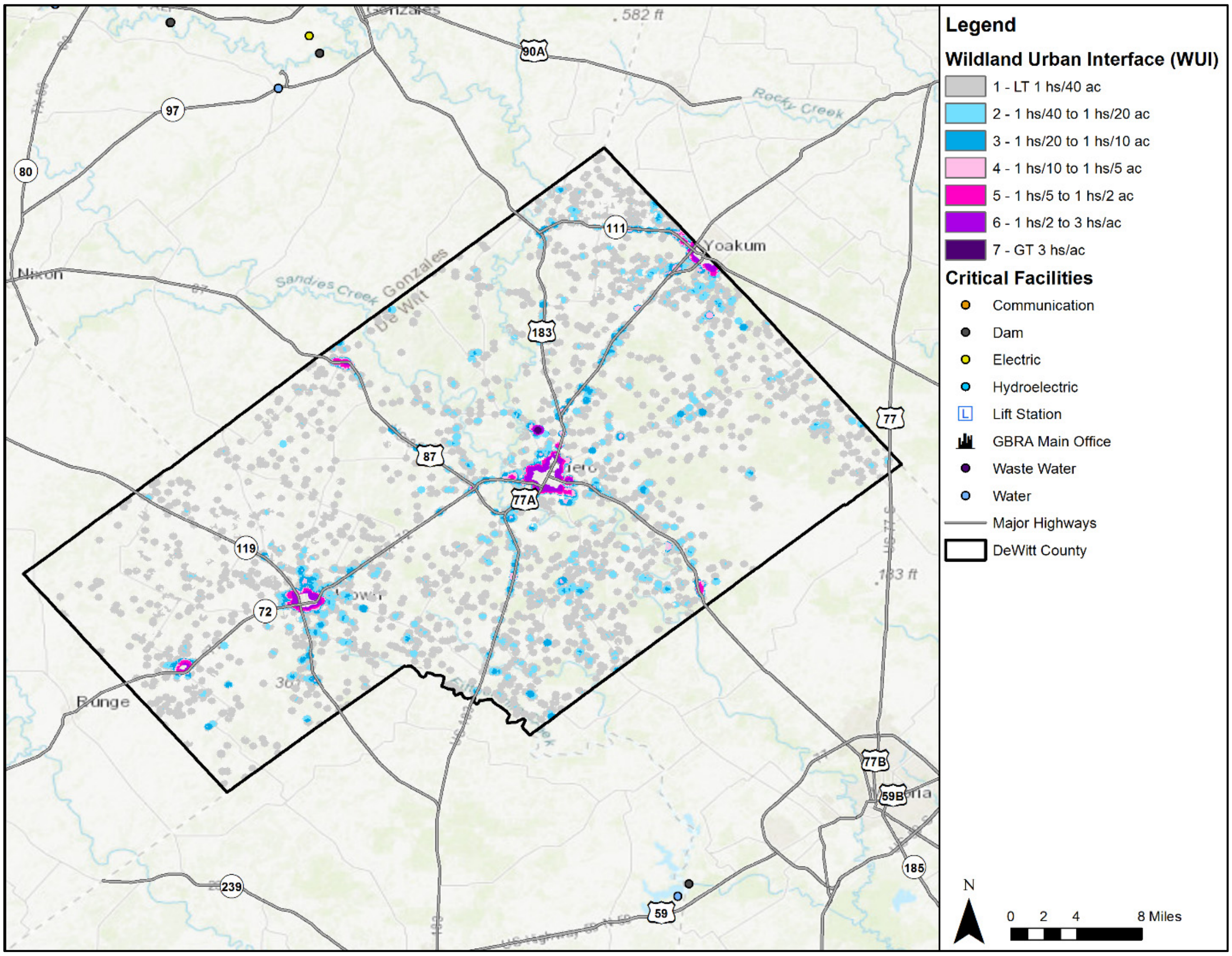


Figure 14-5. GBRA Wildland Urban Interface Map – Gonzales County

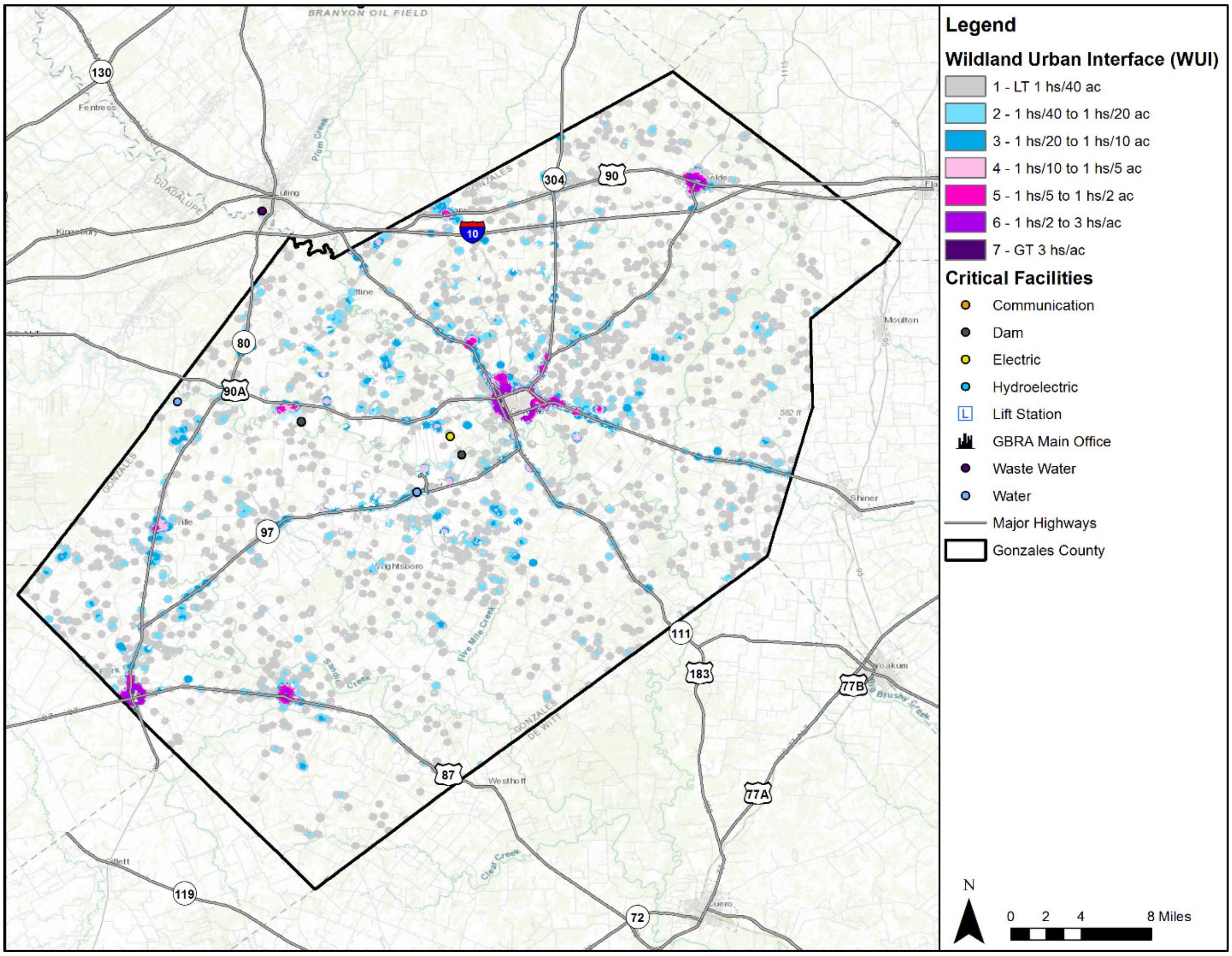


Figure 14-6. GBRA Wildland Urban Interface Map – Guadalupe County

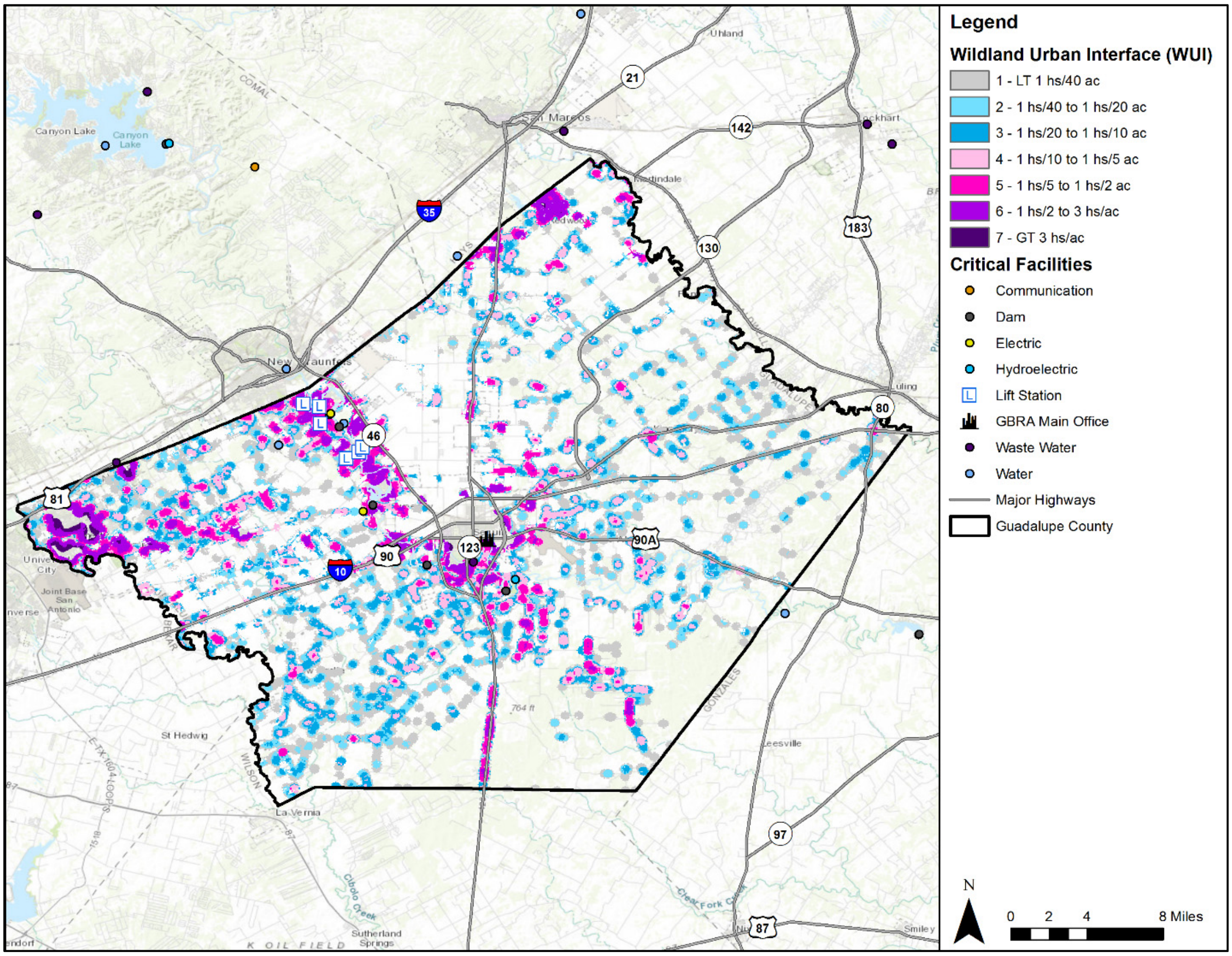


Figure 14-7. GBRA Wildland Urban Interface Map – Hays County

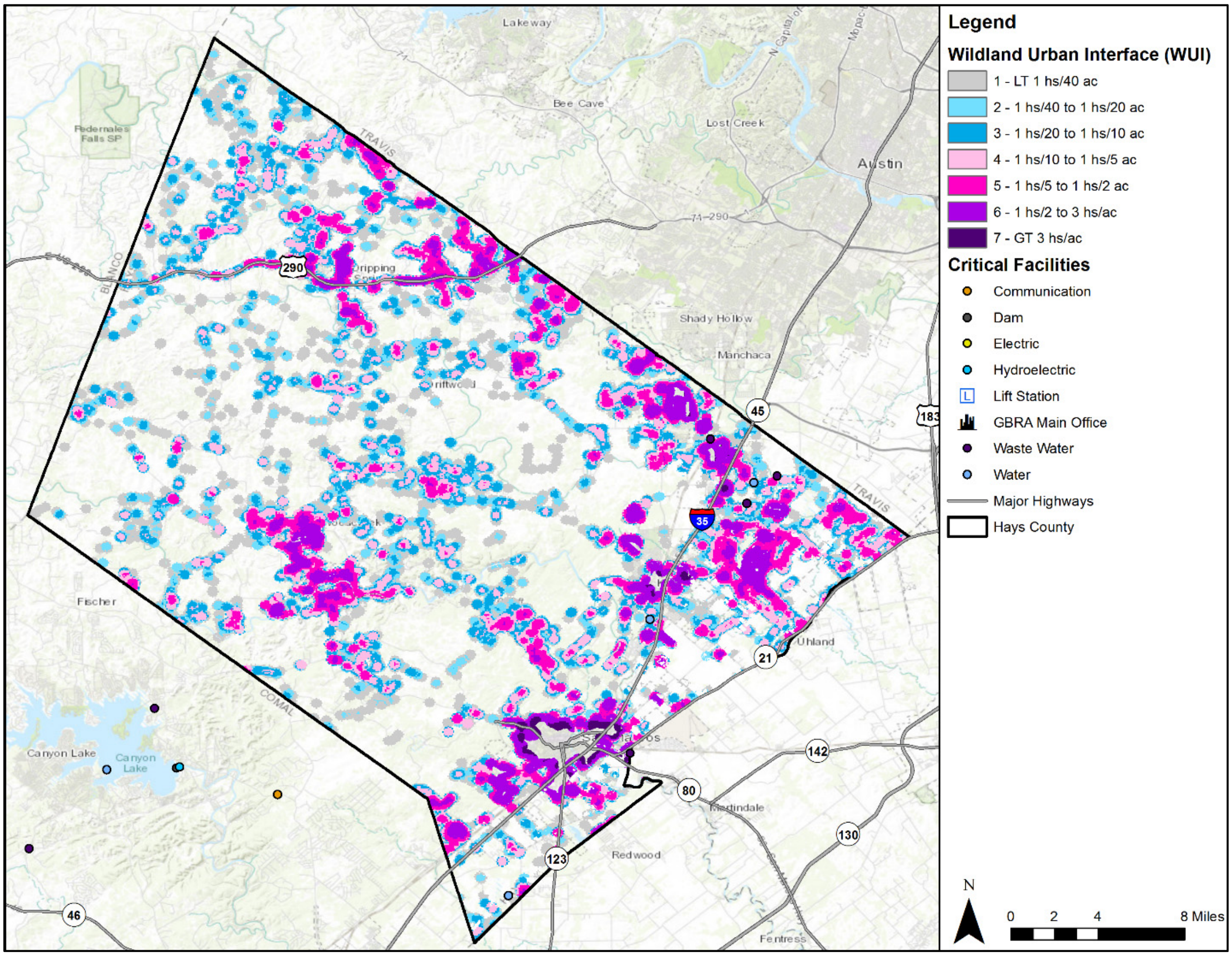


Figure 14-8. GBRA Wildland Urban Interface Map – Kendall County

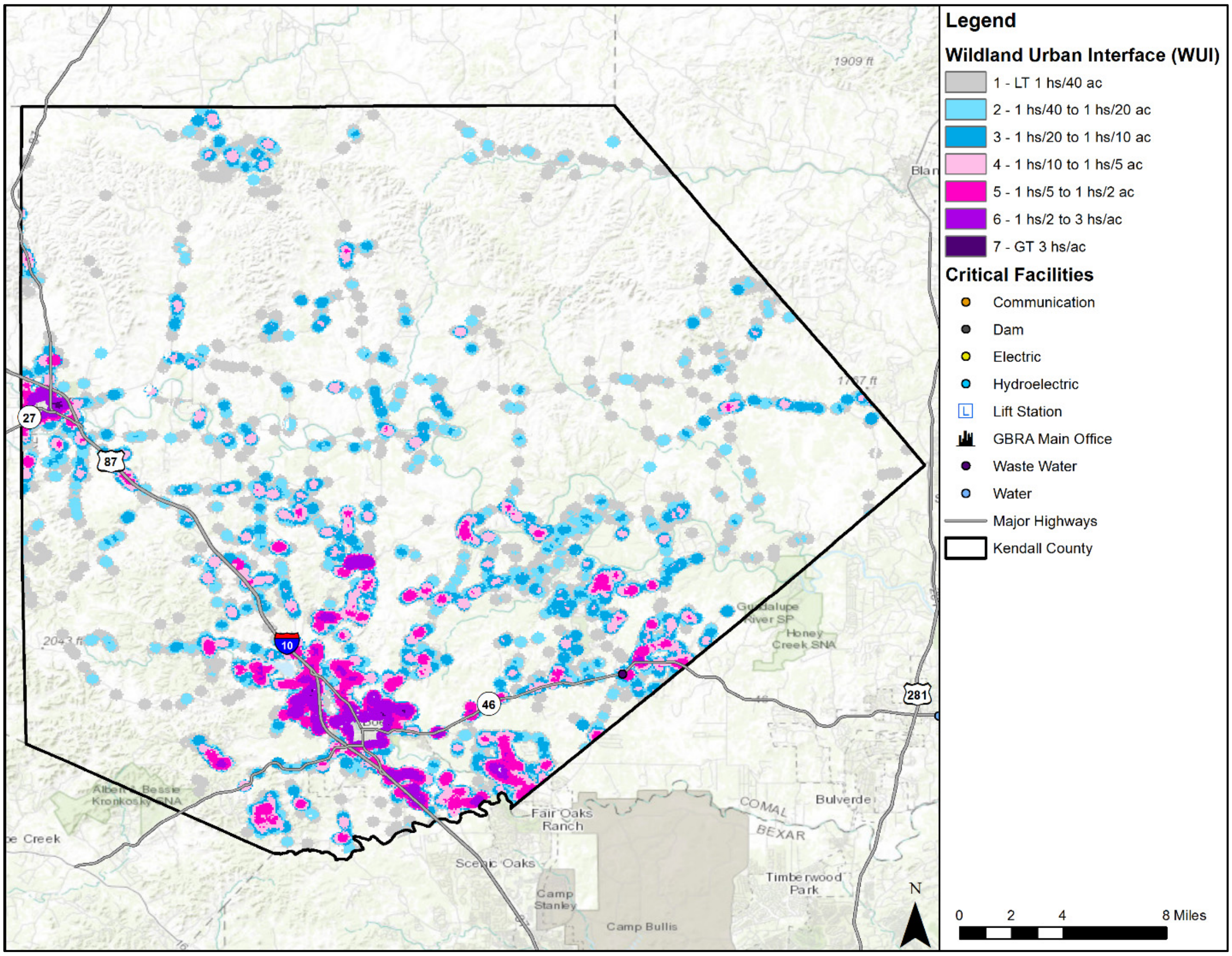


Figure 14-9. GBRA Wildland Urban Interface Map – Refugio County

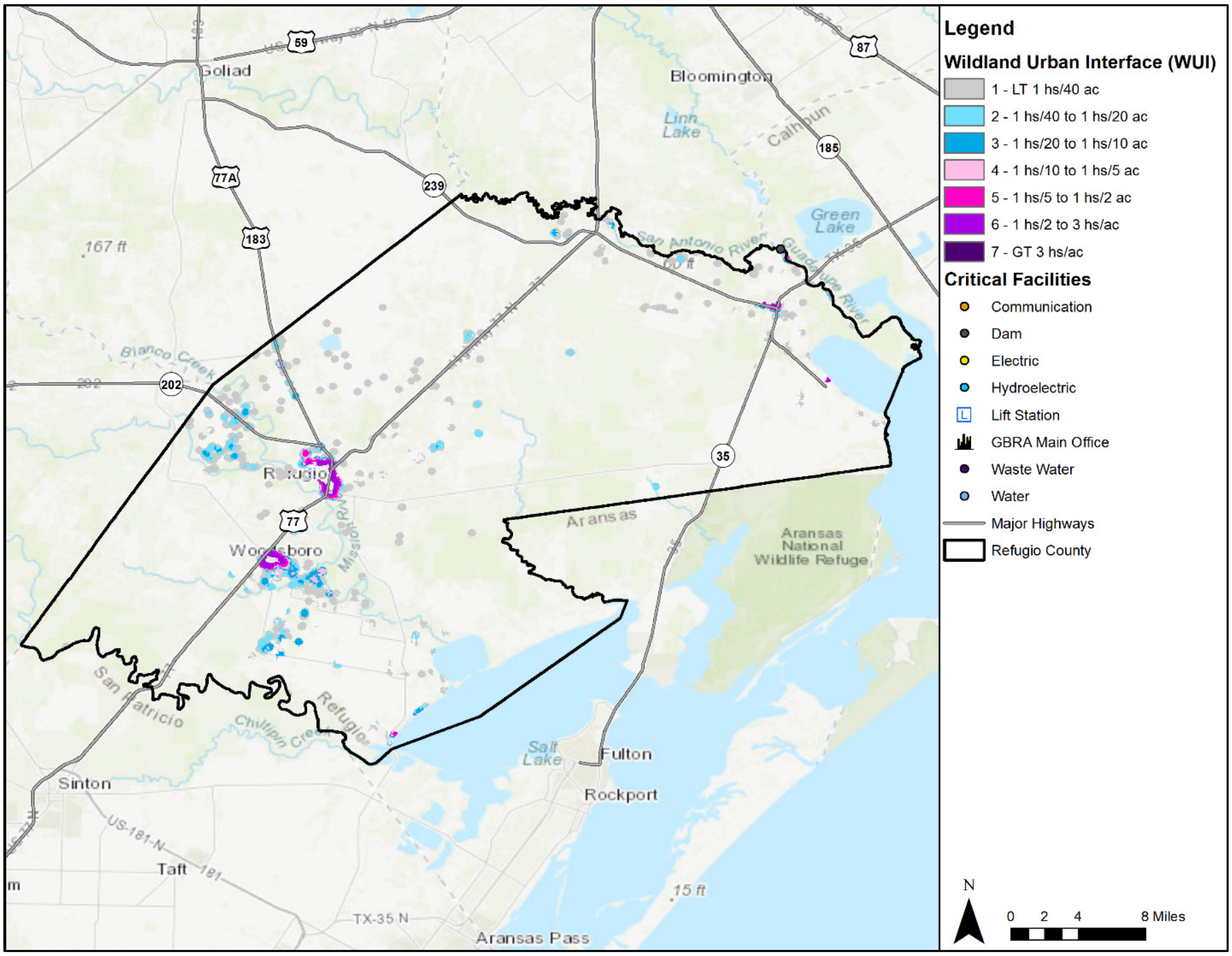
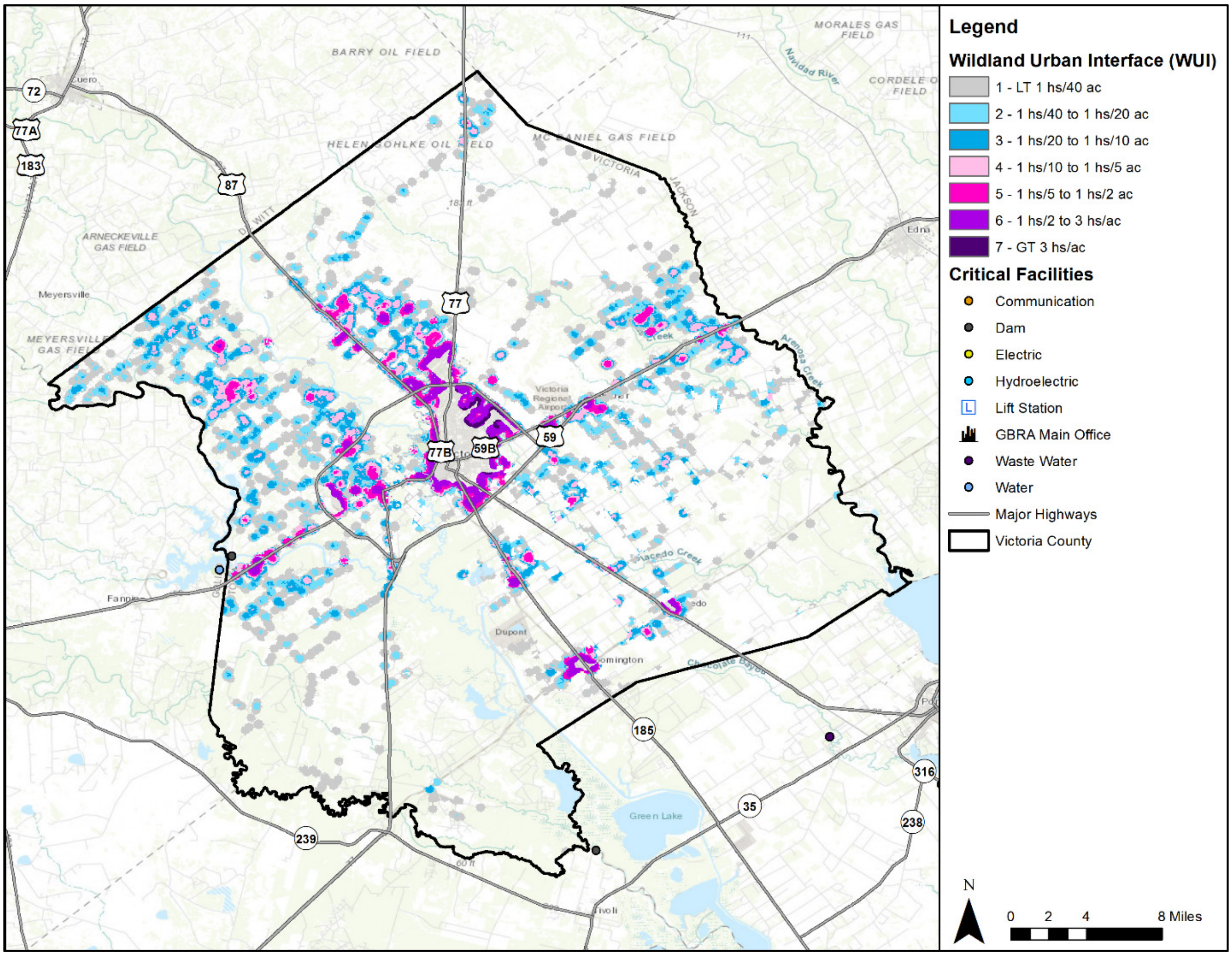


Figure 14-10. GBRA Wildland Urban Interface Map – Victoria County

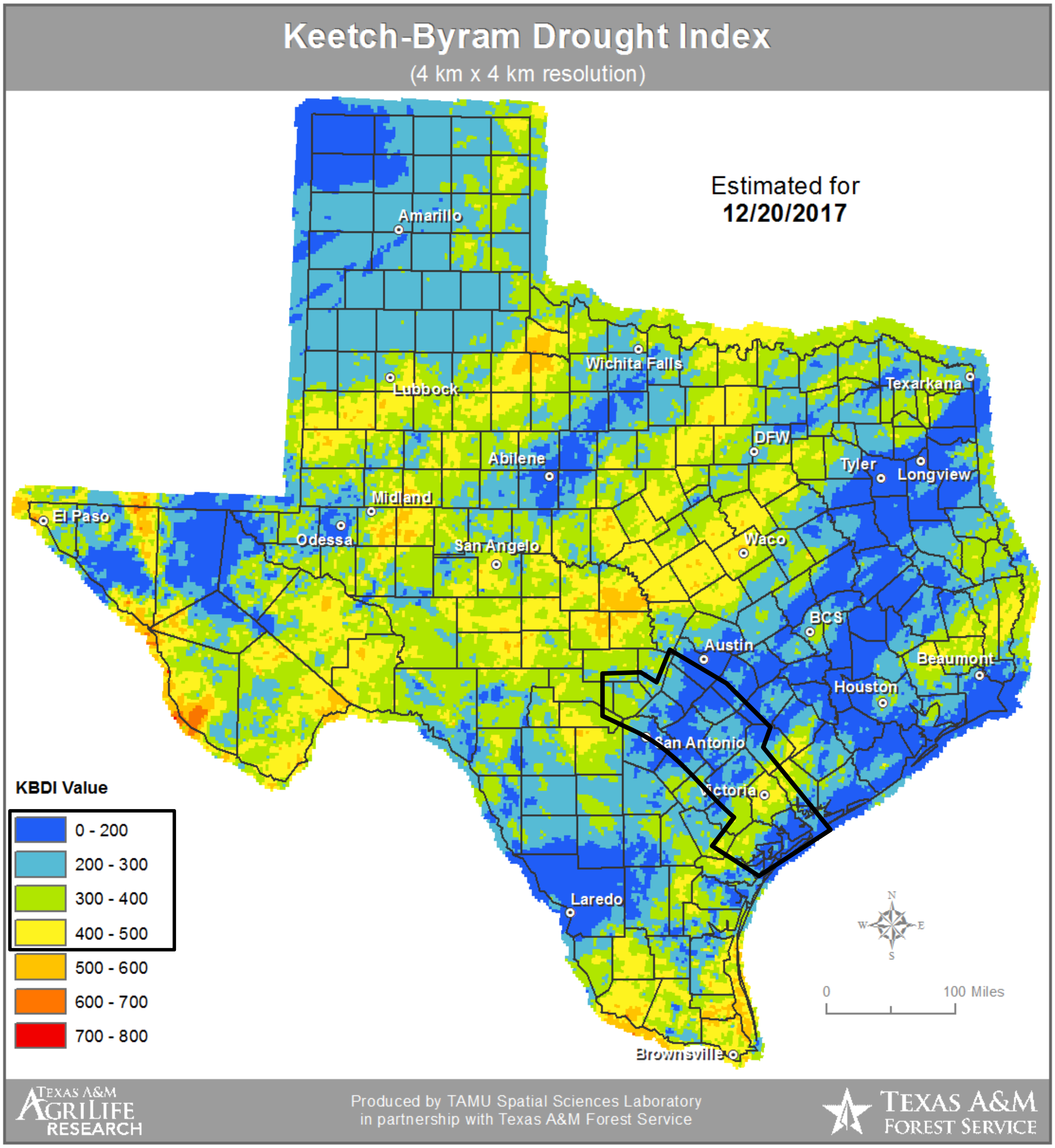


Extent

Risk for a wildfire event is measured in terms of magnitude and intensity using the Keetch Byram Drought Index (KBDI), a mathematical system for relating current and recent weather conditions to potential or expected fire behavior. The KBDI determines forest fire potential based on a daily water balance, derived by balancing a drought factor with precipitation and soil moisture (assumed to have a maximum storage capacity of eight inches), and is expressed in hundredths of an inch of soil moisture depletion.

Each color in Figure 14-11 represents the KBDI at that location and the GBRA planning area is depicted within the black outline. The KBDI ranges from 0 to 800. A KBDI of 0 represents no moisture depletion, and a KBDI of 800 represents absolutely dry conditions.

Figure 14-11. Keetch-Byram Drought Index (KBDI) for the State of Texas, 2017[1]



The Texas A&M Forest Services describes the KBDI at four distinct levels:

- **0 - 200:** Soil and fuel moisture are high. Most fuels will not readily ignite or burn. However, with sufficient sunlight and wind, cured grasses and some light surface fuels will burn in spots and patches.

[1] Source: http://twc.tamu.edu/kbdi; the GBRA planning area is indicated by the black outline.

- **200 - 400:** Fires more readily burn and will carry across an area with no gaps. Heavier fuels will not readily ignite and burn. Expect smoldering and the resulting smoke to carry into and possibly through the night.
- **400 - 600:** Fires intensity begins to significantly increase. Fires will readily burn in all directions exposing mineral soils in some locations. Larger fuels may burn or smolder for several days creating possible smoke and control problems.
- **600 - 800:** Fires will burn to mineral soil. Stumps will burn to the end of underground roots and spotting will be a major problem. Fires will burn through the night and heavier fuels will actively burn and contribute to fire intensity.[2]

The KBDI is a good measure of the readiness of fuels for a wildfire event. The KBDI should be referenced as the area experiences changes in precipitation and soil moisture and caution should be exercised in dryer, hotter conditions.

The current range of intensity for the GBRA planning area in a wildfire event is primarily within 0 to 300 KDBI. Kendall County is within 200 to 400 KDBI. Refugio and Victoria Counties are primarily within 300 to 500 KBDI. The average extent to be mitigated for the GBRA planning area has a KBDI of 233. At 233 KBDI, fires more readily burn and will carry across an area with no gaps. Heavier fuels will not ignite or burn. Though the conditions can vary throughout the planning area the worst extent that can be expected for the planning area in the future is 800 on the KBDI. Figures 14-12 through 14-21 identifies the wildfire intensity for the GBRA planning area by county.

[2] Source: http://twc.tamu.edu/docs/TFS_KBDI_Update.pdf

Figure 14-12. Fire Intensity Scale Map for Caldwell County

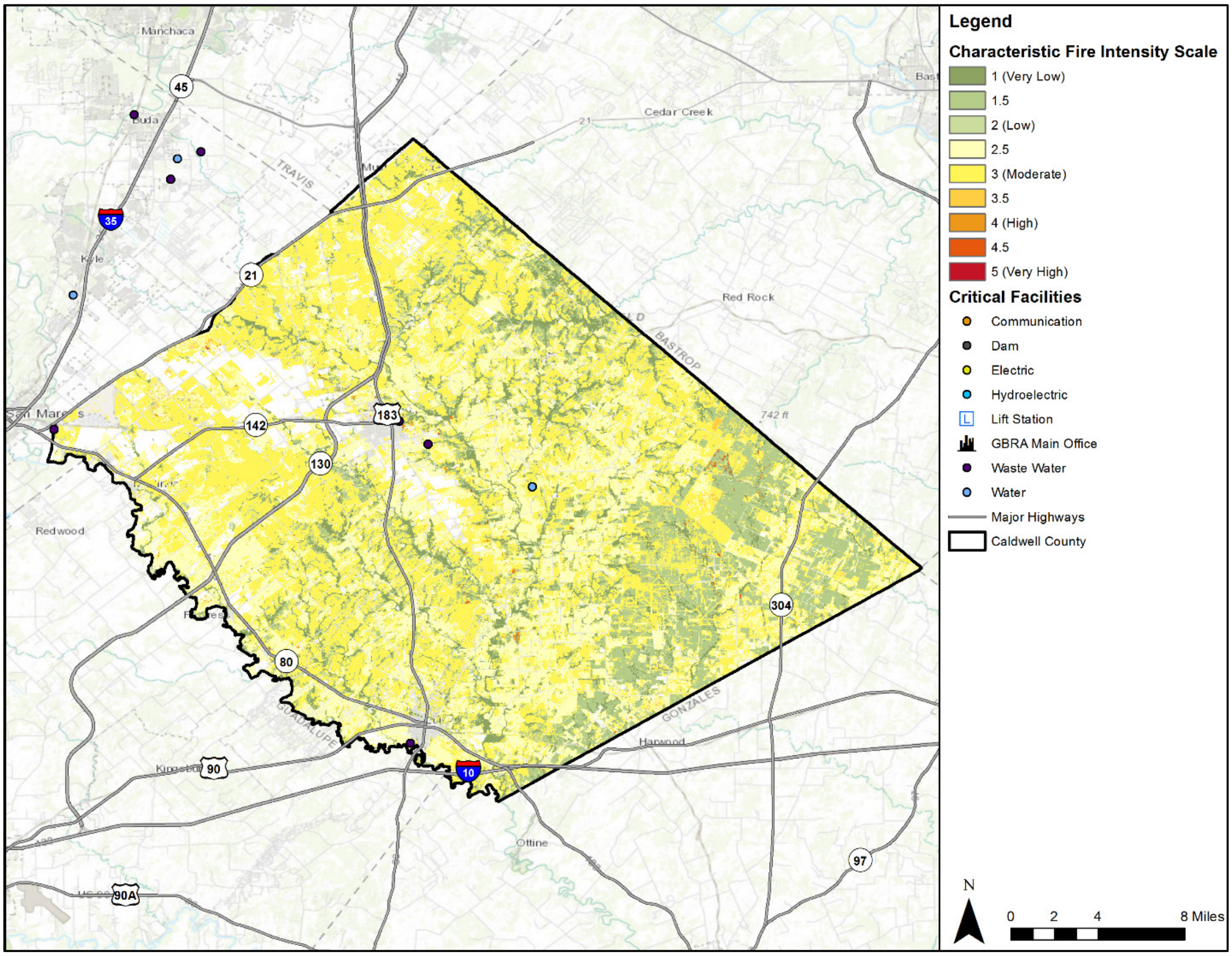


Figure 14-13. Fire Intensity Scale Map for Calhoun County

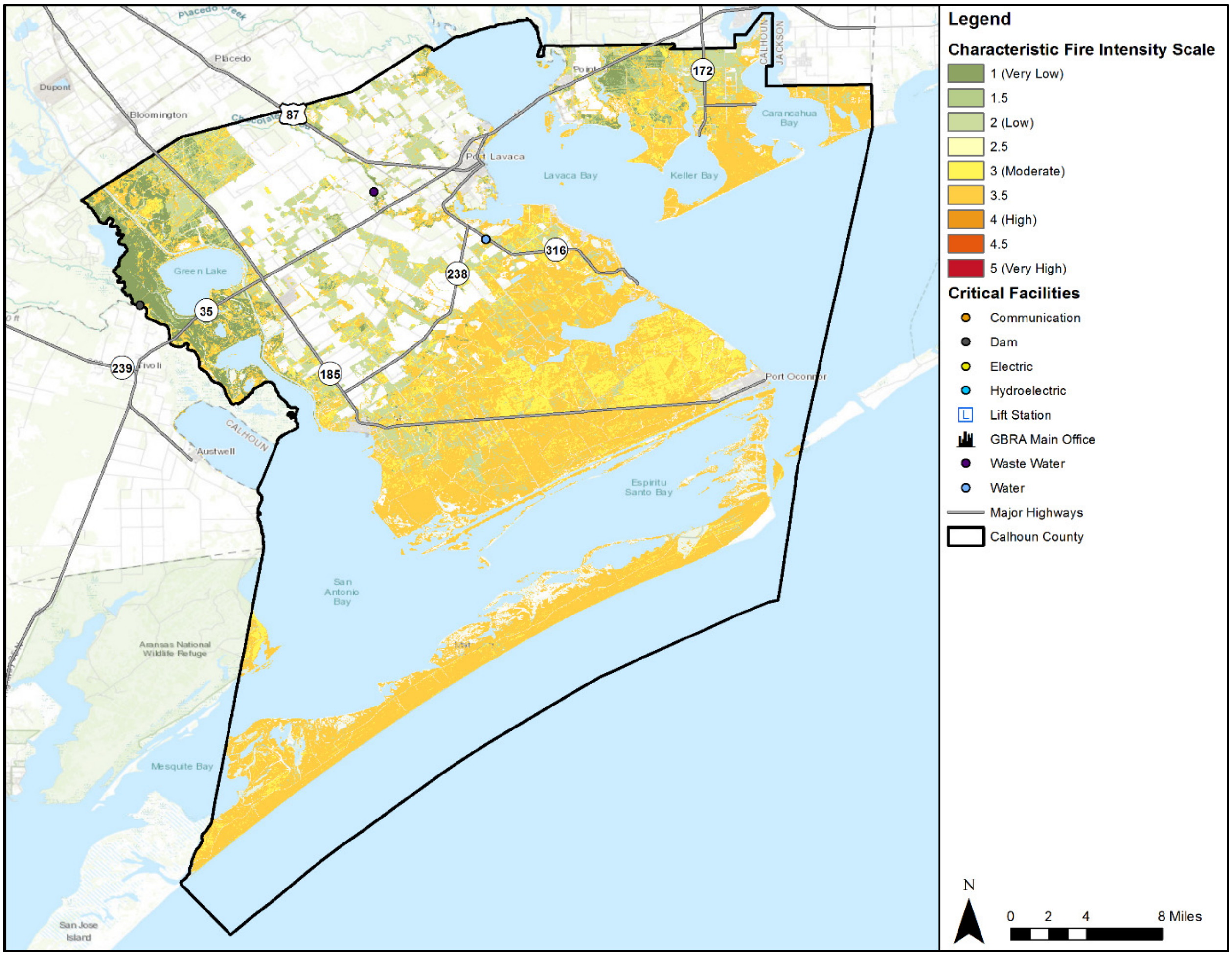


Figure 14-14. Fire Intensity Scale Map for Comal County

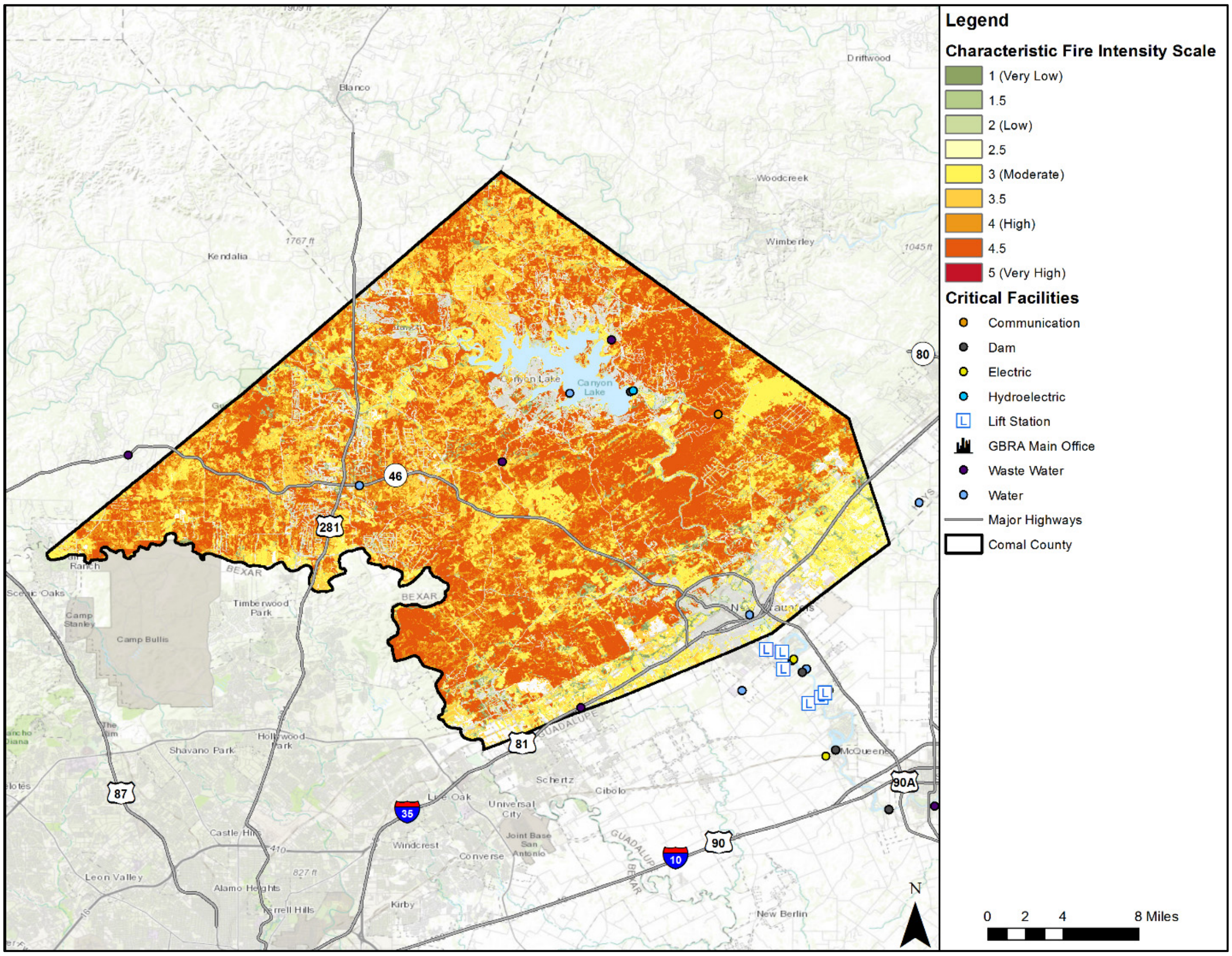


Figure 14-15. Fire Intensity Scale Map for DeWitt County

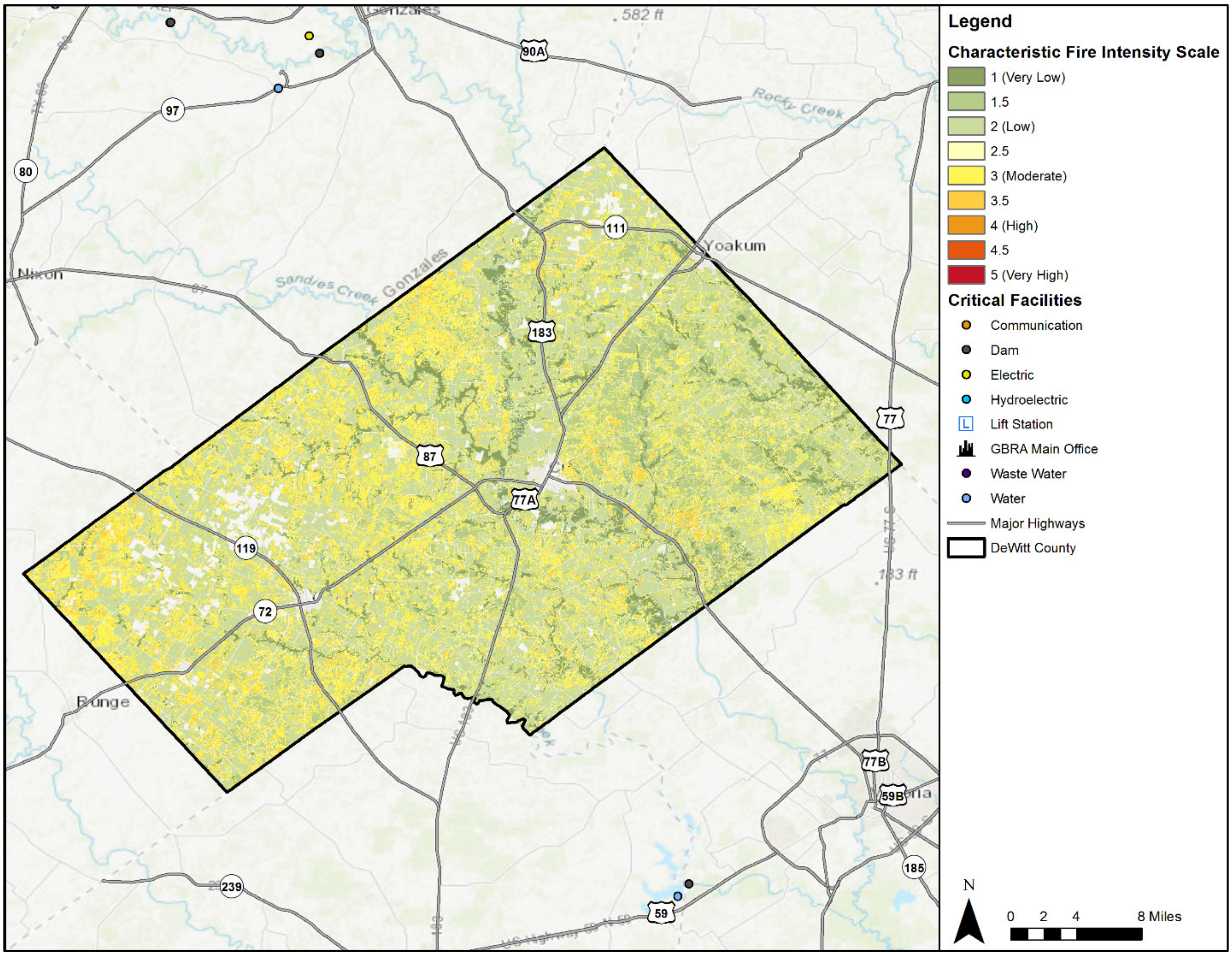


Figure 14-16. Fire Intensity Scale Map for Gonzales County

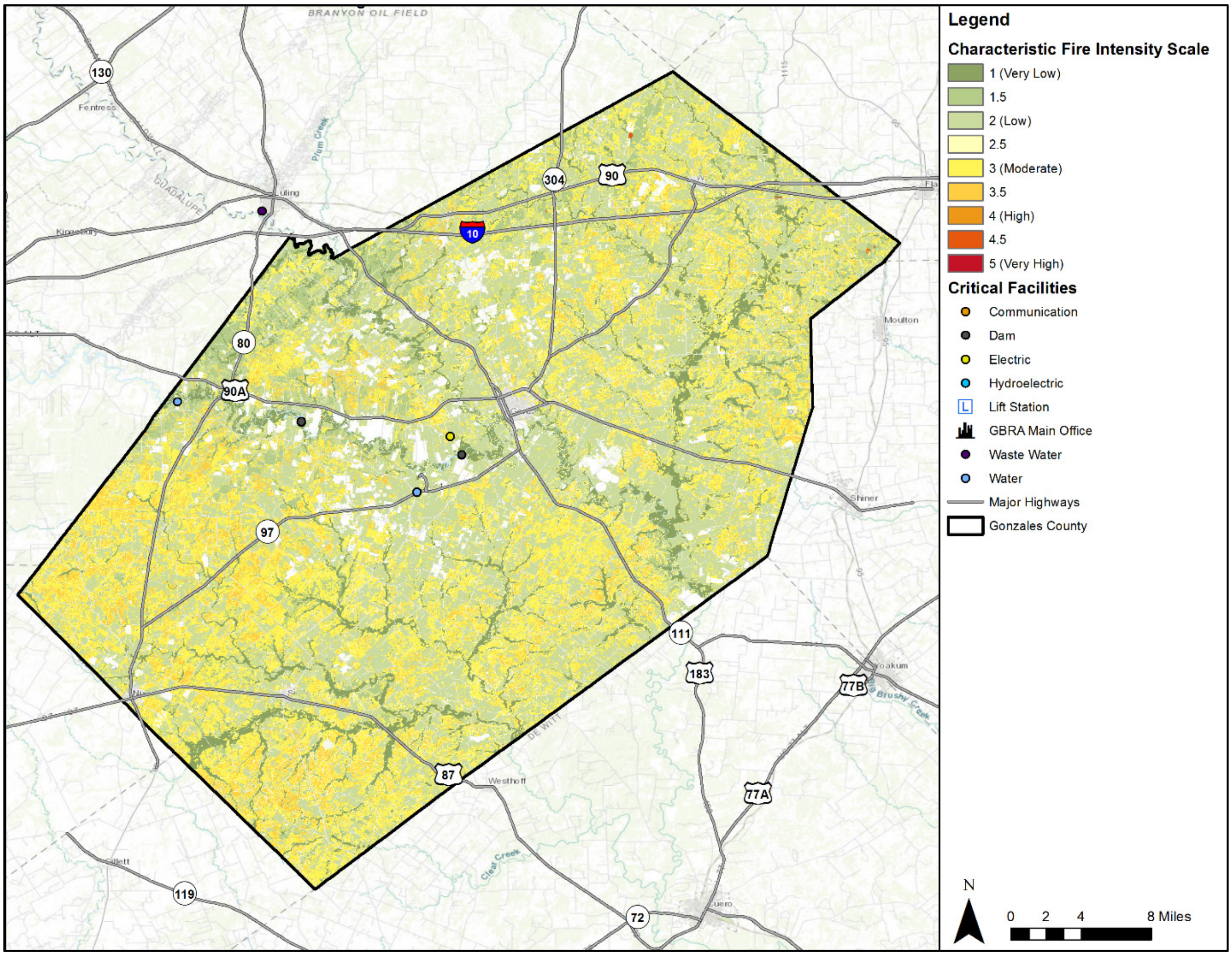


Figure 14-17. Fire Intensity Scale Map for Guadalupe County

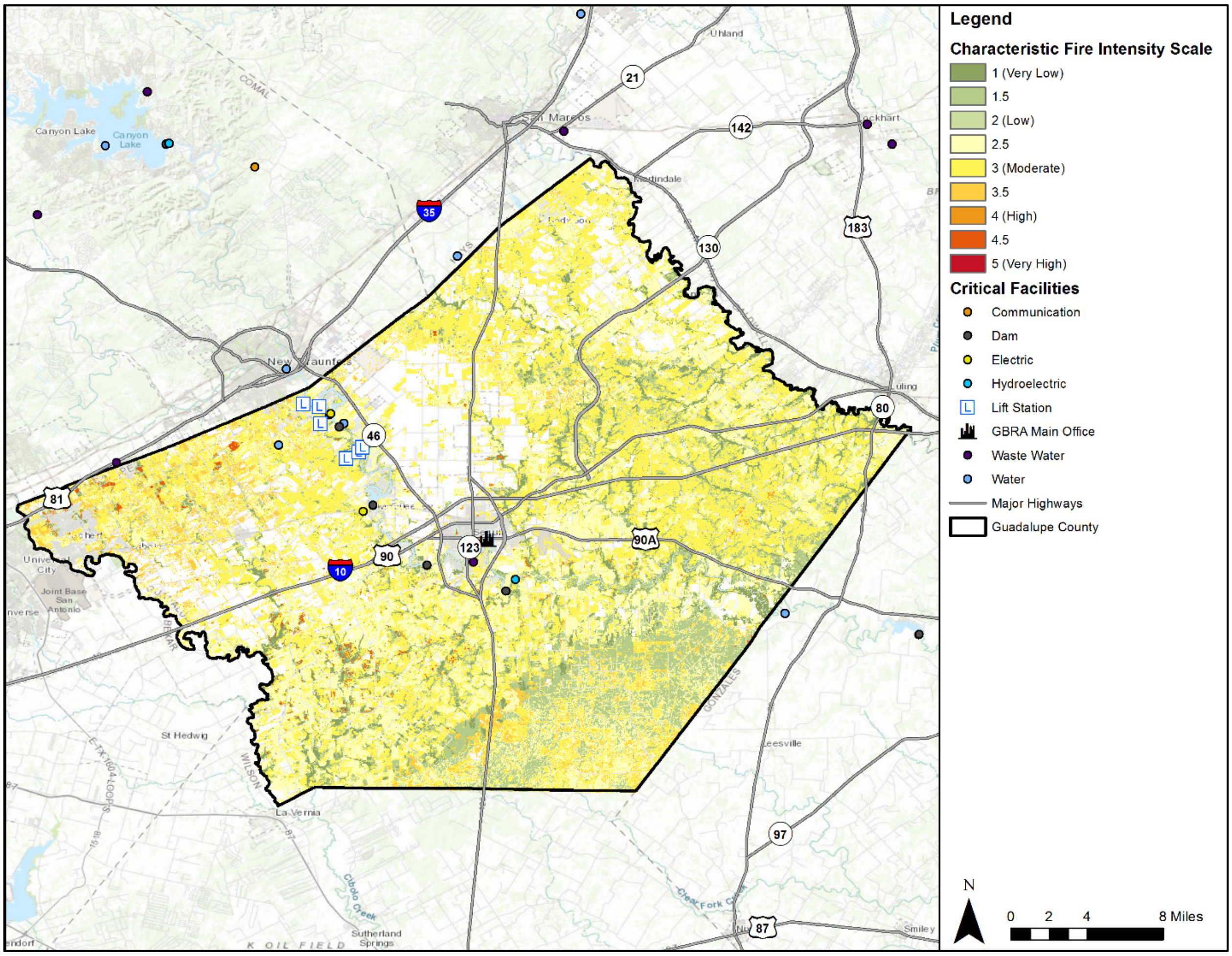


Figure 14-18. Fire Intensity Scale Map for Hays County

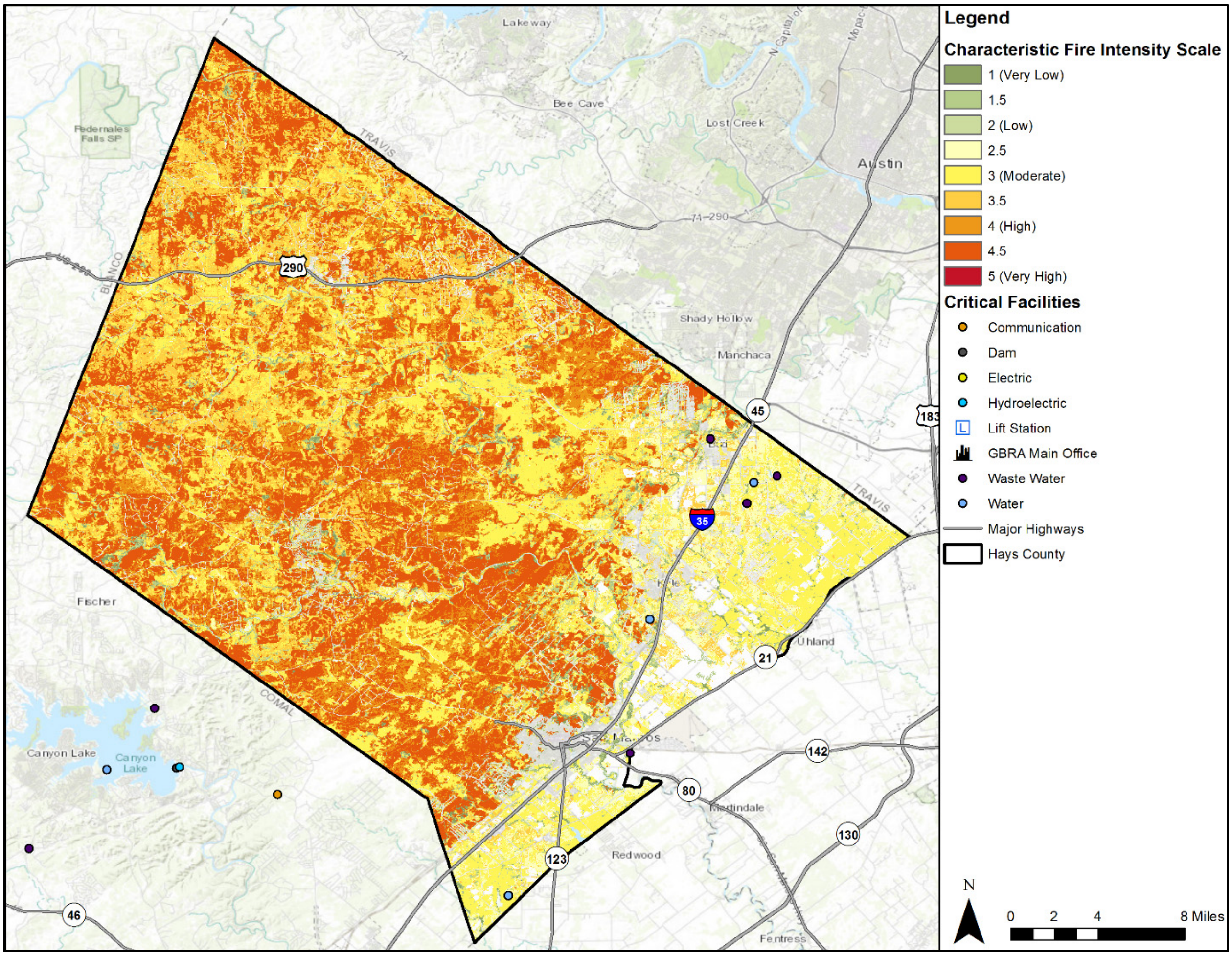


Figure 14-19. Fire Intensity Scale Map for Kendall County

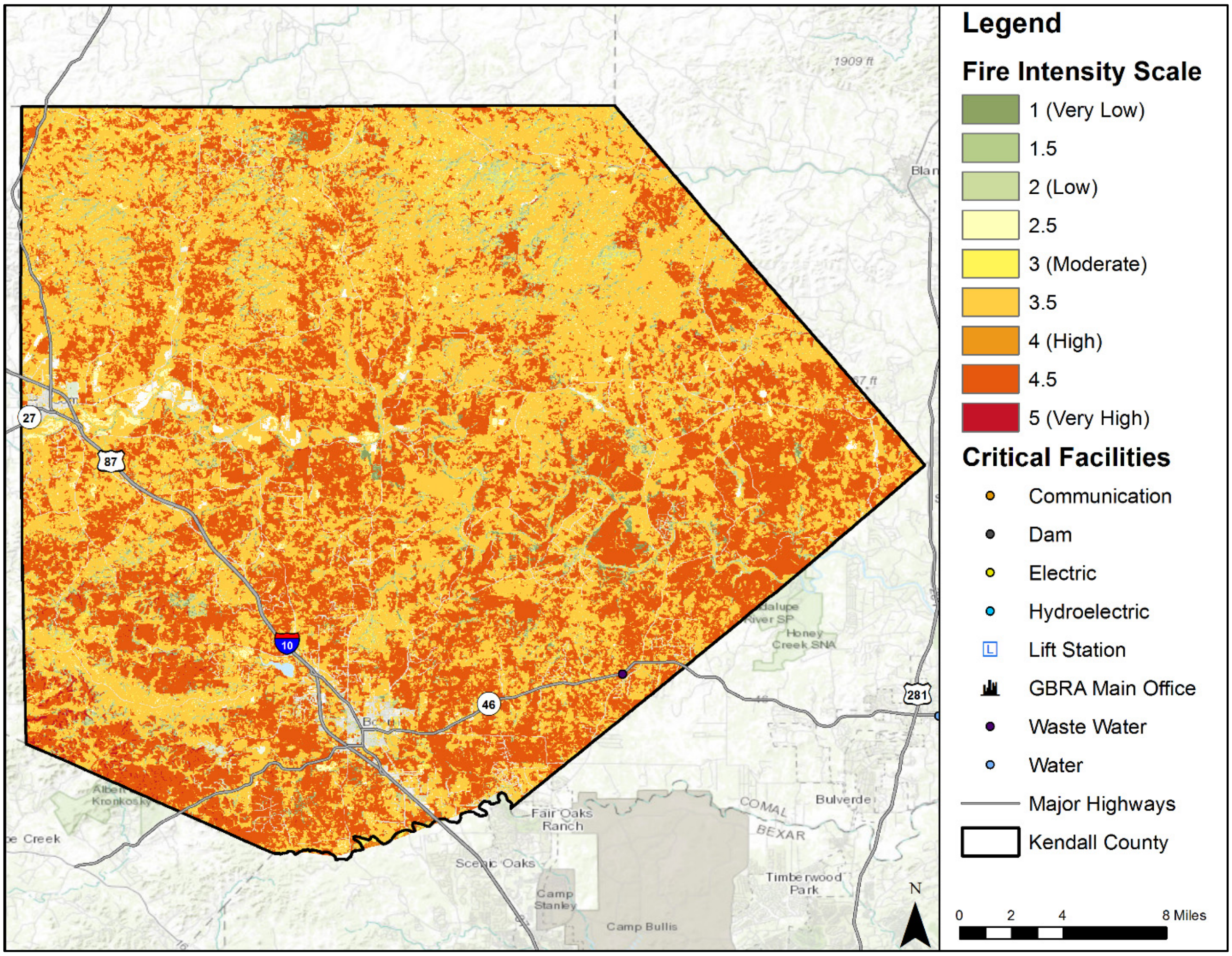


Figure 14-20. Fire Intensity Scale Map for Refugio County

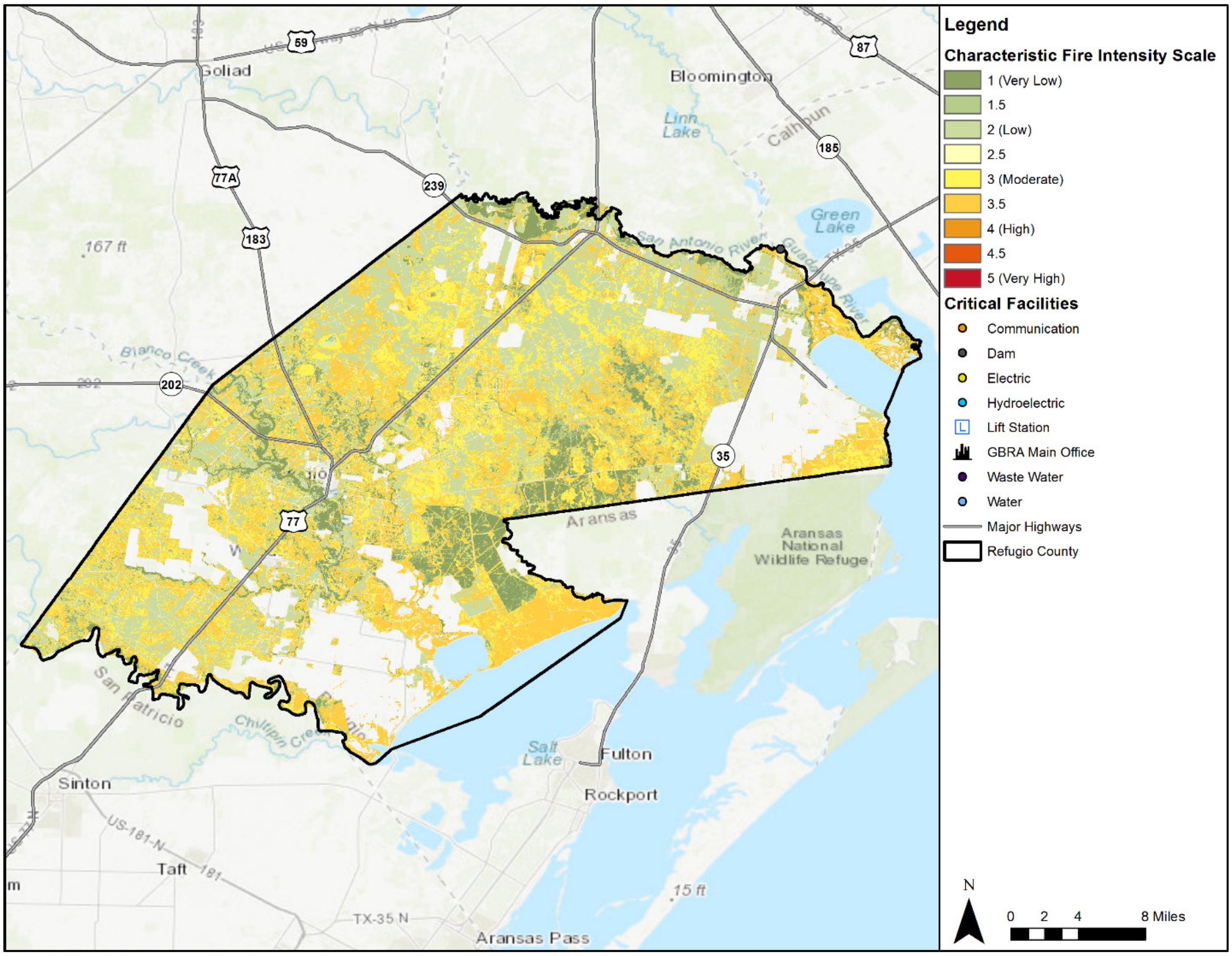
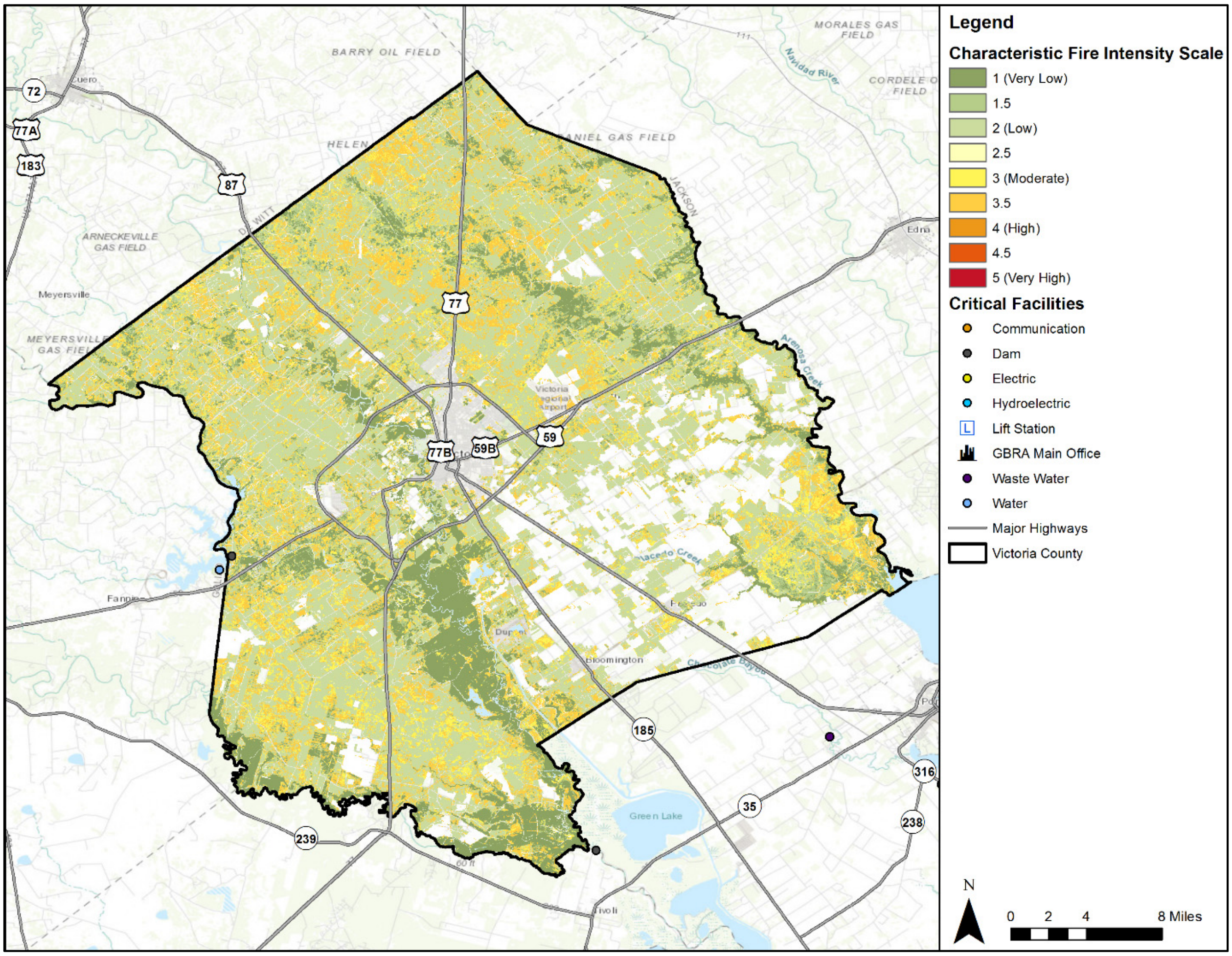


Figure 14-21. Fire Intensity Scale Map for Victoria County



Historical Occurrences

From 2005 to 2015 the Texas Forest Service (TFS) database reported 4,857 wildfire events within the GBRA planning area. TFS and volunteer fire departments started fully reporting events in 2005. The TSF database currently provides historical data from 2005 through 2015. This is considered the most reliable data available and most accurately informs the risk assessment. Due to lack of reporting prior to 2005 and after 2015, frequency calculations were based on an 11 year period, and only data received during those years were included in the calculations. The maps below show approximate locations of wildfires, which can be grass or brushfires of any size, by county (Figures 14-22 through 14-31). Table 14-1 identifies the number of wildfires by county and total acreage burned. Table 14-2 identifies the acreage of suppressed wildfire by county and year.

Figure 14-22. Location and Historic Wildfire Events for Caldwell County

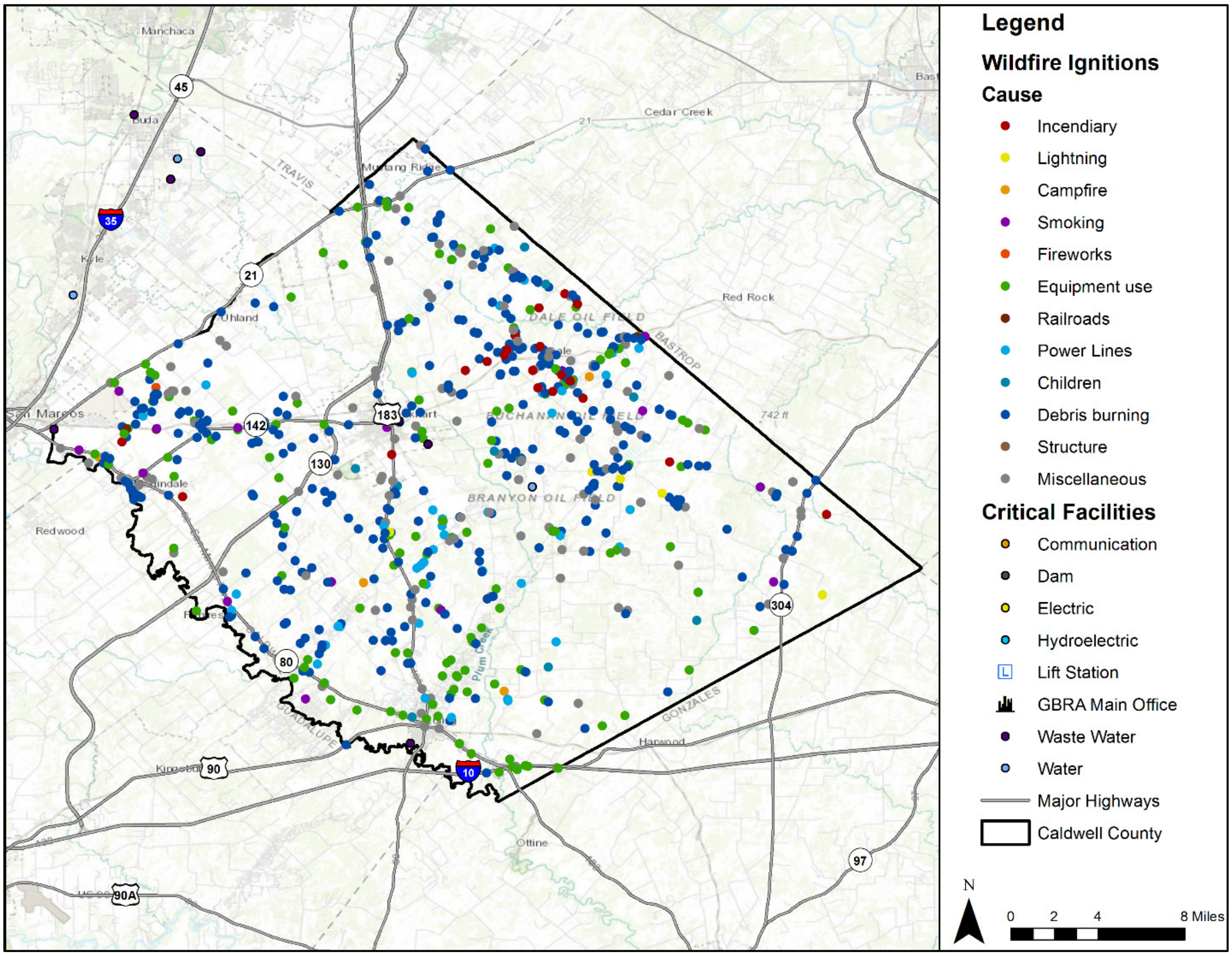


Figure 14-23. Location and Historic Wildfire Events for Calhoun County

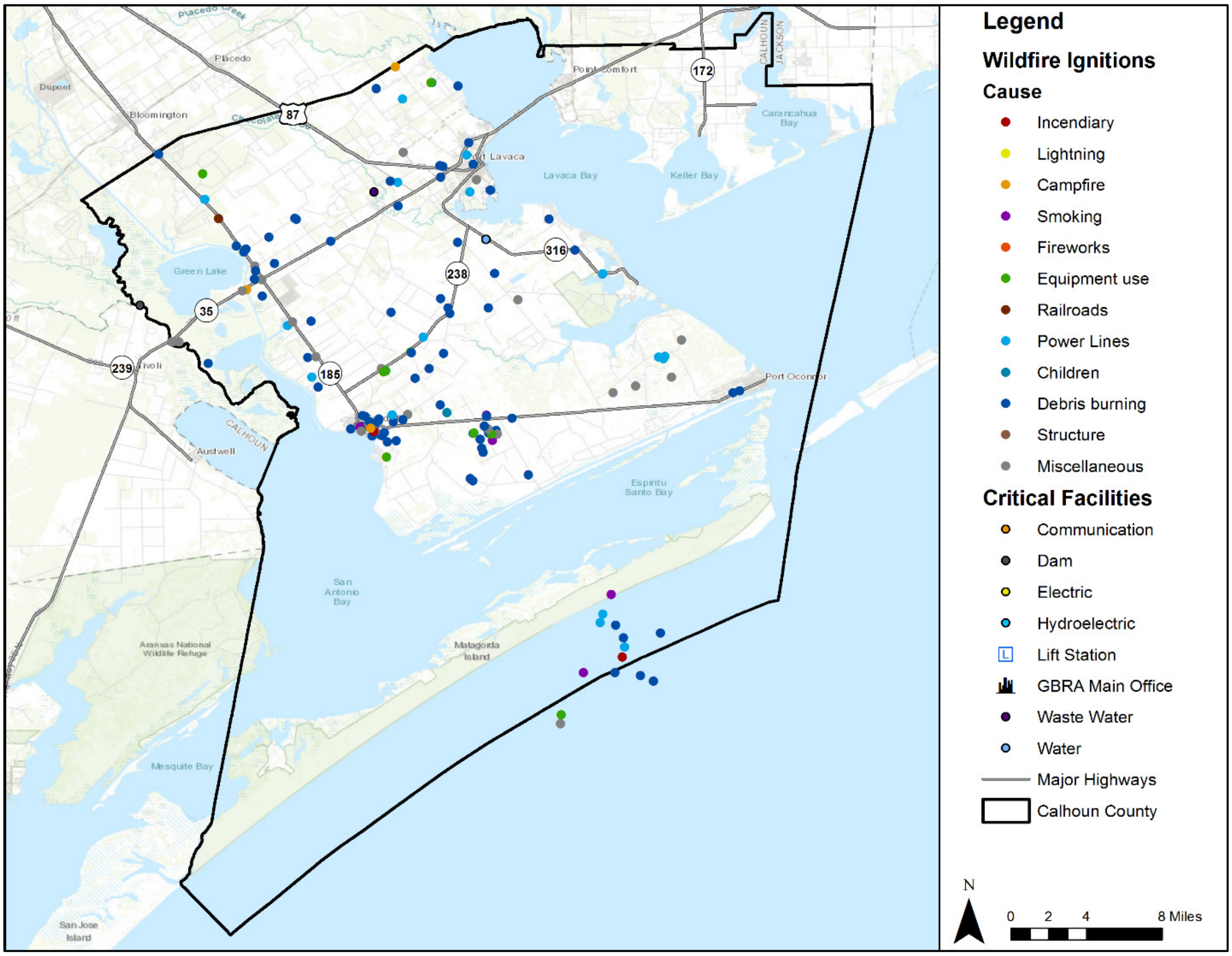


Figure 14-24. Location and Historic Wildfire Events for Comal County

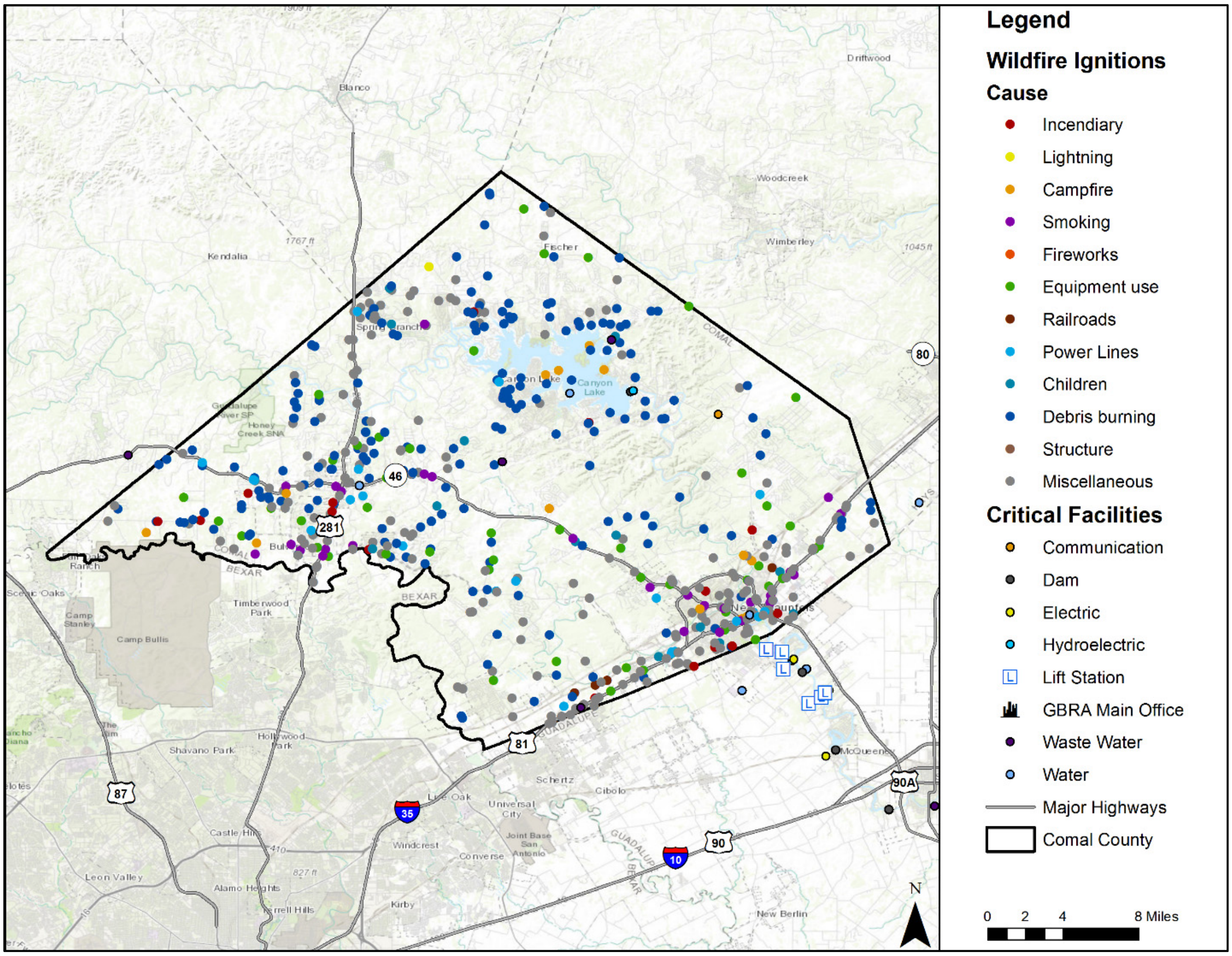


Figure 14-25. Location and Historic Wildfire Events for DeWitt County

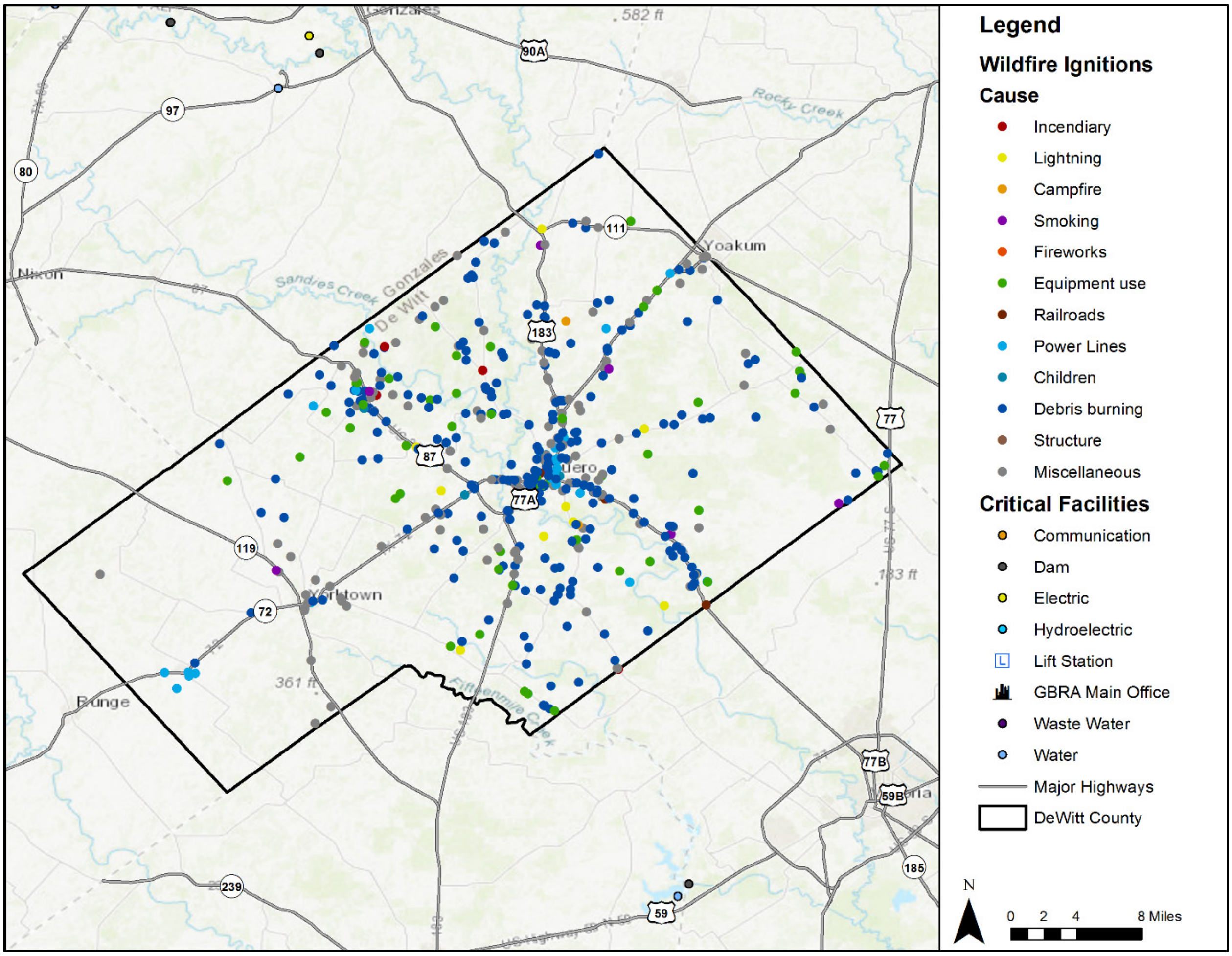


Figure 14-26. Location and Historic Wildfire Events for Gonzales County

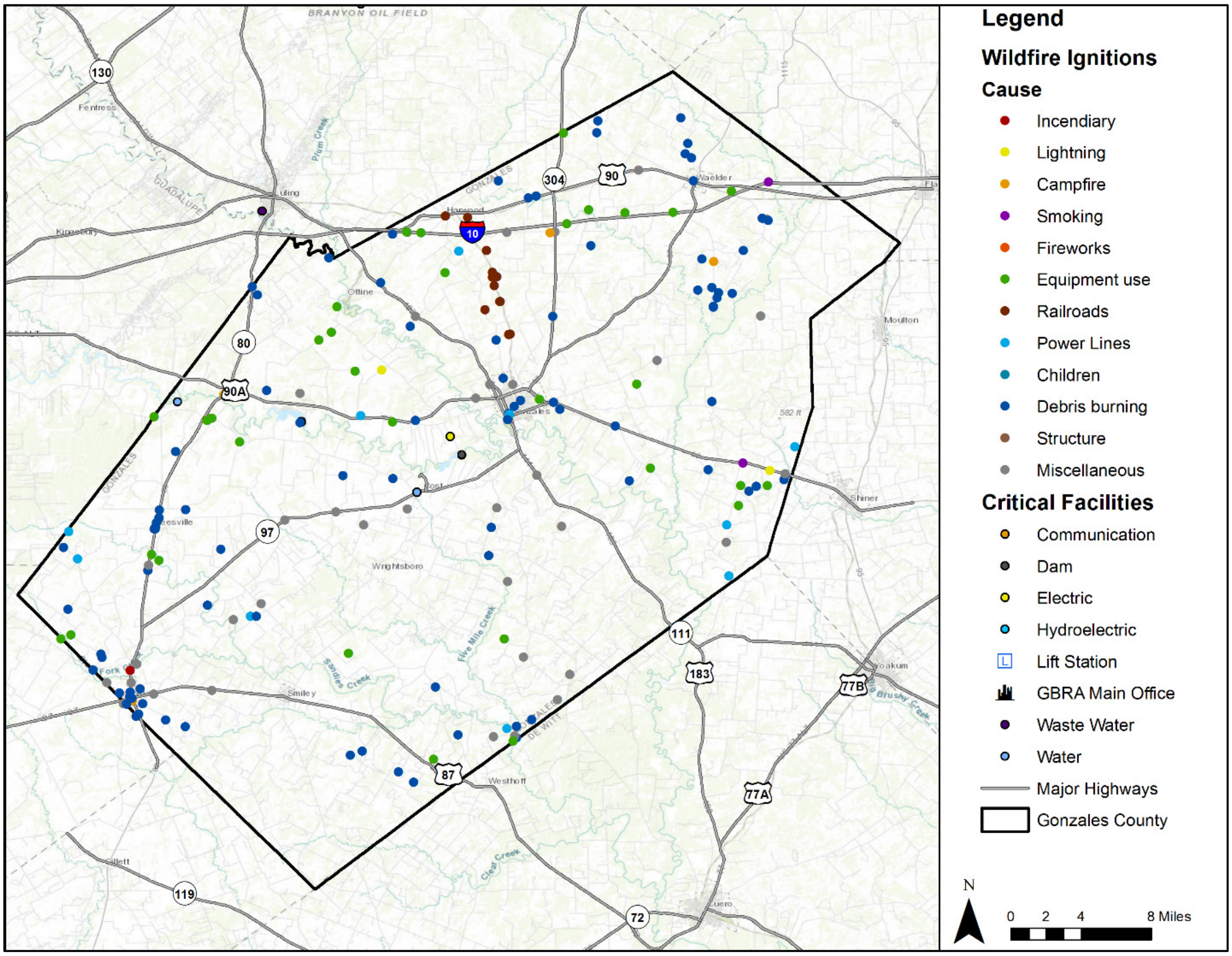


Figure 14-27. Location and Historic Wildfire Events for Guadalupe County

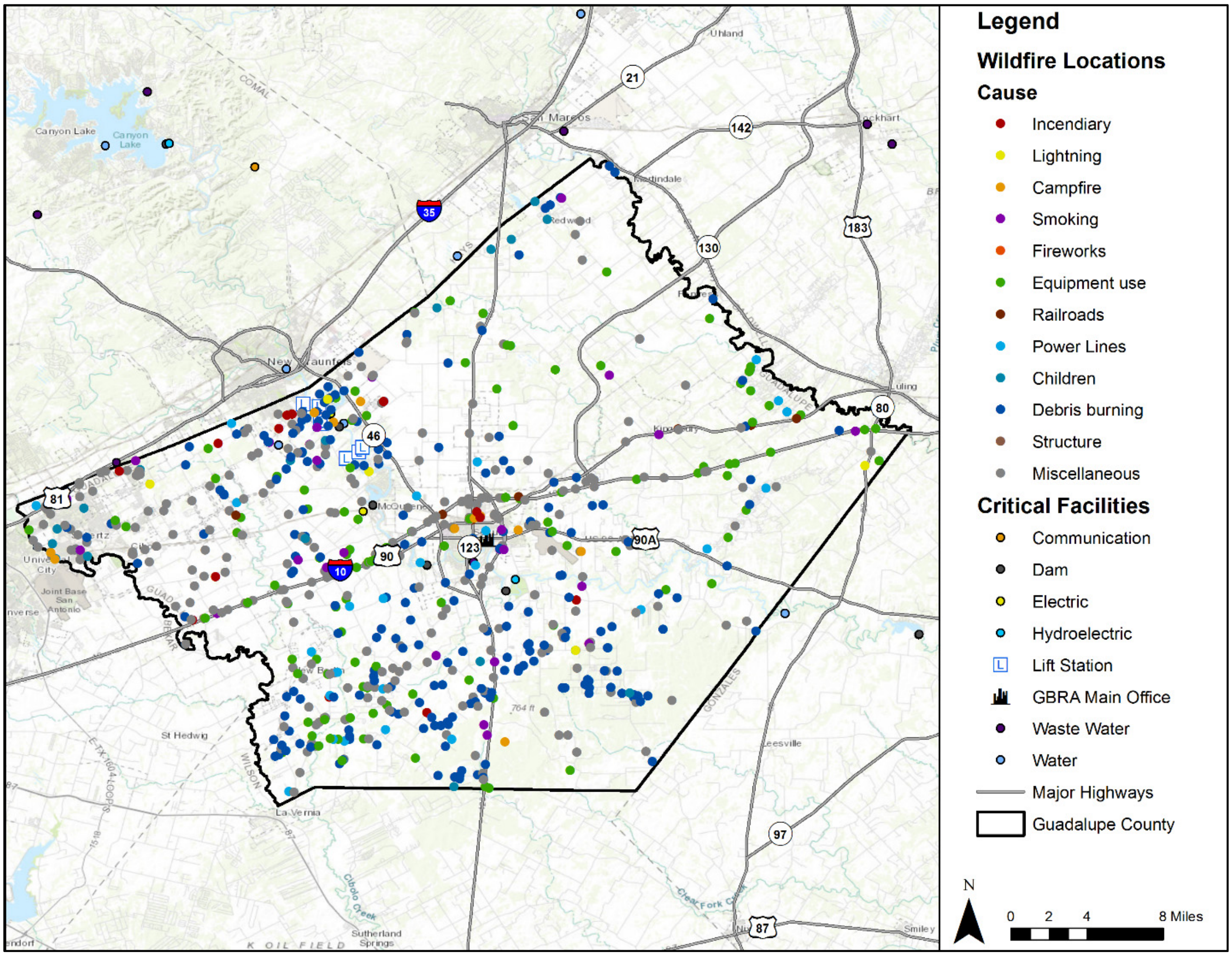


Figure 14-28. Location and Historic Wildfire Events for Hays County

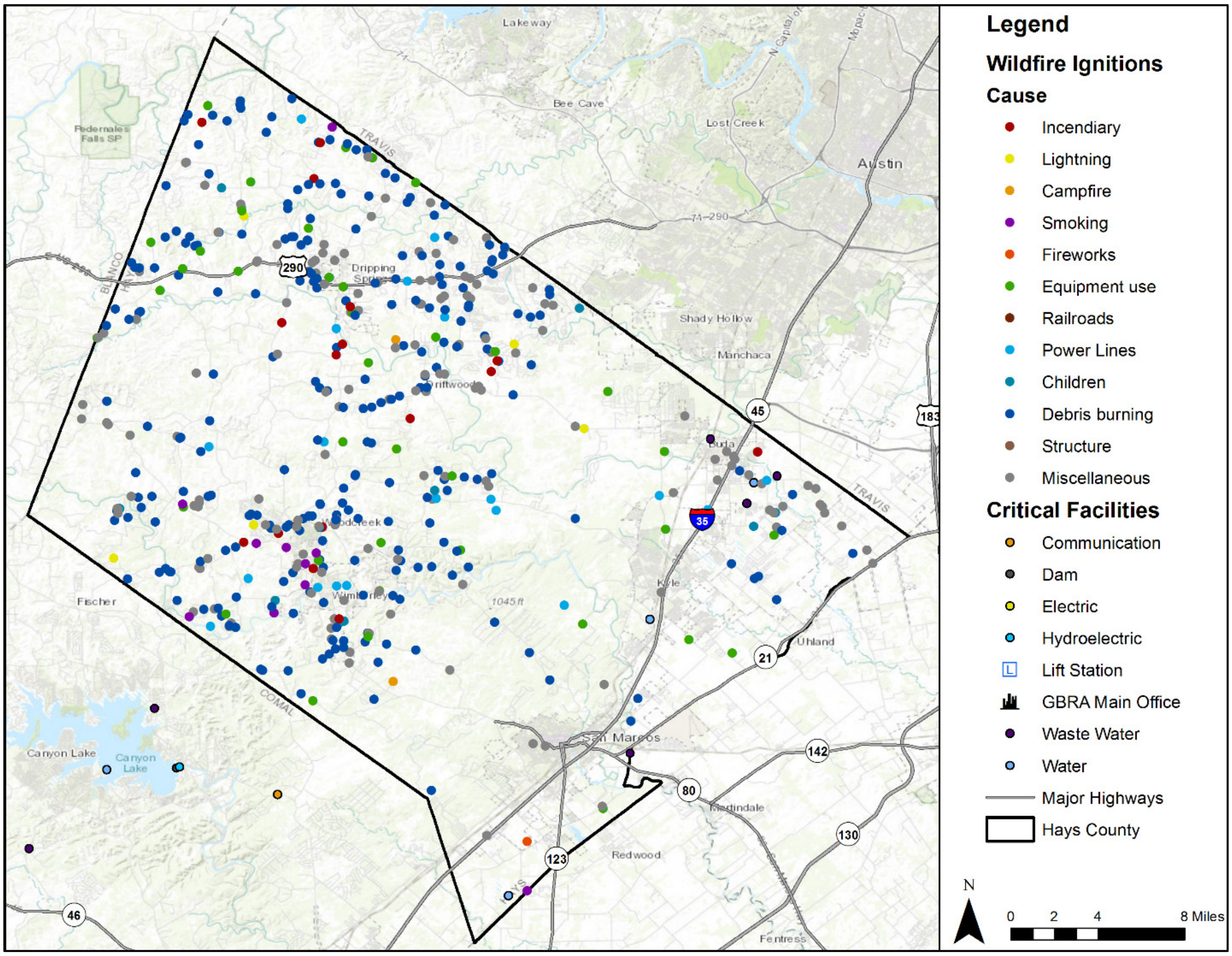


Figure 14-29. Location and Historic Wildfire Events for Kendall County

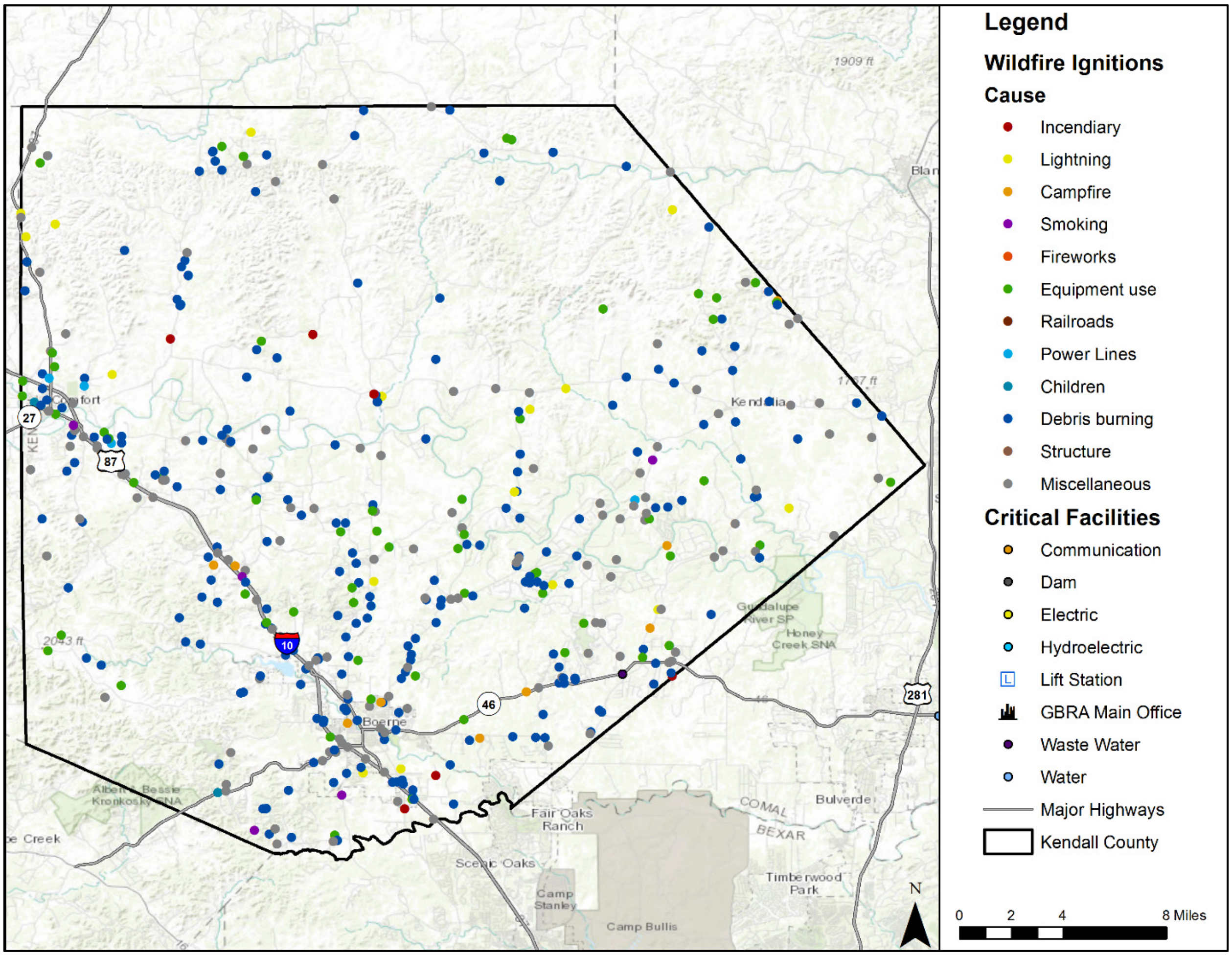


Figure 14-30. Location and Historic Wildfire Events for Refugio County

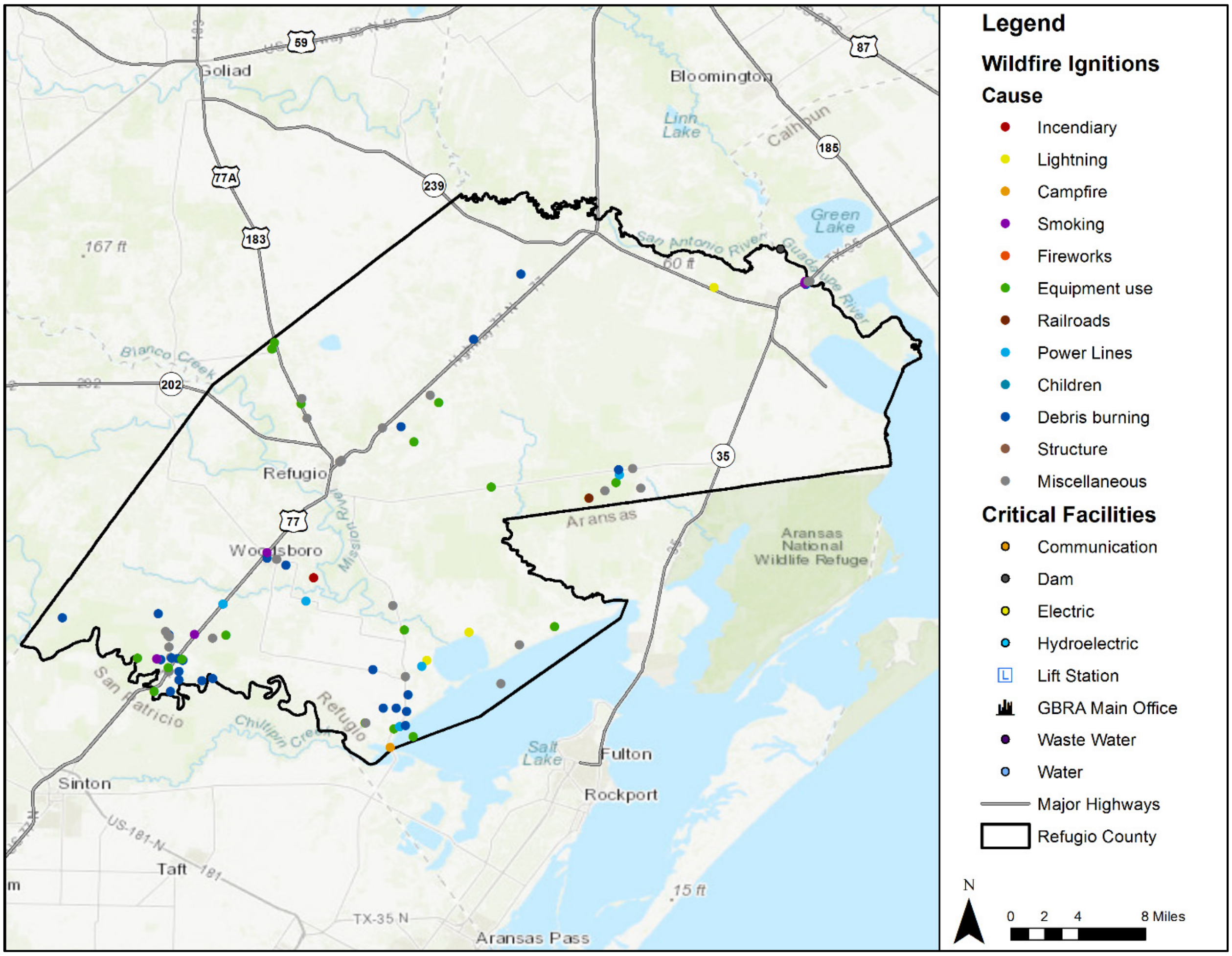


Figure 14-31. Location and Historic Wildfire Events for Victoria County

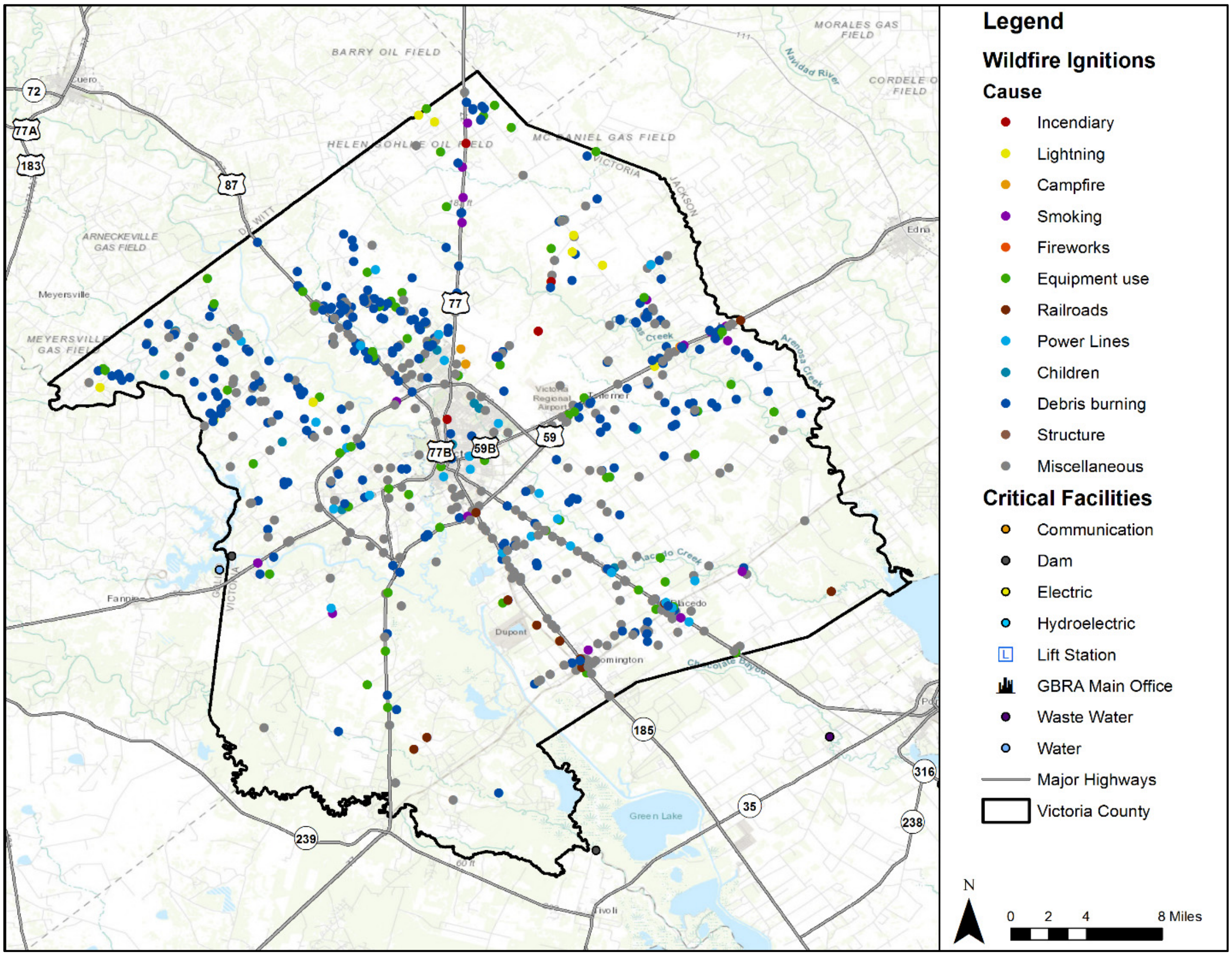


Table 14-1. Historical Wildfire Events Summary

COUNTY	NUMBER OF EVENTS	ACRES BURNED
Caldwell County	846	12,071
Calhoun County	150	7,478
Comal County	591	4,416
DeWitt County	466	4,969
Gonzales County	186	3,287
Guadalupe County	769	12,079
Hays County	534	6,066
Kendall County	477	8,913
Refugio County	91	6,086

COUNTY	NUMBER OF EVENTS	ACRES BURNED
Victoria County	747	13,434
GBRA Planning Area Losses	**4,857**	**78,799**

Table 14-2. Acreage of Suppressed Wildfire by Year

COUNTY	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Caldwell County	136	801	966	1,537	351	93	7,244	290	307	209	137
Calhoun County	0	75	3	369	7,000	18	3	2	6	0	2
Comal County	1,594	1,412	20	377	424	125	361	48	2	53	0
DeWitt County	63	274	87	2,169	1,355	174	668	47	82	18	32
Gonzales County	293	673	0	489	556	169	773	1	200	42	91
Guadalupe County	3,660	1,148	325	3,665	1,821	127	614	70	372	31	246
Hays County	448	1,650	815	1,643	991	2	436	17	6	19	39
Kendall County	36	735	411	4,399	2,132	20	775	19	122	148	116
Refugio County	0	1,001	0	593	1,560	284	1,272	1,365	11	0	0
Victoria County	1,025	739	792	1,806	4,570	22	2,097	238	1,013	547	585

Based on the list of historical wildfire events for the GBRA planning area (listed above), 2,133 of the events have occurred since the 2011 Plan.

Significant Events

June 19-21, 2011 – Green Cedar Wildfire, Kendall County
A wildfire in Kendall County between Boerne and Comfort was spread by southerly winds that gusted between 25 and 30 mph. Temperatures were near 100 degrees. The Green Cedar fire burned 140 acres including an RV park on Interstate 10. One structure and seven recreational vehicles were destroyed by the fire.

September 4-7, 2011 – Pedernales Bend Wildfire – Hays County
The Pedernales Bend Wildfire started in Travis County on September 4 behind Tropical Storm Lee and a cold front that brought strong northerly winds. The peak wind at Austin Bergstrom International Airport was 36 mph. The fire burned into Hays County and eventually consumed 6,500 acres and destroyed 67 homes between Travis and Hays Counties.

September 4-11, 2011 – Delhi Wildfire, Caldwell County
The Delhi Wildfire started on September 4 behind Tropical Storm Lee and a cold front that brought strong northerly winds. The peak wind at Austin Bergstrom International Airport was 36 mph. The fire burned 1,000 acres and destroyed six homes in Caldwell County.

Probability of Future Events

Wildfires can occur at any time of the year. As the GBRA planning area continues to grow and develop more within wild land, the potential area for a wildfire event increases. With 4,857 events in an eleven-year period, an event within the GBRA planning area is highly likely and an event is probable within the next year.

Vulnerability and Impact

Periods of drought, dry conditions, high temperatures, and low humidity are factors that contribute to the occurrence of a wildfire event. Areas along railroads and people whose homes are in woodland settings have an increased risk of being affected by wildfire.

The heavily populated, urban areas of communities within the GBRA planning area are not likely to experience large, sweeping fires. Areas outside of cities, in the unincorporated areas of all ten counties in the planning area, are more vulnerable. Unoccupied buildings and open spaces that have not been maintained have the greatest vulnerability to wildfire. The overall level of concern for wildfires is located mostly along the perimeter of the WUI.

The following GBRA facilities (Table 14-3) are located within the WUI and are more susceptible to wildfire in each county.

Table 14-3. GBRA Assets Located in WUI by County

COUNTY	ASSETS
Caldwell County	4 Structures(Waste Water Treatment Plant and 3 Water Treatment Plants), Infrastructure, Acreage
Calhoun County	1 Structure (Water Treatment Plant), Acreage
Comal County	4 Structures (3 Wastewater Treatment Plants, Pump Station), Infrastructure, Acreage, Pond
DeWitt County	Acreage
Gonzales County	2 Structures (Water Tower, Sub Station), Infrastructure, Acreage
Guadalupe County	3 Structures (Business Office, Wastewater Treatment Plant, Sub Station), 3 Lift Stations, Infrastructure, Acreage
Hays County	2 Structures (Water Treatment Plant, Wastewater Treatment Plant), Infrastructure, Acreage
Kendall County	1 Structure (Wastewater Treatment Plant), Acreage
Refugio County	Acreage
Victoria County	Infrastructure
GBRA Total	**17 Structures, 3 Lift Stations, Infrastructure, Acreage, Pond**

Within the GBRA planning area, a total of 4,857 fire events were reported from 2005 to 2015. All of these events were suspected wildfires. Historic acreage loss and annualized acreage loss estimates due to wildfires are presented in Table 14-4. The frequency is approximately 442 events every year for the ten county planning area.

Table 14-4. Historic Wildfire Event Summary and Annualized Loss[3]

COUNTY	NUMBER OF EVENTS	ACRES BURNED	ANNUAL ACRE LOSSES
Caldwell County	847	12,071	1,097.36
Calhoun County	150	7,478	679.82
Comal County	591	4,416	401.45
DeWitt County	466	4,969	451.73
Gonzales County	186	3,287	298.82
Guadalupe County	769	12,079	1,098.09
Hays County	534	6,066	551.45
Kendall County	477	8,913	810.27
Refugio County	91	6,086	553.27
Victoria County	747	13,434	1,221.27
Total Planning Area	**4,857**	**78,799**	**7,163.55**

Figures 14-32 through 14-41 show the GBRA planning area and the threat of wildfire by county.

[3] Acres divided by 11 years of data.

Figure 14-32. Wildfire Ignition Density Map for Caldwell County

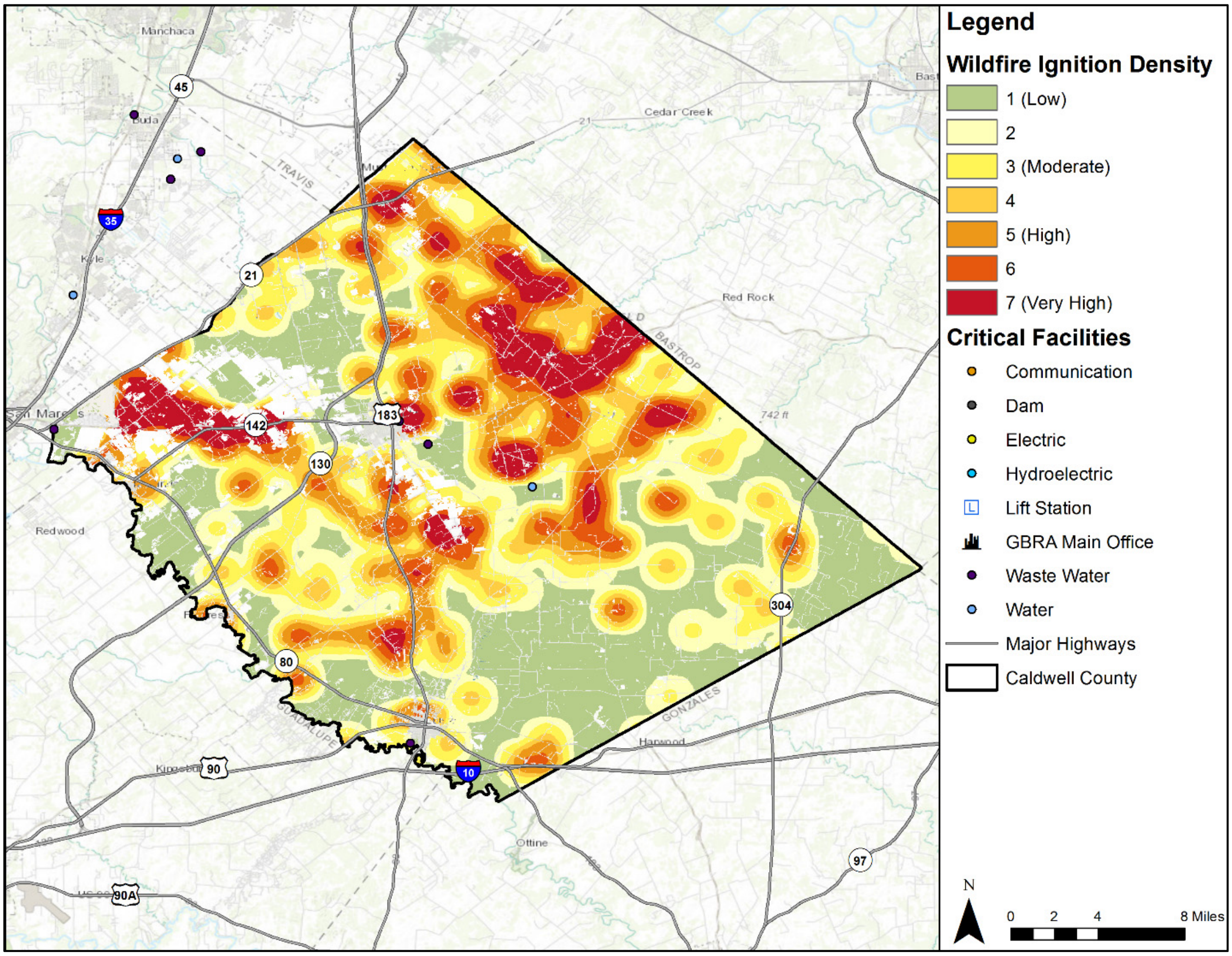


Figure 14-33. Wildfire Ignition Density Map for Calhoun County

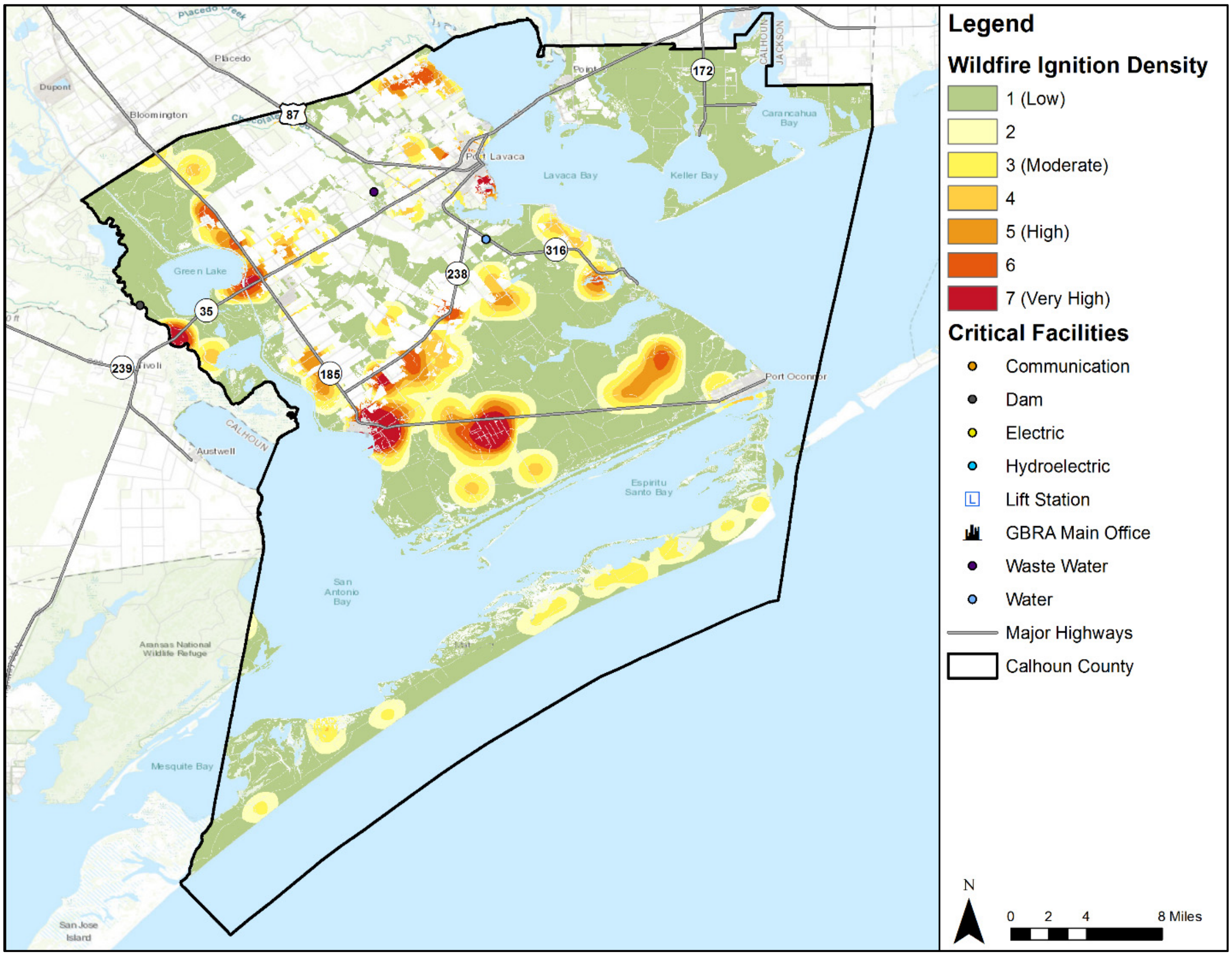


Figure 14-34. Wildfire Ignition Density Map for Comal County

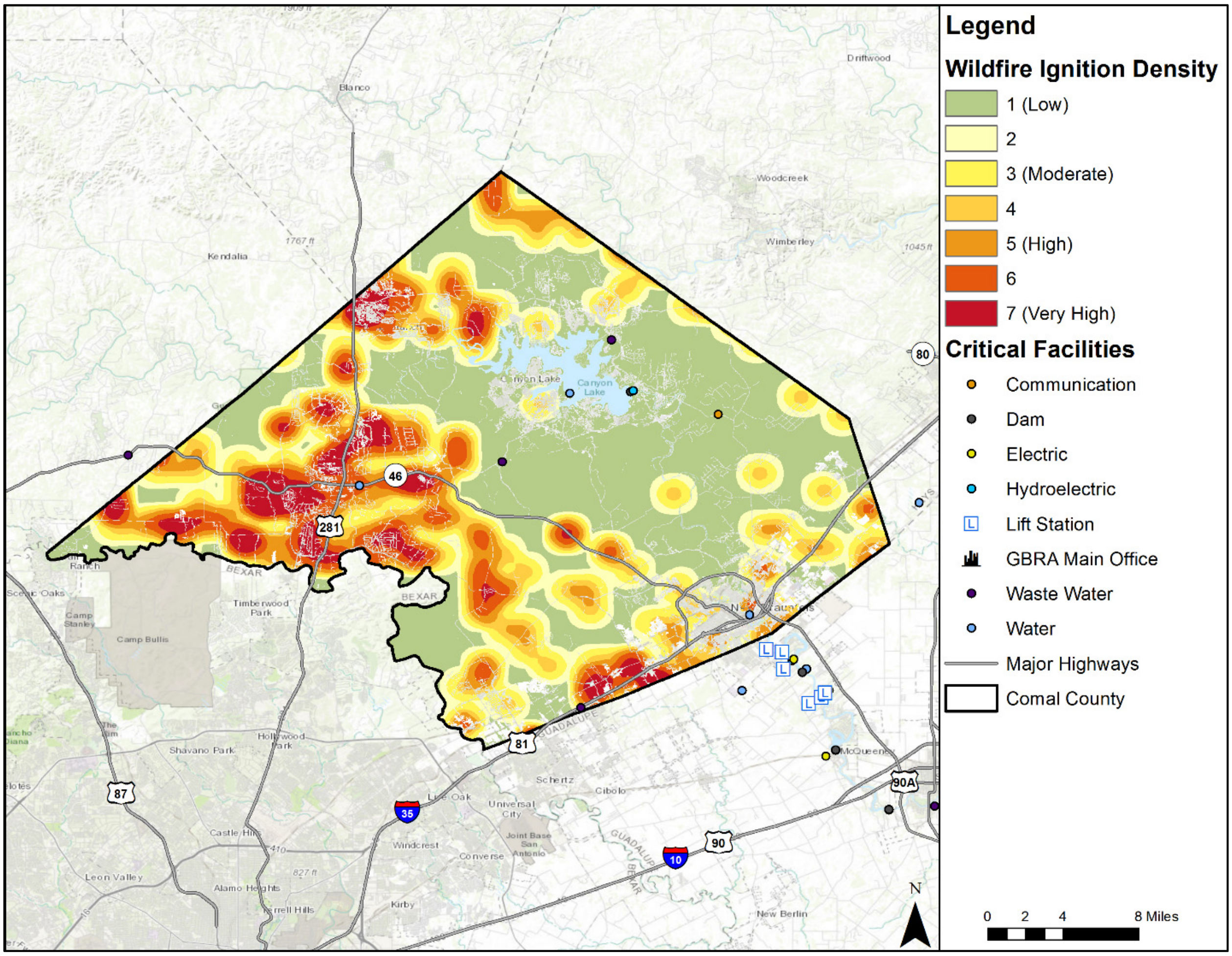


Figure 14-35. Wildfire Ignition Density Map for DeWitt County

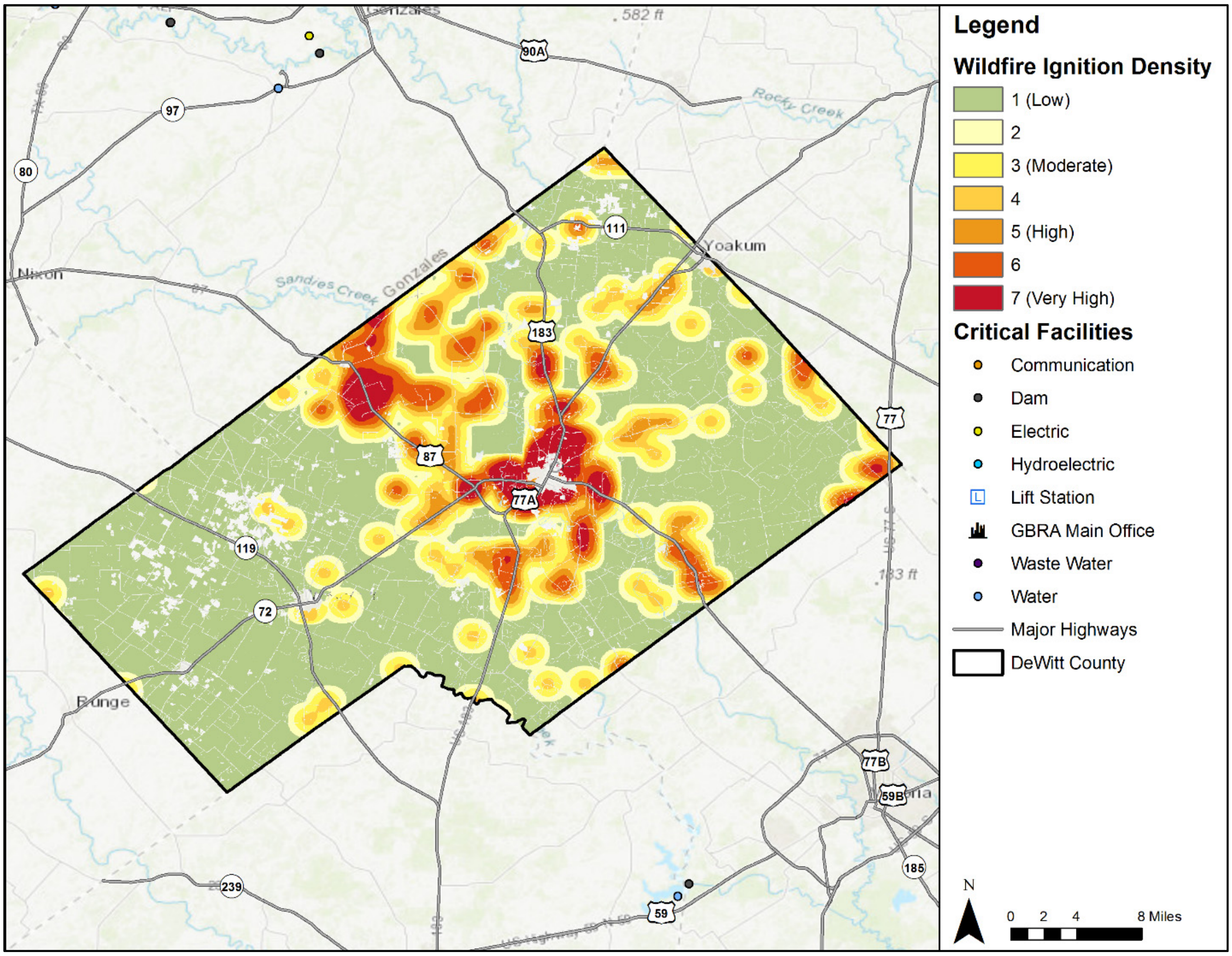


Figure 14-36. Wildfire Ignition Density Map for Gonzales County

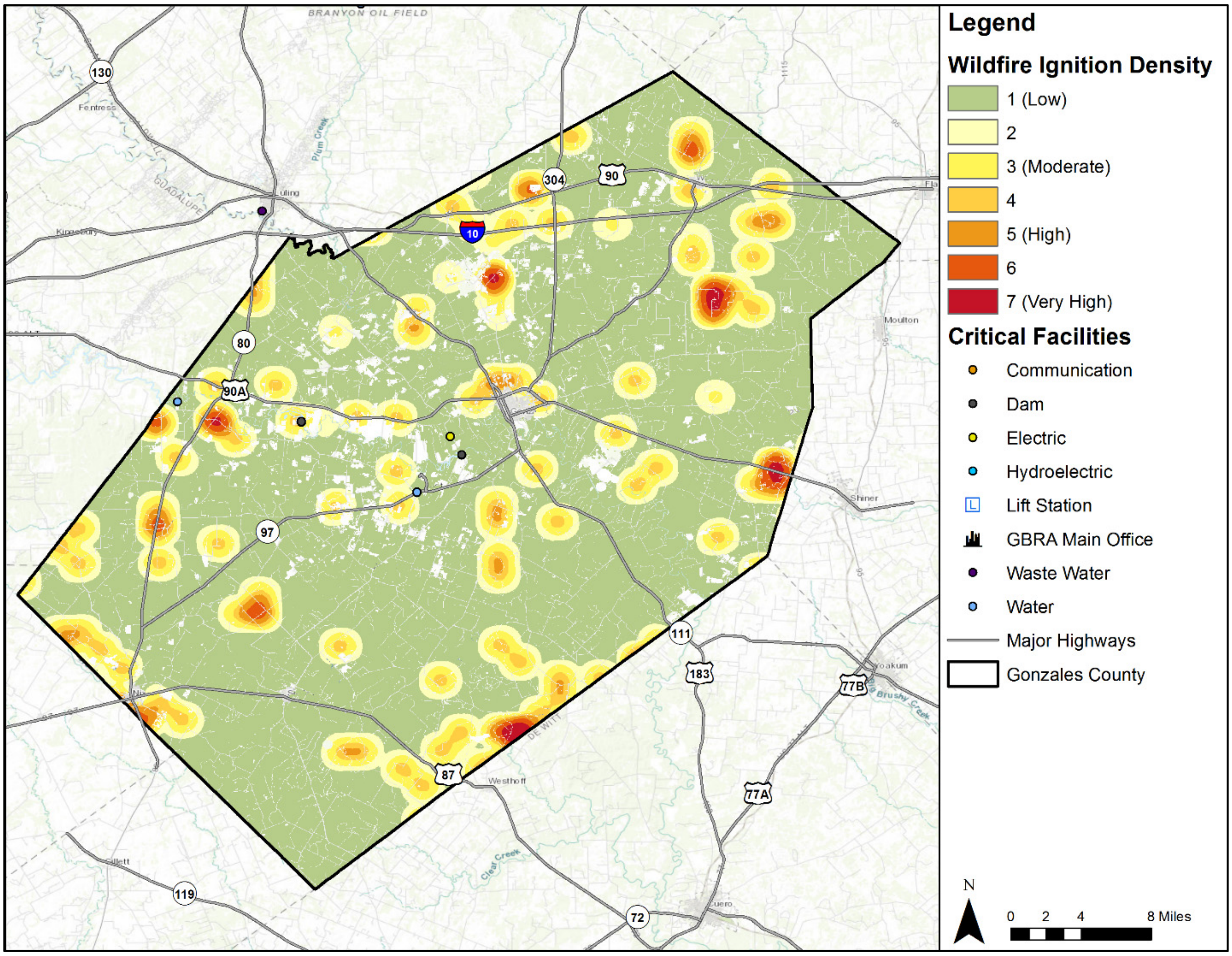


Figure 14-37. Wildfire Ignition Density Map for Guadalupe County

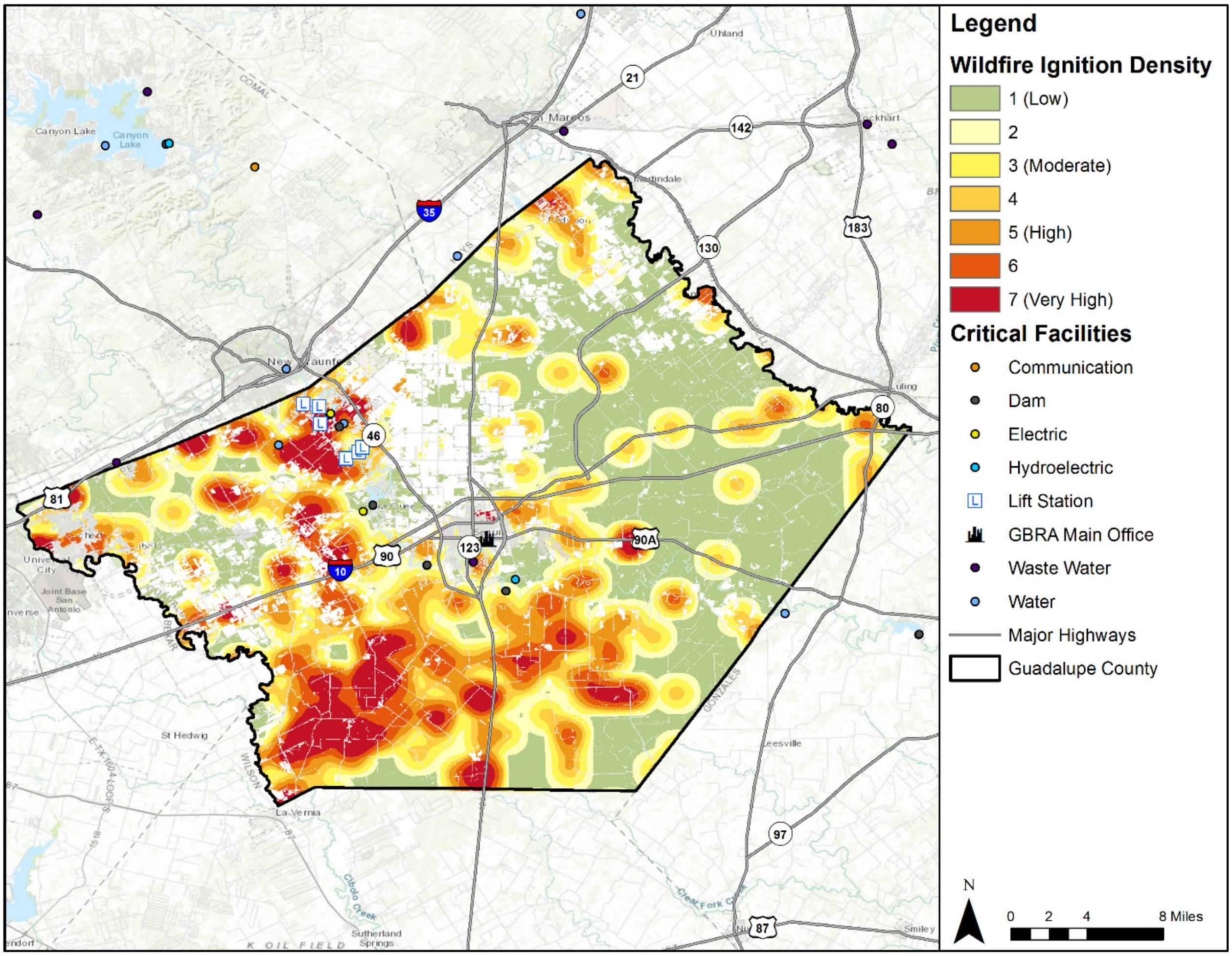


Figure 14-38. Wildfire Ignition Density Map for Hays County

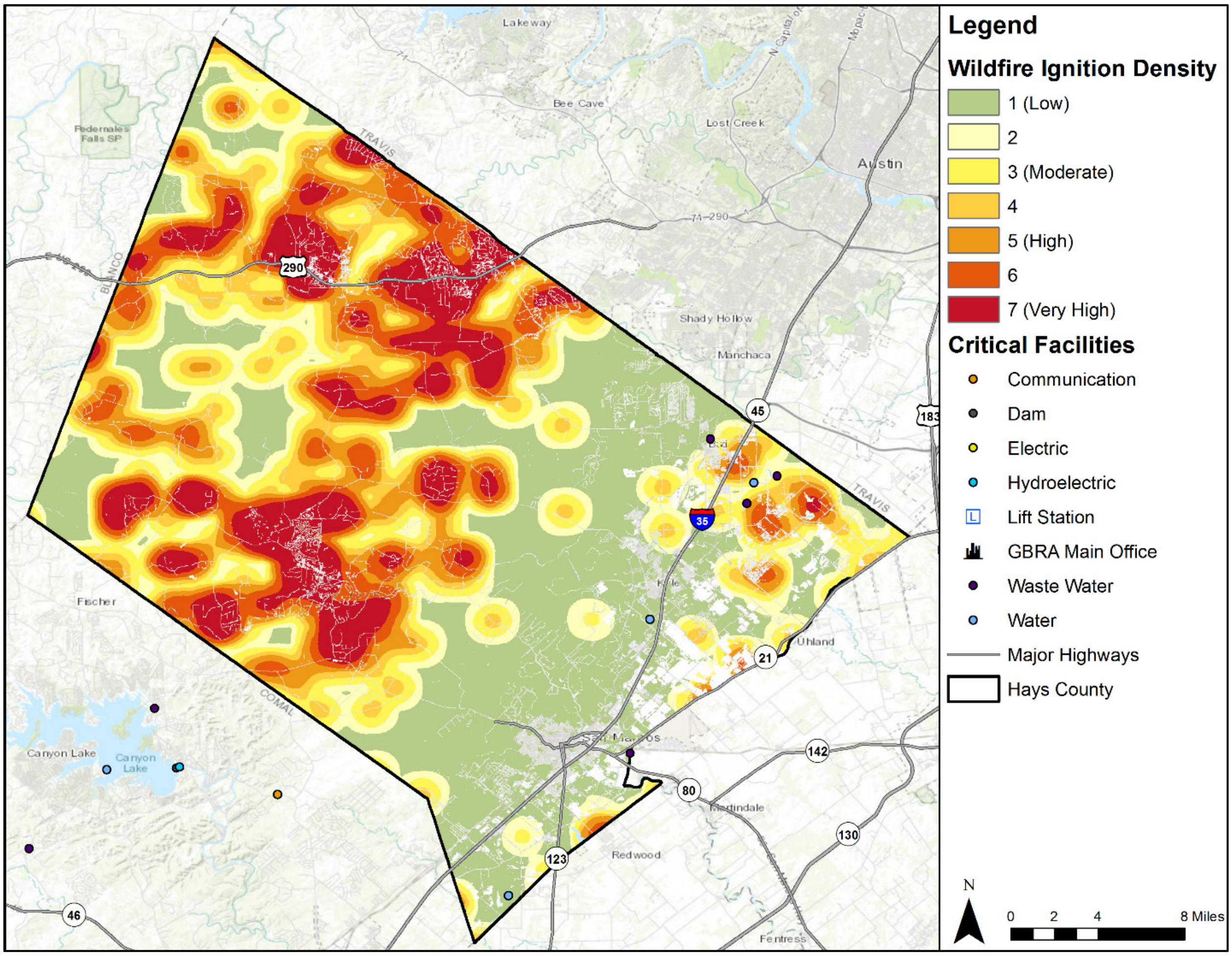


Figure 14-39. Wildfire Ignition Density Map for Kendall County

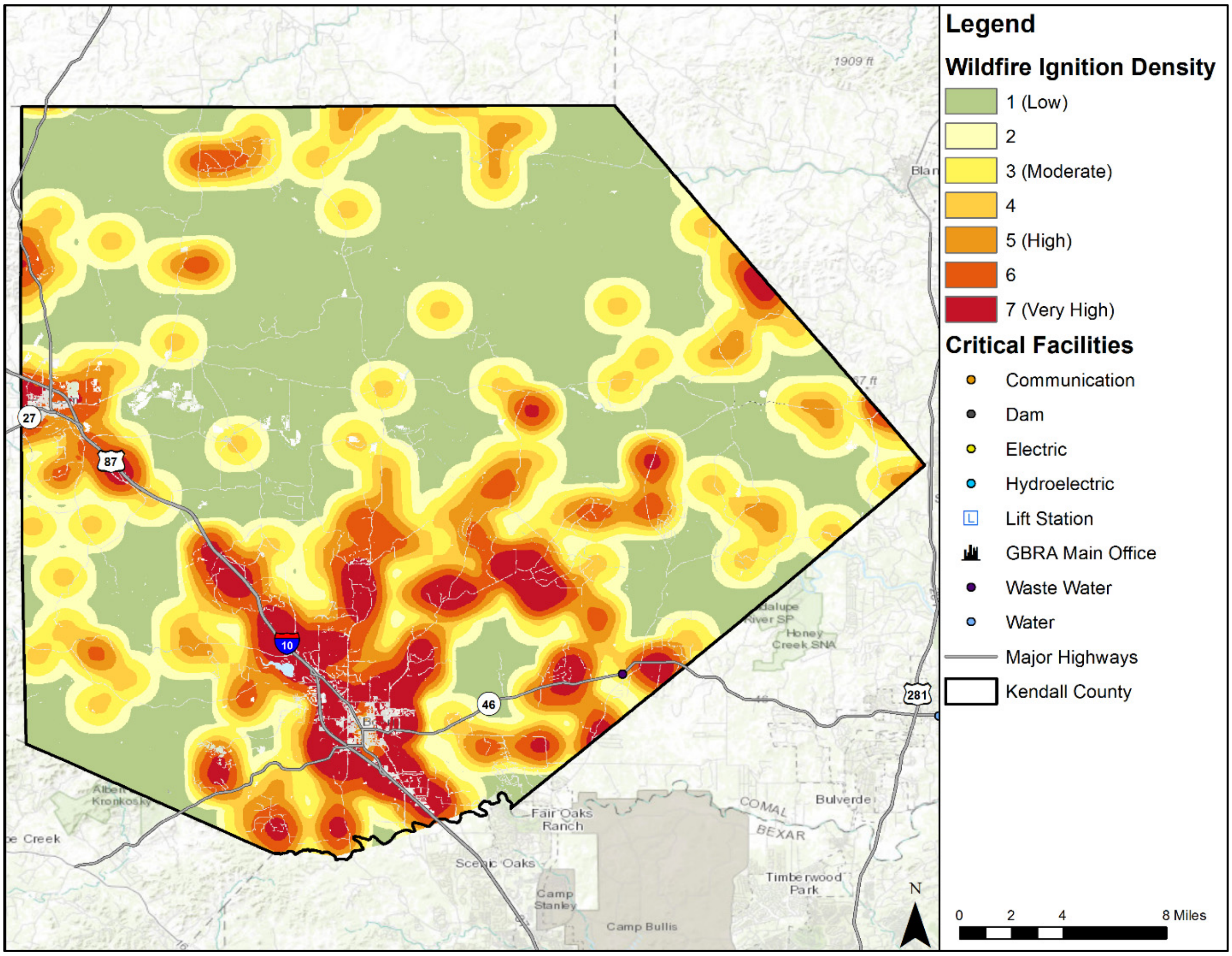


Figure 14-40. Wildfire Ignition Density Map for Refugio County

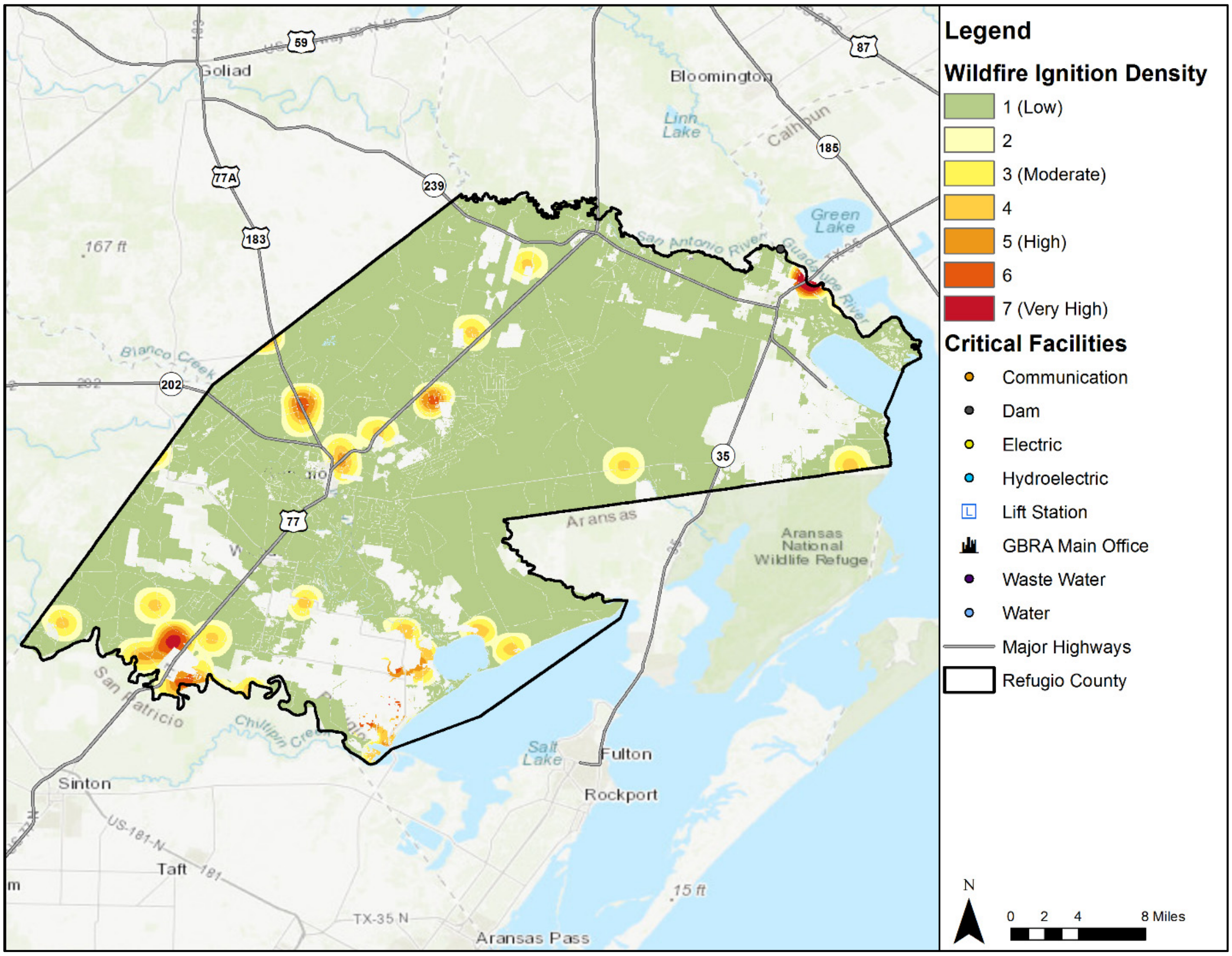
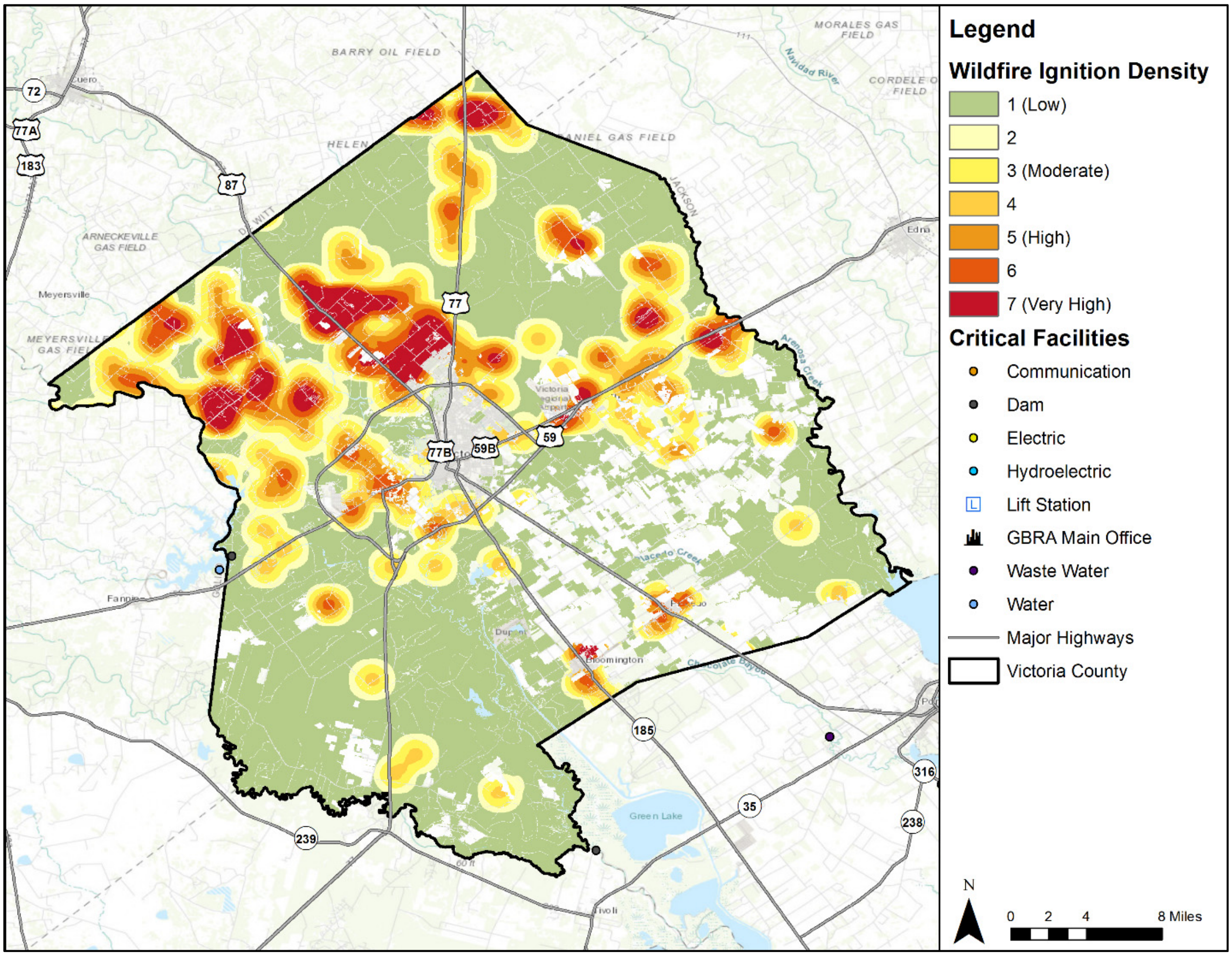


Figure 14-41. Wildfire Ignition Density Map for Victoria County



Diminished air quality is an environmental impact that can result from a wildfire event and pose a potential health risk. The smoke plumes from wildfires can contain potentially inhalable carcinogenic matter. Fine particles of invisible soot and ash that are too microscopic for the respiratory system to filter can cause immediate and possibly long-term health effects. The elderly or those individuals with compromised respiratory systems may be more vulnerable to the effects of diminished air quality after a wildfire event.

Climatic conditions such as severe freezes and drought can significantly increase the intensity of wildfires since these conditions kill vegetation, creating a prime fuel source for wildfires. The intensity and rate at which wildfires spread are directly related to wind speed, temperature, and relative humidity.

The severity of impact from major wildfire events can be substantial. Such events can cause multiple deaths, shut down facilities for 30 days or more, and cause more than 50 percent of affected properties to be destroyed or suffer major damage. Severity of impact is gauged by acreage burned, homes and structures lost, and the number of resulting injuries and fatalities. For the GBRA planning area the impact from a wildfire event can be considered "Limited," and injuries are possible but may not result in permanent disability, complete shutdown of critical area facilities for more than one week, and more than ten percent of property destroyed or with major damage.

Assessment of Impacts

A wildfire event poses a potentially significant risk to public health and safety, particularly if the wildfire is initially unnoticed and spreads quickly. The impacts associated with a wildfire are not limited to the direct damages.

The direct impacts to the GBRA facilities and services may include:

- Injury to vulnerable employees;
- Extensive power outages;
- Damaged or destroyed structures and infrastructure;
- Decreased power generation capabilities;
- Employees unable to report for duty;
- Damages to power grid;
- Inadequate staffing for repair work;
- Decreased revenue;
- Dissatisfied customers.

Impacts to counties in the planning area that could indirectly impact GBRA:

- Persons in the area at the time of the fire are at risk for injury or death from burns and/or smoke inhalation.
- First responders are at greater risk of physical injury since they are in close proximity to the hazard while extinguishing flames, protecting property or evacuating residents in the area.
- First responders can experience heart disease, respiratory problems, and other long term related illnesses from prolonged exposure to smoke, chemicals, and heat.
- Emergency services may be disrupted during a wildfire if facilities are impacted, roadways are inaccessible, or personnel are unable to report for duty.
- Critical city and/or county departments may not be able to function and provide necessary services depending on the location of the fire, and the structures or personnel impacted.
- Non-critical businesses may be directly damaged, suffer loss of utility services, or be otherwise inaccessible, delaying normal operations and slowing the recovery process.
- Displaced residents may not be able to immediately return to work, further slowing economic recovery.
- Roadways in or near the WUI could be damaged or closed due to smoke and limited visibility.
- Older homes are generally exempt from modern building code requirements, which may require fire suppression equipment in the structure.
- Some high-density neighborhoods feature small lots with structures close together, increasing the potential for fire to spread rapidly.
- Air pollution from smoke may exacerbate respiratory problems of vulnerable residents.
- Charred ground after a wildfire cannot easily absorb rainwater, increasing the risk of flooding and potential mudflows.
- Wildfires can cause erosion, degrading stream water quality.
- Wildlife may be displaced or destroyed.
- Historical or cultural resources may be damaged or destroyed.
- Tourism can be significantly disrupted, further delaying economic recovery for the area.
- Vegetated dunes can be stripped, significantly damaging the function of the dunes to protect inland areas from the destructive forces of wind and waves.
- Economic disruption negatively impacts the programs and services provided by the community due to short and long-term loss in revenue.
- Fire suppression costs can be substantial, exhausting the financial resources of the community.

- Residential structures lost in a wildfire may not be rebuilt for years, reducing the tax base for the community.
- Recreation and tourism can be unappealing for years following a large wildfire, devastating directly related businesses.
- Direct impacts to municipal water supply may occur through contamination of ash and debris during the fire, destruction of aboveground delivery lines, and soil erosion or debris deposits into waterways after the fire.

The economic and financial impacts of wildfire will depend entirely on the scale of the event, what is damaged, and how quickly repairs to critical components of the economy can be implemented. The level of preparedness and pre-event planning conducted by the GBRA in coordination with local government, businesses, and citizens will contribute to the overall economic and financial conditions in the aftermath of any wildfire event.

SECTION 15: DAM FAILURE

Hazard Description

Dams are water storage, control or diversion structures that impound water upstream in reservoirs. Dam failure can take several forms, including a collapse of or breach in the structure. While most dams have storage volumes small enough that failures have few or no repercussions, dams storing large amounts can cause significant flooding downstream. Dam failures can result from any one or a combination of the following causes:

- Prolonged periods of rainfall and flooding, which cause most failures;
- Inadequate spillway capacity, resulting in excess overtopping of the embankment;
- Internal erosion caused by embankment or foundation leakage or piping;
- Improper maintenance, including failure to remove trees, repair internal seepage problems, or maintain gates, valves, and other operational components;
- Improper design or use of improper construction materials;
- Failure of upstream dams in the same drainage basin;
- Landslides into reservoirs, which cause surges that result in overtopping;
- High winds, which can cause significant wave action and result in substantial erosion;
- Destructive acts of terrorism; and,
- Earthquakes, which typically cause longitudinal cracks at the tops of the embankments, leading to structural failure.

Benefits provided by dams include water supplies for drinking, irrigation, and industrial uses; flood control; hydroelectric power; recreation; and navigation. At the same time, dams also represent a risk to public safety. Dams require ongoing maintenance, monitoring, safety inspections, and sometimes even rehabilitation to continue safe service.

In the event of a dam failure, the energy of the water stored behind the dam is capable of causing rapid and unexpected flooding downstream, resulting in loss of life and substantial property damage. A devastating effect on water supply and power generation could be expected as well. The terrorist attacks of September 11, 2001 generated increased focus on protecting the country's infrastructure, including ensuring the safety of dams.

One major issue with the safety of dams is their age. The average age of America's 84,000 dams is 52 years. More than 2,000 dams near population centers are in need of repair, according to statistics released in 2009 by the Association of State Dam Safety Officials[1]. In addition to the continual aging

[1] Association of State Dam Safety Officials, Journal of Dam Safety

of dams there have not been significant increases in the number of safety inspectors resulting in haphazard maintenance and inspection.

The Association of State Dam Safety Officials estimate that $18.2 billion will be needed to repair all high-hazard dams, but the total for all state dam-safety budgets is less than $11 million[2]. The current maintenance budget does not match the scale of America's long-term modifications of its watersheds. Worse still, more people are moving into risky areas. As the American population grows, dams that once could have failed without major repercussions are now upstream of cities and development.

Location

The State of Texas has 7,126 dams, all regulated by the Texas Commission on Environmental Quality (TCEQ). Of these, 1,046 are considered "high-hazard," 725 are considered "significant-hazard," and 5,355 are considered "low-hazard." According to the American Society of Civil Engineers "Report Card," the Association of State Dam Safety Officials reports that there are 403 unsafe dams in Texas.[3] The GBRA operates 9 dams in the planning area. Each of these dams were analyzed individually by location, volume, elevation, and condition (where available) when determining the risk, if any, for each dam. Each dam site was further analyzed for potential risks utilizing FEMA's National Flood Hazard Layer to map locations and fully understand development near the dam and topographical variations that may increase risk. Figure 15-1 illustrates locations for each dam operated by the GBRA in the planning area. All dams are listed in Table 15-1 along with regulation information. Based on the in-

[2] Source: www.damsafety.org
[3] Source: http://www.asce.org/reportcard/pdf/tx.pdf

depth analysis of each GBRA dam the planning team was able to determine that only 7 of the 9 dams identified, pose a risk to the planning area. The GBRA Salt Water Barrier and Diversion Dam and the Goff Bayou Saltwater Barrier Dam both feature limited storage capacity and low height and were determined to pose no risk to structures, infrastructure, or citizens. As a result these dams are not profiled further in the plan. The remaining 7 GBRA dams are profiled in detail below (Figures 15-2 through 15-8).

Figure 15-1. Overview of Dams

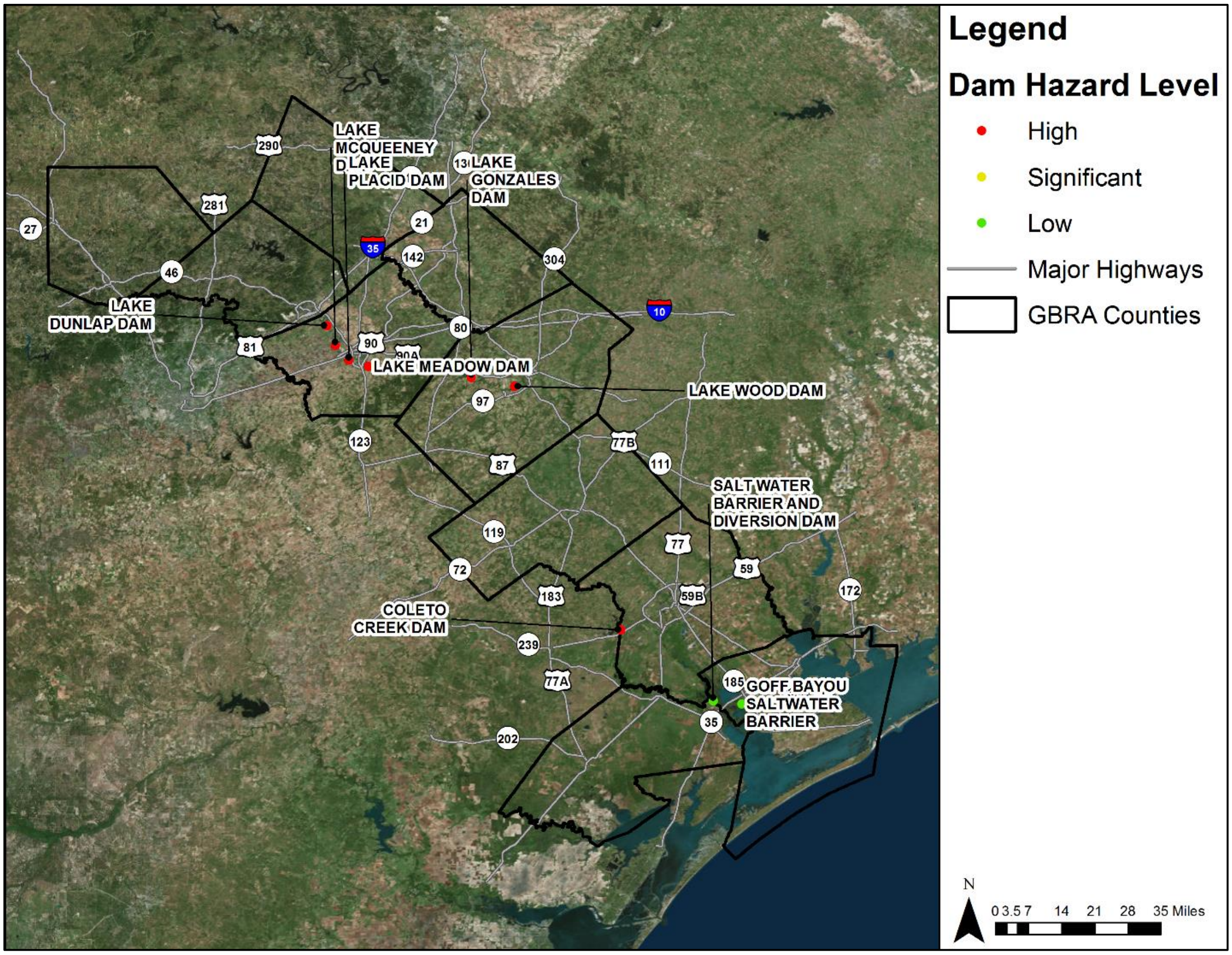


Table 15-1. GBRA Dam Survey

COUNTY	DAM NAME	HEIGHT (Ft.)	STORAGE (Acre Ft.)	CONDITION	PROFILED
Calhoun	Salt Water Barrier And Diversion Dam	11	600	Not Rated	No
Calhoun	Goff Bayou Saltwater Barrier	15	275	Not Rated	No
Gonzales	Lake Gonzales Dam	39	19,295	Fair	Yes
Gonzales	Lake Wood Dam	38.5	17,707	Fair	Yes

COUNTY	DAM NAME	HEIGHT (Ft.)	STORAGE (Acre Ft.)	CONDITION	PROFILED
Guadalupe	Lake McQueeney Dam	50.4	14,104	Fair	Yes
Guadalupe	Lake Dunlap Dam	50.6	13,434	Fair	Yes
Guadalupe	Lake Meadow Dam	43.3	6,075	Fair	Yes
Guadalupe	Lake Placid Dam	44.8	9,785	Fair	Yes
Victoria	Coleto Creek Dam	65	132,536	Satisfactory	Yes

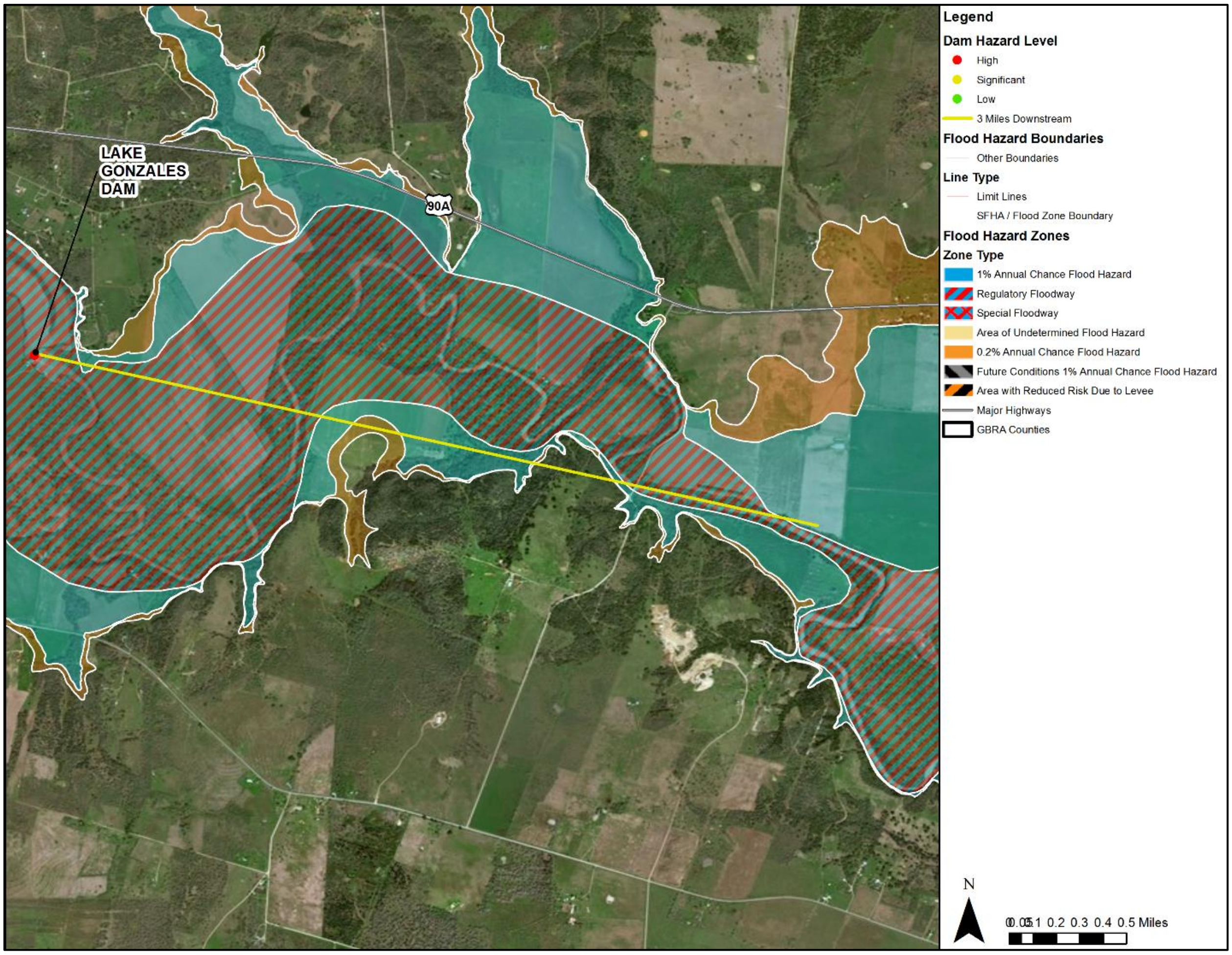
Extent

The extent or magnitude of a dam failure event is described in terms of the classification of damages that could result from a dam's failure, not the probability of failure. For dams with a maximum storage capacity of 100,000 acre-feet or more, all structures within five miles are considered to be at risk to potential dam failure hazards. For dams with a maximum storage capacity between 10,000 and 100,000 acre-feet, all structures within three miles are considered to be at risk to potential dam failure hazards. For dams with a maximum storage capacity of less than 10,000 acre-feet, all structures within one mile are considered to be at risk to potential dam failure hazards.

Figures 15-2 through 15-8 are inundation maps that show the flood risk areas for each dam that poses a risk and needs to be mitigated, according to the FEMA National Flood Hazard Layer (NFHL); in the event of a dam breach, the flow of water is expected to follow the same path of flood as the NFHL. An estimated depth for dam breach is indicated in the paragraph below Figures 15-2 through 15-8.[4]

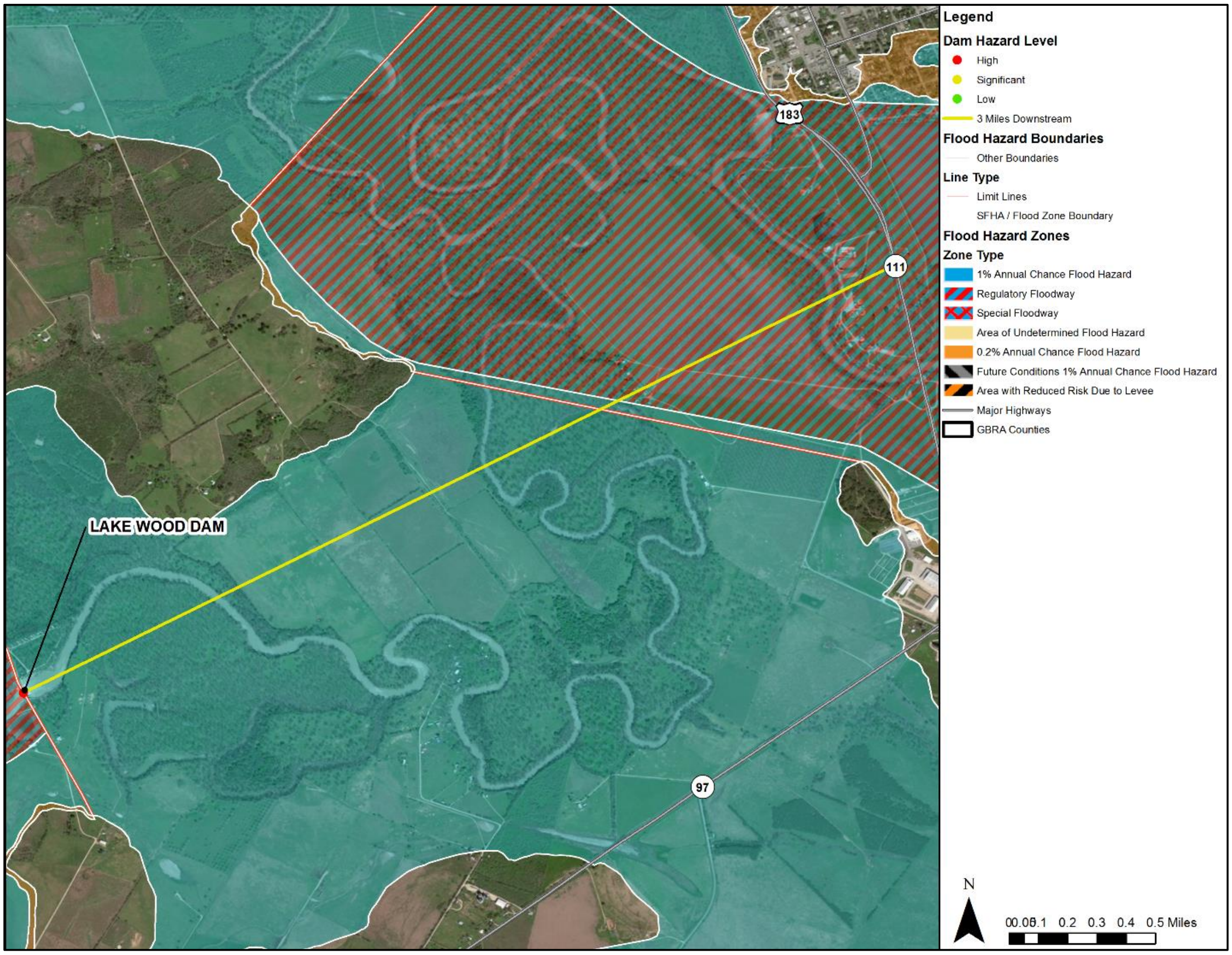
[4] Dam breach depth is an estimate based on best available data, not statistical data.

Figure 15-2. Lake Gonzales Dam Flood Risk Areas



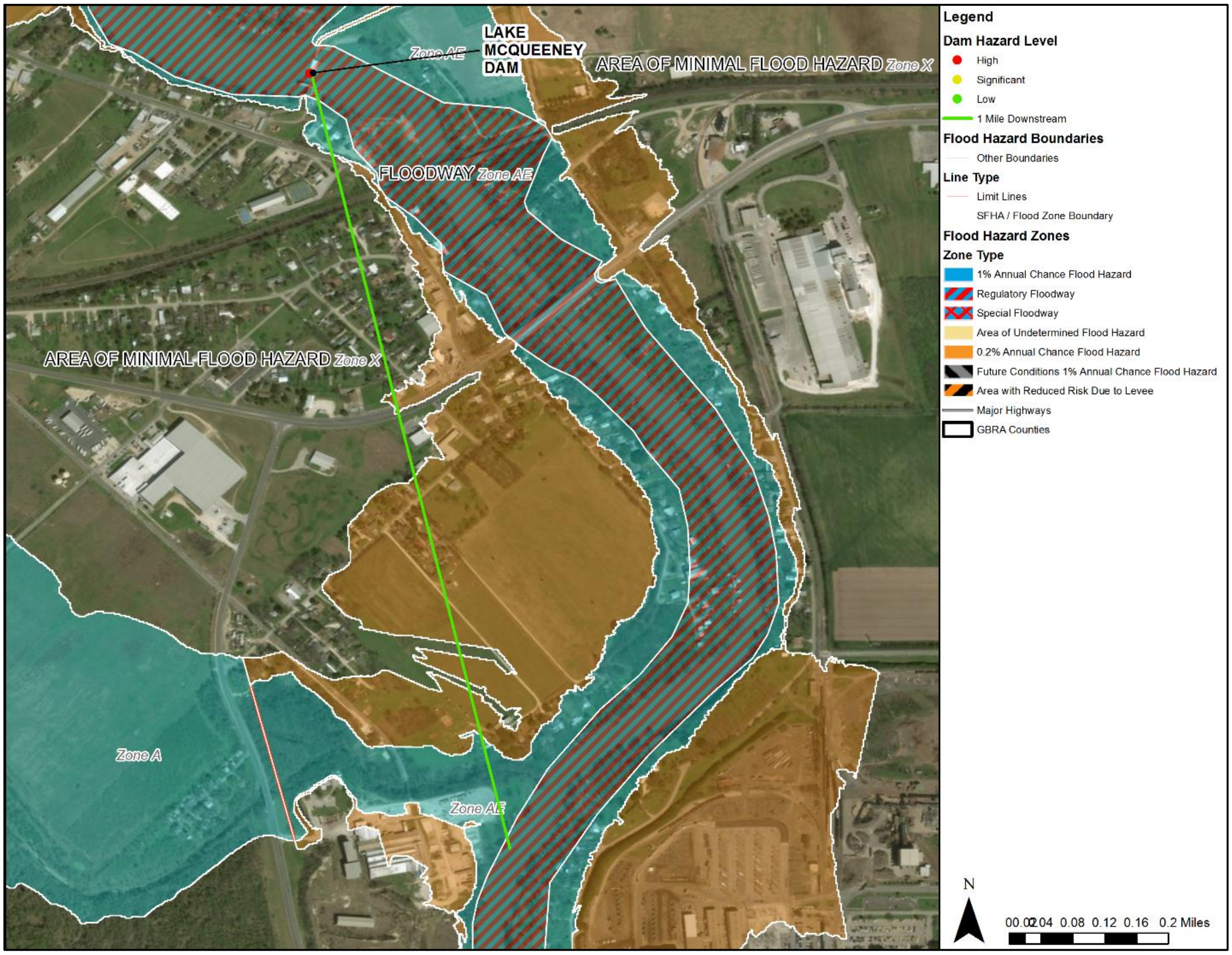
Lake Gonzales Dam is on the Guadalupe River in Gonzales County and is used for hydroelectric power and recreational purposes. The earthen construction dam is owned by the Guadalupe-Blanco River Authority and was constructed in 1931. The water height behind the dam is 22 feet. The area located near the dam is a sparsely populated area. A dam failure could cause power outages and disrupt utility systems. Approximately twelve homes within three miles of the dam could be impacted. The GBRA facilities at risk include the structures and infrastructure at the dam, hydroelectric power capabilities, and the power grid. In the event of a breach, it is estimated the average breach width would be 313.0 feet with a maximum breach flow of 90,237 cubic feet per second according to the National Weather Service (NWS) Dam Break Equation. A dam breach could result in an estimated depth of up to 15 feet.

Figure 15-3. Lake Wood Dam Flood Risk Areas



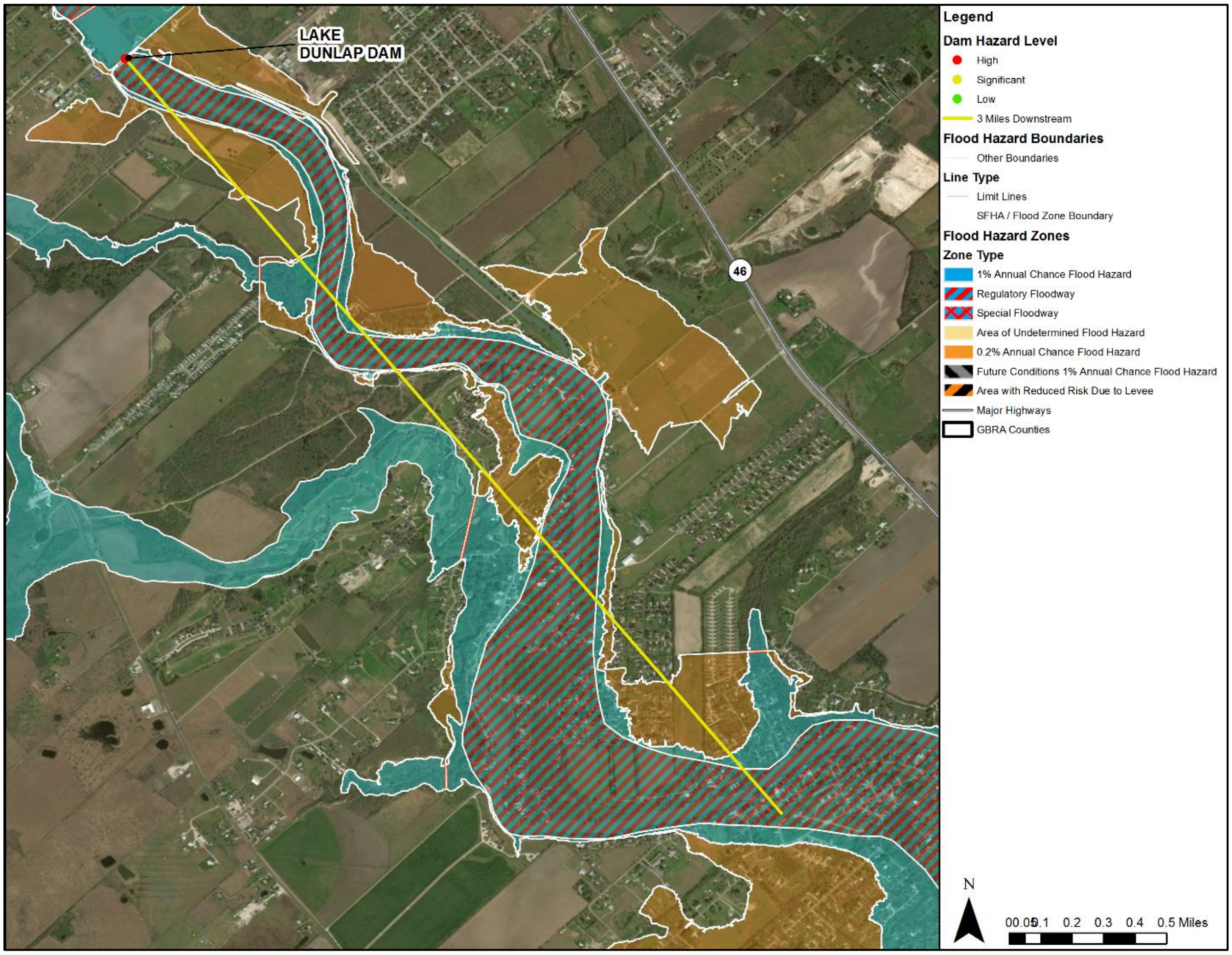
Lake Wood Dam is on the Guadalupe River in Gonzales County and is used for hydroelectric power and recreation purposes. The earthen construction dam is owned by the Guadalupe-Blanco River Authority and was constructed in 1931. The water height behind the dam is 28 feet. The area located near the dam is a sparsely populated area. Approximately fifty residential structures within three miles of the dam could be impacted. A dam failure could cause power outages and disrupt utility systems. The GBRA facilities at risk include the structures and infrastructure at the dam, hydroelectric power capabilities, the power grid and the Lake Wood Recreational Area. In the event of a breach, it is estimated the average breach width would be 311.3 feet with a maximum breach flow of 91,040 cubic feet per second according to the National Weather Service (NWS) Dam Break Equation. A dam breach could result in an estimated depth of up to 15 feet.

Figure 15-4. Lake McQueeney Dam Flood Risk Areas



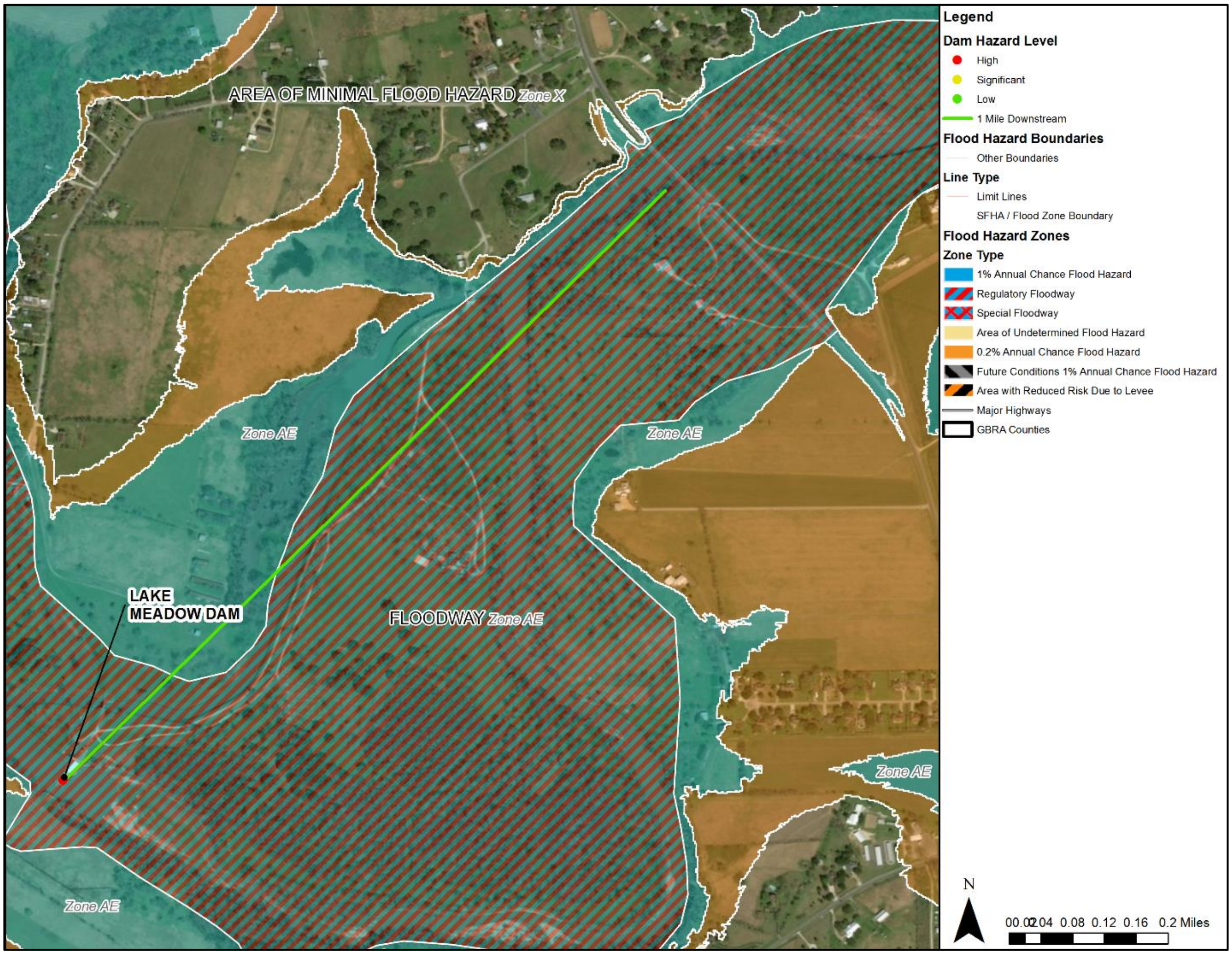
Lake McQueeney Dam is on the Guadalupe River in Guadalupe County and is used for hydroelectric power and recreation purposes. The earthen construction dam is owned by the Guadalupe-Blanco River Authority and was constructed in 1928. The water height behind the dam is 31 feet. The area located near the dam is densely populated. A dam failure could cause power outages and disrupt utility systems. Approximately 300 residential structures and 40 commercial structures would be vulnerable within three miles of the dam in the event of a dam failure. The GBRA facilities at risk include structures and infrastructure at the dam, hydroelectric power capabilities, and the power grid. In the event of a breach, it is estimated the average breach width would be 214.3 feet with a maximum breach flow of 110,577 cubic feet per second according to the National Weather Service (NWS) Dam Break Equation. A dam breach could result in an estimated depth of up to 20 feet.

Figure 15-5. Lake Dunlap Dam Flood Risk Areas



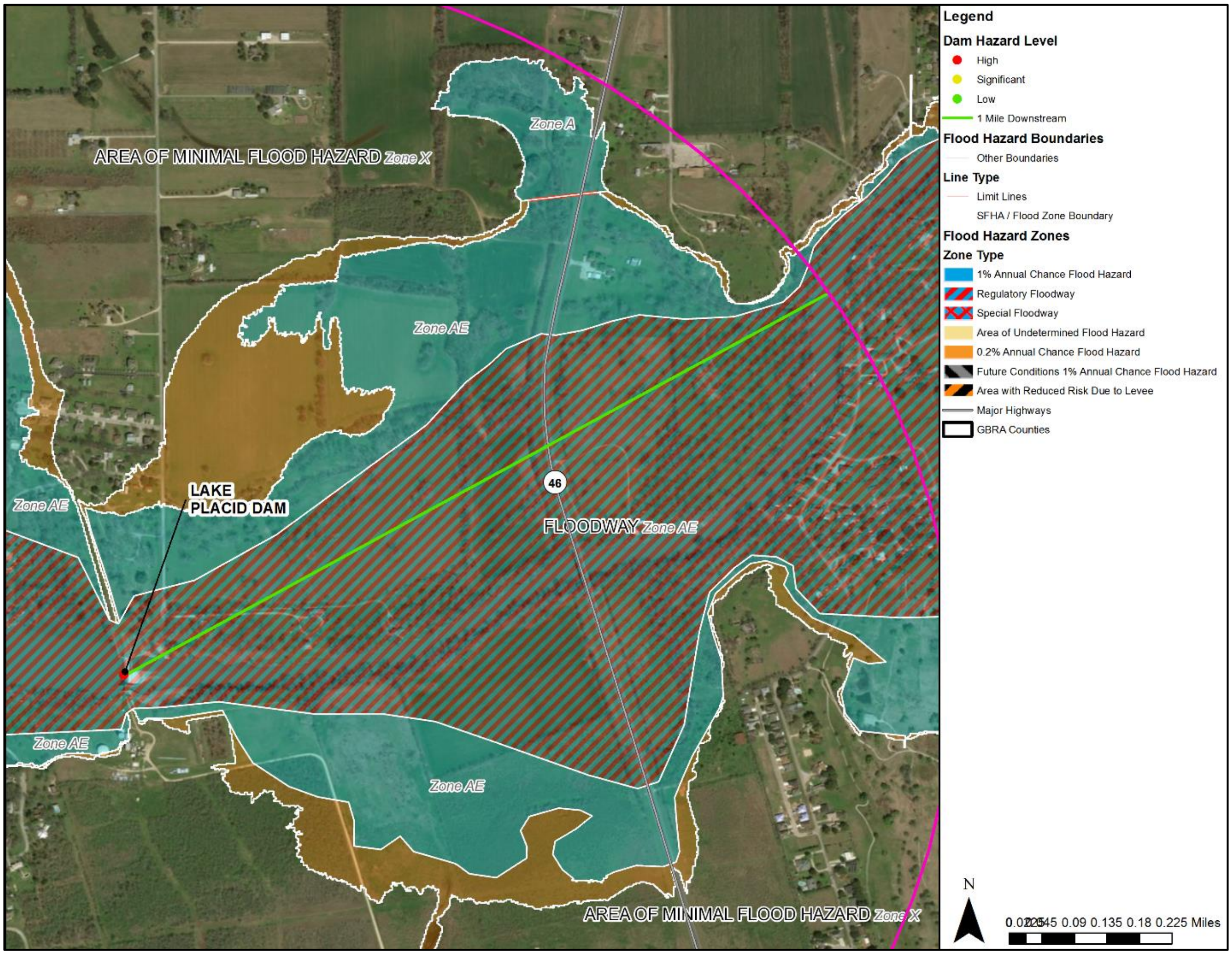
Lake Dunlap Dam is on the Guadalupe River in Guadalupe County and is used for hydroelectric power and recreation purposes. The earthen construction dam is owned by the Guadalupe-Blanco River Authority and was constructed in 1928. The water height behind the dam is 38 feet. The area located near the dam is densely populated. A dam failure could cause power outages and disrupt utility systems. Approximately 200 residential structures and 10 commercial structures would be vulnerable within three miles of the dam in the event of a dam failure. The GBRA facilities at risk include the structures and infrastructure at the dam, hydroelectric power capabilities, and the power grid. In the event of a breach, it is estimated the average breach width would be 263.0 feet with a maximum breach flow of 93,710 cubic feet per second according to the National Weather Service (NWS) Dam Break Equation. A dam breach could result in an estimated depth of up to 20 feet.

Figure 15-6. Lake Meadow Dam Flood Risk Areas



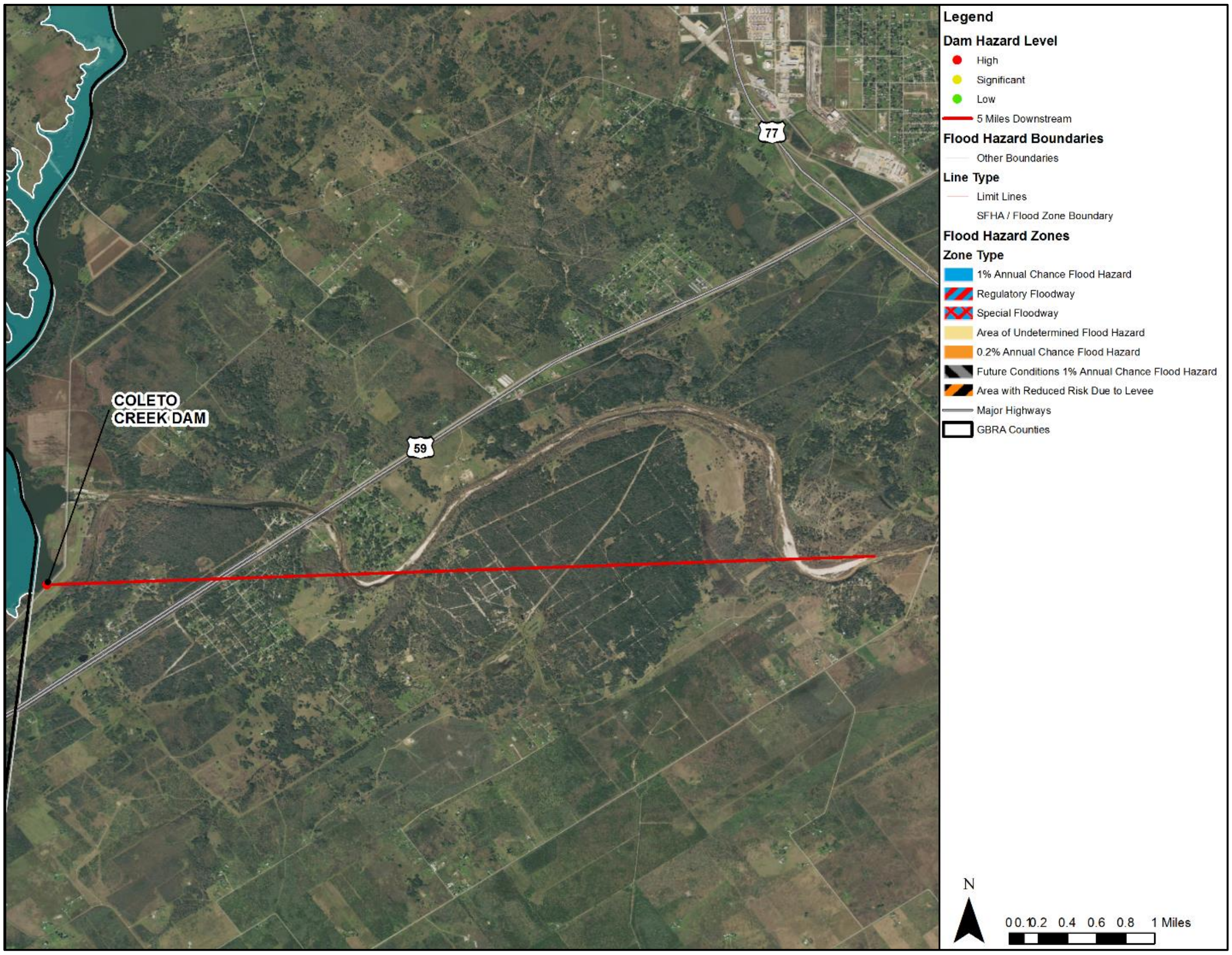
Lake Meadow Dam is on the Guadalupe River in Guadalupe County and is used for hydroelectric power and recreation purposes. The earthen construction dam is owned by the Guadalupe-Blanco River Authority and was constructed in 1930. The water height behind the dam is 27 feet. The area located near the dam is a sparsely populated area. A dam failure could cause power outages and disrupt utility systems within one mile of the dam. The GBRA facilities at risk include the structures and infrastructure at the dam, hydroelectric power capabilities, and the power grid. In the event of a breach, it is estimated the average breach width would be 183.7 feet with a maximum breach flow of 101,010 cubic feet per second according to the National Weather Service (NWS) Dam Break Equation. A dam breach could result in an estimated depth of up to 15 feet.

Figure 15-7. Lake Placid Dam Flood Risk Areas



Lake Placid Dam is on the Guadalupe River in Guadalupe County and is used for hydroelectric power and recreation purposes. The earthen construction dam is owned by the Guadalupe-Blanco River Authority and was constructed in 1930. The water height behind the dam is 29 feet. The area located near the dam is a sparsely populated area. A dam failure could cause power outages and disrupt utility systems. Approximately 10 residential structures would be vulnerable within one mile of the dam in the event of a dam failure. The GBRA facilities at risk include the structures and infrastructure at the dam, hydroelectric power capabilities, and the power grid. In the event of a breach, it is estimated the average breach width would be 514.7 feet with a maximum breach flow of 492,181 cubic feet per second according to the National Weather Service (NWS) Dam Break Equation. A dam breach could result in an estimated depth of up to 15 feet.

Figure 15-8. Coleto Creek Dam Flood Risk Areas



Coleto Creek Dam is located in Victoria and Guadalupe County downstream of the Coleto and Perdido Creek. The dam was constructed in 1980 by the Guadalupe-Blanco River Authority to provide a power station cooling pond for electric power generation. The reservoir is also used for recreational purposes including fishing and boating. The area located near the dam is rural with limited residential development. The area near the dam is rolling terrain with relatively limited changes in elevations. Approximately 250 residential structures within five miles of the dam may be impacted in the event of a breach. In addition, Highway 59, Union Pacific Railroad, FM 446, State Highway 77, camping grounds, a park, day care center, volunteer fire department, church, and three commercial structures lie within the potential inundation zone. A dam failure could cause limited infrastructure damages, minor power outages, and utility systems disruptions. The GBRA facilities at risk include the structures and infrastructure at the dam, power generation capabilities, and the power grid. In the event of a breach, it is estimated the average breach width would be 514.7 feet with a maximum breach flow of 492,181 cubic feet per second according to the National Weather Service (NWS) Dam Break Equation. A dam breach could result in an estimated depth of zero to 25 feet with the highest depth in the immediate area of the dam.

Table 15-2 represents the “average” extent or magnitude of a dam failure event that could be expected for the GBRA planning area.

Table 15-2. Extent for the GBRA by County

COUNTY	PROFILED DAM	EXTENT (Flow Depth)	LEVEL OF INTENSITY TO MITIGATE
Gonzales County	Lake Gonzales Dam	0-20 Feet	Dam failure presents a low threat for the area. In the event of a breach, loss of life can be expected. Structures, highways and infrastructure would be impacted, and economic loss would be significant in the event of a dam failure.
Gonzales County	Lake Wood Dam	0-20 Feet	Dam failure presents a low threat for the area. In the event of a breach, loss of life can be expected. Structures, highways and infrastructure would be impacted, and economic loss would be significant in the event of a dam failure.
Guadalupe County	Lake McQueeney Dam	0-20 Feet	Dam failure presents a minor threat for the County. In the event of a breach, loss of life can be expected. Structures, highways and infrastructure would be impacted, and economic loss would be significant in the event of a dam failure.
Guadalupe County	Lake Dunlap Dam	0-20 Feet	Dam failure presents a minor threat for the County. In the event of a breach, loss of life can be expected. Structures, highways and infrastructure would be impacted, and economic loss would be significant in the event of a dam failure.
Guadalupe County	Lake Meadow Dam	0-15 Feet	Dam failure presents a low threat for the area. In the event of a breach, loss of life can be expected. Structures, highways and infrastructure would be impacted, and economic loss would be significant in the event of a dam failure.
Guadalupe County	Lake Placid Dam	0-15 Feet	Dam failure presents a low threat for the area. In the event of a breach, loss of life can be expected. Structures, highways and infrastructure would be impacted, and economic loss would be significant in the event of a dam failure.
Victoria County	Coleto Creek Dam	0-25 Feet	Dam failure presents a minor threat for the County. In the event of a breach, loss of life can be expected. Structures, highways and infrastructure would be impacted, and economic loss would be substantial in the event of a dam failure.

Historical Occurrences

There are approximately 87,000 dams in the United States today.[5] Catastrophic dam failures have occurred frequently throughout the past century. Between 1918 and 1958, 33 major U.S. dam failures caused 1,680 deaths. From 1959 to 1965, nine major dams failed worldwide. Some of the largest

[5] Federal Emergency Management Agency, Dam Safety Program

disasters in the U.S. have resulted from dam failures. More than 90 dam incidents, including 23 dam failures, were reported in the past ten years to the National Performance of Dams Program, which collects and archives information on dam performance from state and federal regulatory agencies and dam owners.

In the State of Texas there have been 171 dam failures since 1900, although the State has not experienced loss of life or extensive economic damage due to a dam failure since the first half of the twentieth century. However, there may be many incidents that are not reported and, therefore, the actual number of incidents is likely to be greater. There have been no reported dam failures that have affected the GBRA planning area.

Probability of Future Events

Based on historical occurrences of dam failures, the probability for future events is unlikely for the GBRA planning area, meaning an event is probable in the next ten years.

Vulnerability and Impact

There are 9 dams operated by the GBRA throughout the planning area. All dams were evaluated in-depth to determine the risk, if any, associated with each dam. This analysis indicated 7 dams in the planning area that present a risk to structures or infrastructure in the planning area.

Flooding is the most prominent effect of dam failure. If the dam failure is extensive, a large amount of water would enter the downstream waterways forcing them out of their banks. There may be significant environmental effects, resulting in flooding that could disperse debris and hazardous materials downstream that can damage local ecosystems. If the event is severe, debris carried downstream can block traffic flow, cause power outages, and disrupt local utilities, such as water and wastewater.

Annualized loss-estimates for dam failure are not available, and neither is a breakdown of potential dollar losses for critical facilities, infrastructure and lifelines, or hazardous-materials facilities. If a major dam should fail, however, the severity of impact could be substantial.

A dam breach could result in multiple deaths with facilities being shut down for 30 days or more, and more than 50 percent of property destroyed or damaged. For these reasons, creating mitigation actions to remove or protect people and structures from the path of destruction is necessary in order to minimize impact from dam failure.

Any individual dam has a very specific area that will be impacted by a catastrophic failure. The impact from any catastrophic failure would be similar to that of a flash flood; extensive property damage and injuries could result from collisions with debris carried by the flood waters, and/or lives could be lost.

Dam failure can quickly become a hazardous situation involving massive amounts of water flowing quickly through the inundation zone. Swift-water rescue of individuals trapped by the water puts the immediate responders at risk for their own lives, in addition to the risk of the trapped individuals' lives. After the water has receded, those involved in the cleanup may be at risk from the debris left behind.

While the impacts of a dam breach are very similar to flood situations, they are different in that a dam failure's impact will be limited to an area within a single watercourse. This results in potential devastating impacts on the inundation zone, however the impact to areas outside the direct impact area could be very limited. Additionally, while flooding can occur over an extended period of time, a dam failure will typically have an initial surge of water downstream, but then the quantity of floodwaters will taper off relatively quickly. Exceptions would include the failure of a major dam during a severe rain event; a flood hazard already in existence when the dam fails could cause major extended flooding.

Despite the impacted area being limited and having the damage located within a single watercourse, a dam failure could still cause major disruption of operations and the delivery of services. The heavy onrush of water associated with an event of this type could, through the destruction of infrastructure in the impacted area, put a total halt on the GBRA's ability to respond to many of the day-to-day needs.

Assessment of Impacts

The direct impacts to the GBRA facilities and services may include:

- Dam failure at a hydroelectric dam would eliminate power generation capabilities, potentially long term.
- Employees stationed at dams could be killed or significantly injured during a dam breach.
- Extensive damages to facilities and infrastructure in the breach area.
- Extensive damage to the GBRA power grid.
- Decreased revenue.
- Potential liability for damages in the breach area.
- Extensive response and recovery costs.
- Loss of life
- Private property impacts
- Public infrastructure damages
- Impacts to water supply diversions from reservoirs

The overall extent of damages caused by dam failure is dependent on its extent and duration. The level of preparedness and pre-event planning done by the GBRA in coordination with local government, businesses, and citizens will contribute to the overall economic and financial conditions following a dam failure.

SECTION 16: MITIGATION STRATEGY

Mitigation Goals

Based on the results of the risk and capability assessments, the Planning Team developed and prioritized the mitigation strategy. This involved utilizing the results of both assessments and reviewing the goals and objectives that were included in the previous 2011 Plan.

At the Mitigation Workshop, held on October 25, 2017, Planning Team members refined the Plan's mitigation strategy. The goals were incorporated and expanded upon in the Plan Update. The following goals and objectives were identified.

Goal 1

Protect public health and safety.

Objective 1.1

Partner with agencies serving vulnerable populations to minimize harm in the event of an emergency.

Objective 1.2

Promote disaster contingency planning and facility safety among institutions that provide essential services such as food, clothing, shelter, and health care to vulnerable populations.

Objective 1.3

Educate individuals and communities about disaster preparedness and mitigation.

Objective 1.4

Improve disaster warning systems.

Objective 1.5

Strengthen local building code enforcement.

Objective 1.6

Train emergency responders.

Goal 2
Protect critical public facilities and infrastructure.

Objective 2.1
Implement mitigation programs that protect critical facilities and services and promote reliability of lifeline systems to minimize impacts from hazards, maintain operations, and expedite recovery in an emergency.

Objective 2.2
Consider known hazards when siting new facilities and systems.

Objective 2.3
Create redundancies for critical networks such as water, sewer, digital data, power, and communications.

Objective 2.4
Educate public officials, developers, realtors, contractors, building owners, and the public about hazard risks and building requirements.

Goal 3
Protect the environment.

Objective 3.1
Consider the secondary effects of disasters, such as hazardous waste and hazardous materials spills, when planning and developing mitigation projects.

Objective 3.2
Use environmentally and conservation friendly materials in mitigation projects whenever possible and economically feasible.

Goal 4
Increase public education and awareness.

Objective 4.1
Enhance understanding of local hazards and the risks they pose.

Objective 4.2
Educate the public on actions they can take to prevent or reduce the loss of life or property from all hazards and increase individual efforts to respond to potential hazards.

Objective 4.3
Publicize and encourage the adoption of appropriate hazard mitigation measures.

Goal 5

Encourage partnerships.

Objective 5.1

Partner with private sector, including small businesses, to promote structural and non-structural hazard mitigation as part of standard business practice.

Objective 5.2

Educate businesses about contingency planning citywide, targeting small businesses and those located in high risk areas.

Objective 5.3

Partner with private sector to promote employee education about disaster preparedness and practice conservation while at work and at home.

SECTION 17: PREVIOUS ACTIONS

Summary

Planning Team members were given copies of the previous mitigation actions submitted in the 2011 Plan. GBRA reviewed the previous actions and provided an analysis as to whether the action had been completed, should be deferred as an ongoing activity, or be deleted from the Plan Update. The actions from the 2011 Plan are included in this section as they were written in 2011, with the exception of the “2018 Analysis” section.

Guadalupe-Blanco River Authority

		GBRA (Past Action) – #1
	Proposed Action:	Repair erosion downstream of hydro dams
	History of Damages	The Guadalupe River experiences frequent small to large flood events which create bank and river-bend erosion downstream of the six low head hydroelectric plants.

MITIGATION ACTION DETAILS	
Hazard Addressed:	Dam Failure
Effect on new/existing buildings:	N/A
Priority (High, Moderate, Low):	High
Estimated Cost:	$5,000,000
Potential Funding Sources:	Grants, Hydro Electric Budget, Bonds
Lead Agency/Department Responsible:	GBRA Hydro Electric Division
Implementation Schedule:	2016

2018 Analysis:
Completed – Action is in progress of being completed.

		GBRA (Past Action) – #2
	Proposed Action:	Harden spillways and embankments to handle extreme flood events
	History of Damages	Earthen embankments need to be hardened in the event of possible dam failure.

MITIGATION ACTION DETAILS	
Hazard Addressed:	Dam Failure
Effect on new/existing buildings:	N/A
Priority (High, Moderate, Low):	High
Estimated Cost:	$15,000,000
Potential Funding Sources:	Grants, Bonds, Operating Budget
Lead Agency/Department Responsible:	GBRA Hydro Electric Division
Implementation Schedule:	2016

2018 Analysis:
Defer Action – Action will be included in the 2018 Plan.

GBRA (Past Action) – #3	
Proposed Action:	Develop and implement brush management programs in key areas within the GBRA Basin
History of Damages	In Central Texas, brush such as Mesquite and Juniper have taken over the pasture land and resulted in reduced runoff to the streams and rivers of the region.

MITIGATION ACTION DETAILS	
Hazard Addressed:	Drought
Effect on new/existing buildings:	N/A
Priority (High, Moderate, Low):	High
Estimated Cost:	To be determined
Potential Funding Sources:	Grants, Bonds, Low interest loans
Lead Agency/Department Responsible:	Staff
Implementation Schedule:	2016

2018 Analysis:
Completed.

GBRA (Past Action) – #4	
Proposed Action:	Review and update drought contingency plans annually and provide public information regarding drought awareness
History of Damages	Drought has occurred historically and periodically.

MITIGATION ACTION DETAILS	
Hazard Addressed:	Drought
Effect on new/existing buildings:	An effective drought contingency plan can extend water and supplies of affected jurisdictions and affected structures
Priority (High, Moderate, Low):	High
Estimated Cost:	$10,000
Potential Funding Sources:	GBRA Operating Budget
Lead Agency/Department Responsible:	Engineering Department
Implementation Schedule:	2016

2018 Analysis:
Defer Action – Action will be included in 2018 Plan.

GBRA (Past Action) – #5	
Proposed Action:	Develop new water supply projects and initiatives working with colleagues in Region L
History of Damages	Future water supply a concern.

MITIGATION ACTION DETAILS	
Hazard Addressed:	Drought
Effect on new/existing buildings:	GBRA's continued participation within the planning effort will help ensure the region has an adequate water supply
Priority (High, Moderate, Low):	High
Estimated Cost:	$10,000
Potential Funding Sources:	Operating Budget
Lead Agency/Department Responsible:	Engineering
Implementation Schedule:	2011

2018 Analysis:
Defer Action – Action will be included in 2018 Plan.

GBRA (Past Action) – #6	
Proposed Action:	Develop training program for employees on hydration and other safety protection measures pertaining to working outdoors in extreme heat
History of Damages	None

MITIGATION ACTION DETAILS	
Hazard Addressed:	Extreme Heat
Effect on new/existing buildings:	N/A
Priority (High, Moderate, Low):	High
Estimated Cost:	$2,000 annually
Potential Funding Sources:	GBRA plant operations
Lead Agency/Department Responsible:	GBRA Operations Manager
Implementation Schedule:	2011

2018 Analysis:
Completed.

GBRA (Past Action) – #7	
Proposed Action:	Install stream gauges and citizen monitors where needed in the Basin and develop software to allow general public to view gauges and anticipated flood events
History of Damages	Fewer gauges results in less warning time during severe storm and weather events.

MITIGATION ACTION DETAILS	
Hazard Addressed:	Flood
Effect on new/existing buildings:	N/A
Priority (High, Moderate, Low):	High
Estimated Cost:	$100,000
Potential Funding Sources:	Grants, Other government entities
Lead Agency/Department Responsible:	Engineering Department
Implementation Schedule:	2015

2018 Analysis:
Defer Action – Action will be included in 2018 Plan.

GBRA (Past Action) – #8	
Proposed Action:	Develop hydrologic forecast models for the Guadalupe Basin
History of Damages	The headwaters of the Guadalupe Basin are located in a region known as “Flash Flood Alley”. These intense rain events are difficult to forecast. Better tools are needed.

MITIGATION ACTION DETAILS	
Hazard Addressed:	Flood
Effect on new/existing buildings:	N/A
Priority (High, Moderate, Low):	High
Estimated Cost:	$2,000,000
Potential Funding Sources:	Grants, Each plant operation budget
Lead Agency/Department Responsible:	Engineering Department
Implementation Schedule:	2015

2018 Analysis:
Defer Action – Action will be included in 2018 Plan.

GBRA (Past Action) – #9	
Proposed Action:	Develop job description and employ new FTE Risk Assessment personnel and/or retain consultant.
History of Damages	

MITIGATION ACTION DETAILS	
Hazard Addressed:	Hazardous Materials Release
Effect on new/existing buildings:	N/A
Priority (High, Moderate, Low):	High
Estimated Cost:	$100,000 annually
Potential Funding Sources:	O&M Budget
Lead Agency/Department Responsible:	Operations Manager
Implementation Schedule:	2012

2018 Analysis:
Delete Action – Hazardous Materials Release is not included in the 2018 Plan.

GBRA (Past Action) – #10	
Proposed Action:	Implement employee training on hazardous material release prevention and response.
History of Damages	GBRA employees work with and are exposed to hazardous materials.

MITIGATION ACTION DETAILS	
Hazard Addressed:	Hazardous Materials Release
Effect on new/existing buildings:	N/A
Priority (High, Moderate, Low):	High
Estimated Cost:	$2,000
Potential Funding Sources:	GBRA operational budgets
Lead Agency/Department Responsible:	
Implementation Schedule:	2011

2018 Analysis:
Delete Action – Hazardous Materials Release is not included in the 2018 Plan.

GBRA (Past Action) – #11	
Proposed Action:	Develop and implement a pathogen control plan.
History of Damages	Potential for Infectious disease needs to be addressed and preparations outlined.

MITIGATION ACTION DETAILS	
Hazard Addressed:	Infectious Disease
Effect on new/existing buildings:	N/A
Priority (High, Moderate, Low):	High
Estimated Cost:	$10,000
Potential Funding Sources:	GBRA plant operation budget
Lead Agency/Department Responsible:	GBRA Safety Committee
Implementation Schedule:	2011

2018 Analysis:
Delete Action – Infectious Disease is not included in the 2018 Plan.

GBRA (Past Action) – #12	
Proposed Action:	Facilitate employee training relative to infectious diseases
History of Damages	Employees that work with wastewater have the potential to be exposed to diseases caused by pathogens in untreated or treated wastewater.

MITIGATION ACTION DETAILS	
Hazard Addressed:	Infectious Disease
Effect on new/existing buildings:	N/A
Priority (High, Moderate, Low):	High
Estimated Cost:	$10,000
Potential Funding Sources:	GBRA plant operations budget
Lead Agency/Department Responsible:	Operations Manager
Implementation Schedule:	2011

2018 Analysis:
Delete Action – Infectious Disease is not included in the 2018 Plan.

GBRA (Past Action) – #13	
Proposed Action:	Provide program to offer tetanus and annual flu shots to GBRA employees
History of Damages	

MITIGATION ACTION DETAILS	
Hazard Addressed:	Infectious Disease
Effect on new/existing buildings:	N/A
Priority (High, Moderate, Low):	High
Estimated Cost:	$10,000
Potential Funding Sources:	GBRA plant operation budgets
Lead Agency/Department Responsible:	GBRA Safety Committee
Implementation Schedule:	2011

2018 Analysis:
Delete Action – Infectious Disease is not included in the 2018 Plan.

GBRA (Past Action) – #14	
Proposed Action:	Acquire and install additional cameras and intrusion alarms at the hydro dams and at critical facilities in the basin
History of Damages	These 6 facilities could possibly be a target of terrorism.

MITIGATION ACTION DETAILS	
Hazard Addressed:	Terrorism
Effect on new/existing buildings:	N/A
Priority (High, Moderate, Low):	High
Estimated Cost:	$500,000
Potential Funding Sources:	Grants
Lead Agency/Department Responsible:	GBRA Hydroelectric Manager
Implementation Schedule:	2016

2018 Analysis:
Delete Action – Terrorism is not included in the 2018 Plan.

GBRA (Past Action) – #15	
Proposed Action:	Harden security at critical wells and water treatment and delivery systems in the basin.
History of Damages	Potential targets for terrorism exist in the Basin.

MITIGATION ACTION DETAILS	
Hazard Addressed:	Terrorism
Effect on new/existing buildings:	N/A
Priority (High, Moderate, Low):	High
Estimated Cost:	$20,000
Potential Funding Sources:	Plant operation budgets
Lead Agency/Department Responsible:	Operations Manager
Implementation Schedule:	2014

2018 Analysis:
Delete Action – Terrorism is not included in the 2018 Plan.

GBRA (Past Action) – #16	
Proposed Action:	Update security policy accordingly and maintain GBRA's Security Committee
History of Damages	Potential security risks exist at various GBRA sites.

MITIGATION ACTION DETAILS	
Hazard Addressed:	Terrorism
Effect on new/existing buildings:	N/A
Priority (High, Moderate, Low):	High
Estimated Cost:	$2,000 annually
Potential Funding Sources:	GBRA operation budgets
Lead Agency/Department Responsible:	Staff
Implementation Schedule:	2010

2018 Analysis:
Delete Action – Terrorism is not included in the 2018 Plan.

		GBRA (Past Action) – #17
	Proposed Action:	Upgrade lightning protection equipment and critical equipment at all GBRA facilities
	History of Damages	Lightning from severe thunderstorms can result in major electronic damage to water and wastewater plants. A plant can be out of commission for several days.

MITIGATION ACTION DETAILS	
Hazard Addressed:	Thunderstorm
Effect on new/existing buildings:	N/A
Priority (High, Moderate, Low):	High
Estimated Cost:	$300,000
Potential Funding Sources:	Grants, plant operating budgets
Lead Agency/Department Responsible:	Operations Manager
Implementation Schedule:	2015

2018 Analysis:
Defer Action – Action will be included in 2018 Plan.

		GBRA (Past Action) – #18
	Proposed Action:	Install emergency generator hook-ups at GBRA critical facilities and install quick-connect hook-ups at all GBRA facilities to accept a mobile generator.
	History of Damages	Lightning strikes and other weather events pose a threat to loss of power.

MITIGATION ACTION DETAILS	
Hazard Addressed:	Thunderstorm
Effect on new/existing buildings:	N/A
Priority (High, Moderate, Low):	High
Estimated Cost:	$100,000
Potential Funding Sources:	Grants, plant operating budgets
Lead Agency/Department Responsible:	Operations Manager
Implementation Schedule:	2013

2018 Analysis:
Defer Action – Action will be included in 2018 Plan.

GBRA (Past Action) – #19	
Proposed Action:	Add back-up SCADA control room at alternate locations in the basin
History of Damages	Damage may occur if no back-up equipment during tornado events.

MITIGATION ACTION DETAILS	
Hazard Addressed:	Tornado
Effect on new/existing buildings:	N/A
Priority (High, Moderate, Low):	High
Estimated Cost:	$300,000
Potential Funding Sources:	Grant
Lead Agency/Department Responsible:	Hydro Division
Implementation Schedule:	2015

2018 Analysis:
Defer Action – Action will be included in 2018 Plan.

GBRA (Past Action) – #20	
Proposed Action:	Develop a delta model for the lower basin area
History of Damages	Lower basin area model needed to accurately assess changes in wildlife and flow patterns.

MITIGATION ACTION DETAILS	
Hazard Addressed:	Flood
Effect on new/existing buildings:	N/A
Priority (High, Moderate, Low):	High
Estimated Cost:	$1,200,000
Potential Funding Sources:	Grants, bonds, operating budget
Lead Agency/Department Responsible:	Engineering
Implementation Schedule:	2015

2018 Analysis:
Defer Action – Action will be included in 2018 Plan.

GBRA (Past Action) – #21	
Proposed Action:	Improve the Dam Failure (Breach) Model for Dunlap, McQueeney, TP4 and Nolte Dams in the Basin in order to strengthen dam structure so that it will pass Probable Maximum Flood (PMF)
History of Damages	Although there have been no previous occurrences of breach, this is a needed property protection action. An improved Dam Breach Model will provide a better understanding of possible areas of inundation.

MITIGATION ACTION DETAILS	
Hazard Addressed:	Dam Failure
Effect on new/existing buildings:	N/A
Priority (High, Moderate, Low):	High
Estimated Cost:	$150,000
Potential Funding Sources:	Grants, operating budget
Lead Agency/Department Responsible:	Hydro Electric Division
Implementation Schedule:	2015

2018 Analysis:
Completed.

GBRA (Past Action) – #22	
Proposed Action:	Develop detailed Dam Failure (Breach) Model for the H4 and H5 Dams in the Basin in order to harden the dam structure so that it will pass PMF
History of Damages	Although there have been no previous occurrences of breach, this is a needed property protection action and will provide a better understanding of possible areas of inundation. The older dam structure needs to be strengthen, but a model must be developed first.

MITIGATION ACTION DETAILS	
Hazard Addressed:	Dam Failure
Effect on new/existing buildings:	N/A
Priority (High, Moderate, Low):	High
Estimated Cost:	$150,000
Potential Funding Sources:	Grants, operating budget
Lead Agency/Department Responsible:	Hydro Electric Division
Implementation Schedule:	2016

2018 Analysis:
Defer Action – Action will be included in 2018 Plan.

GBRA (Past Action) – #23	
Proposed Action:	Improve communication with GBRA staff and County EMC's regarding Emergency Action Plan for Dam Failure and Safety
History of Damages	There have been no previous occurrences, which is why this awareness action has been developed.

MITIGATION ACTION DETAILS	
Hazard Addressed:	Dam Failure
Effect on new/existing buildings:	N/A
Priority (High, Moderate, Low):	High
Estimated Cost:	Minimal
Potential Funding Sources:	Operating Budget
Lead Agency/Department Responsible:	Hydro Electric Division
Implementation Schedule:	Upon Plan approval

2018 Analysis:
Defer Action – Action will be included in 2018 Plan.

SECTION 18: MITIGATION ACTIONS

Summary

As discussed in Section 2, at the mitigation workshop the planning team and stakeholders met to develop mitigation actions for each of the natural hazards included in the Plan Update. Each of the actions in this section were prioritized based on FEMA's Social, Technical, Administrative, Political, Legal, Economic, and Environmental (STAPLEE) criteria necessary for the implementation of each action. As a result of this exercise, an overall priority was assigned to each mitigation action.

As part of the economic evaluation of the STAPLEE analysis, GBRA analyzed each action in terms of the overall costs, measuring whether the potential benefit to be gained from the action outweighed costs associated with it. Priority was assigned to each mitigation action by marking them as High (H), Moderate (M), or Low (L). An action that is ranked "High" indicates that the action will be implemented as soon as funding is received. A "Moderate" action is one that may not be implemented right away depending on the cost and number of citizens served by the action. Actions ranked as "Low" indicate that they will not be implemented without first seeking grant funding and after "High" and "Moderate" actions have been completed.

All mitigation actions created by Planning Team members are presented in this section in the form of Mitigation Action Worksheets. More than one hazard is sometimes listed for an action, if appropriate. Actions presented in this section represent a comprehensive range of mitigation actions per current State and FEMA Guidelines, including two actions per hazard and of two different types.

Table 18-1. Guadalupe-Blanco River Authority Mitigation Action Matrix*

* FEMA does not review mitigation actions for human-caused hazards; therefore, they are not included in the comprehensive list of mitigation actions in Table 18-1.

GUADALUPE-BLANCO RIVER AUTHORITY : MITIGATION ACTION MATRIX				
Actions presented in this matrix represent a comprehensive range and minimum number of required mitigation actions per current State and FEMA Guidelines, including two actions per hazard and of two different types.				
HAZARDS	Types of Action:			
	LOCAL PLANS/ REGULATIONS	STRUCTURAL/ INFRASTRUCTURE	NATURAL SYSTEM PROTECTION	EDUCATION & AWARENESS
Dam Failure		XXXXXXXXXXXXXXXXXXXX		XXX
Drought	X	X		XXX
Extreme Heat		XX		XX
Flood	XX	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	X	XXXXXX
Hail		XXXXXXX		XX
Hurricane	X	XXXXXXXXXXXXXX	X	XXXX
Lightning		XXXXXXXXXX		XX
Thunderstorm Wind	X	XXXXXXXXXXXXXX		XXXX
Tornado	X	XXXXXXXXXXX		XXXX
Wildfire	XXX	XXXX	XX	XXXX
Winter Storm	X	XXXXX		XXX
Preparedness/ Response	XXXXXXX			

Guadalupe-Blanco River Authority

GBRA – Action #1	
Proposed Action:	Purchase and install generators and hardwired quick connections at all GBRA critical facilities (including pump stations/lift stations).
BACKGROUND INFORMATION	
Site and Location:	All GBRA critical sites
Risk Reduction Benefit (Current Cost/Losses Avoided)**:**	Reduce risk of loss of service; Reduce loss of revenue.
Type of Action: (Local Plans and Regulations, Structure and Infrastructure Projects, Natural Systems Protection, or Education and Awareness)	Structure and Infrastructure

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Dam Failure, Extreme Heat, Flood, Hail, Hurricane, Lightning, Thunderstorm Wind, Tornado, Wildfire, Winter Storm
Effect on new/existing buildings:	N/A
Priority (High, Moderate, Low):	High
Estimated Cost:	$2,000,000
Potential Funding Sources:	HMA Grants, Hydro Budget, Bonds
Lead Agency/Department Responsible:	Operations Manager
Implementation Schedule:	Within 12-24 months of plan adoption
Incorporation into Existing Plans:	Strategic Plan

COMMENTS:
ADDITIONAL CONSIDERATIONS: (Rate action as indicated below) The following STAPLEE criteria were evaluated on a scale of 1 to 5 indicating the extent to which this action satisfies each consideration. (1= Does Not Satisfy 3 = Moderately Satisfies 5 = Strongly Satisfies)
Socially Acceptable = 5; Technically Feasible = 5; Administratively Possible = 5; Politically Acceptable = 5; Legal = 5; Economically Sound = 5; and Environmentally Sound = 5

GBRA – Action #2	
Proposed Action:	Retrofit all existing manholes to be watertight; Test all existing lines to verify they are all watertight.
BACKGROUND INFORMATION	
Site and Location:	Dunlap collection area, south of New Braunfels
Risk Reduction Benefit (Current Cost/Losses Avoided)**:**	Continue operation of the WWTP for area residents without a sewer overflow that threatens the environment.
Type of Action: (Local Plans and Regulations, Structure and Infrastructure Projects, Natural Systems Protection, or Education and Awareness)	Structure and Infrastructure

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flood
Effect on new/existing buildings:	Reduce risk of contamination and unwanted inflow at existing facility
Priority (High, Moderate, Low):	Moderate
Estimated Cost:	$250,000 – 1,000,000 (Depending on test findings)
Potential Funding Sources:	HMA Grants, Bonds, Revenues
Lead Agency/Department Responsible:	GBRA Rural Utilities
Implementation Schedule:	Within 24-36 months of plan adoption
Incorporation into Existing Plans:	Strategic Plan

COMMENTS:
ADDITIONAL CONSIDERATIONS: (Rate action as indicated below) The following STAPLEE criteria were evaluated on a scale of 1 to 5 indicating the extent to which this action satisfies each consideration. (1= Does Not Satisfy 3 = Moderately Satisfies 5 = Strongly Satisfies)
Socially Acceptable = 5; Technically Feasible = 4; Administratively Possible = 5; Politically Acceptable = 5; Legal = 5; Economically Sound = 5; and Environmentally Sound = 4

	GBRA – Action #3
Proposed Action:	Educate all of the Whitewater customers about making sure all cleanouts are secure and that gutters do not drain into our collection system.
BACKGROUND INFORMATION	
Site and Location:	GBRA customers
Risk Reduction Benefit (Current Cost/Losses Avoided)**:**	Reduce risk of flood; Maintain drainage capacity.
Type of Action: (Local Plans and Regulations, Structure and Infrastructure Projects, Natural Systems Protection, or Education and Awareness)	Education and Awareness

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flood
Effect on new/existing buildings:	Reduce risk to existing structures and infrastructure
Priority (High, Moderate, Low):	Moderate
Estimated Cost:	$1,000
Potential Funding Sources:	Operating Budget (staff time)
Lead Agency/Department Responsible:	Strategic Communications and Education Manager
Implementation Schedule:	Within 24 months of plan adoption
Incorporation into Existing Plans:	Strategic Plan

COMMENTS:
ADDITIONAL CONSIDERATIONS: (Rate action as indicated below) The following STAPLEE criteria were evaluated on a scale of 1 to 5 indicating the extent to which this action satisfies each consideration. (1= Does Not Satisfy 3 = Moderately Satisfies 5 = Strongly Satisfies)
Socially Acceptable = 5; Technically Feasible = 5; Administratively Possible = 5; Politically Acceptable = 5; Legal = 5; Economically Sound = 5; and Environmentally Sound = 5

GBRA – Action #4	
Proposed Action:	Provide guidance and training/education to local community, customers and employees regarding water safety and available laboratory services prior to and after a flood event.
BACKGROUND INFORMATION	
Site and Location:	GBRA customers, area residents and GBRA employees in all ten counties serviced by GBRA
Risk Reduction Benefit (Current Cost/Losses Avoided)**:**	Educate citizens; Increased lab capabilities via ample samples and staff in preparation for a major flood event; Improve water quality.
Type of Action: (Local Plans and Regulations, Structure and Infrastructure Projects, Natural Systems Protection, or Education and Awareness)	Education and Awareness

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flood
Effect on new/existing buildings:	N/A
Priority (High, Moderate, Low):	Moderate
Estimated Cost:	$2,500
Potential Funding Sources:	Operating Budget (staff time)
Lead Agency/Department Responsible:	GBRA Lab
Implementation Schedule:	Within 24 months of plan adoption
Incorporation into Existing Plans:	Strategic Plan

COMMENTS:
ADDITIONAL CONSIDERATIONS: (Rate action as indicated below) The following STAPLEE criteria were evaluated on a scale of 1 to 5 indicating the extent to which this action satisfies each consideration. (1= Does Not Satisfy 3 = Moderately Satisfies 5 = Strongly Satisfies)
Socially Acceptable = 5; Technically Feasible = 5; Administratively Possible = 5; Politically Acceptable = 5; Legal = 5; Economically Sound = 5; and Environmentally Sound = 5

		GBRA – Action #5
	Proposed Action:	Encourage local jurisdictions to acquire back-up supply of potable water for surface water communities (Ground wells or interconnect with other sources).
	BACKGROUND INFORMATION	
	Site and Location:	GBRA site to be determined
	Risk Reduction Benefit (Current Cost/Losses Avoided)**:**	Ensure continuity of services; Reduce loss in revenue.
	Type of Action: (Local Plans and Regulations, Structure and Infrastructure Projects, Natural Systems Protection, or Education and Awareness)	Structure and Infrastructure - Other

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flood, Drought, Dam Failure
Effect on new/existing buildings:	N/A
Priority (High, Moderate, Low):	Moderate
Estimated Cost:	$3,000,000
Potential Funding Sources:	HMA Grants; TWDB Grants; Local Sponsors
Lead Agency/Department Responsible:	GBRA Rural Utilities
Implementation Schedule:	Within 24-36 months of plan adoption
Incorporation into Existing Plans:	Strategic Plan

COMMENTS:
ADDITIONAL CONSIDERATIONS: (Rate action as indicated below) The following STAPLEE criteria were evaluated on a scale of 1 to 5 indicating the extent to which this action satisfies each consideration. (1= Does Not Satisfy 3 = Moderately Satisfies 5 = Strongly Satisfies)
Socially Acceptable = 5; Technically Feasible = 5; Administratively Possible = 5; Politically Acceptable = 5; Legal = 4; Economically Sound = 4; and Environmentally Sound = 4

GBRA – Action #6	
Proposed Action:	Harden/retrofit GBRA critical facilities to hazard-resistant levels.
BACKGROUND INFORMATION	
Site and Location:	GBRA critical facilities
Risk Reduction Benefit (Current Cost/Losses Avoided)**:**	Ensure continuity of services; Reduce loss in revenue; Reduce damages to structures and infrastructure.
Type of Action: (Local Plans and Regulations, Structure and Infrastructure Projects, Natural Systems Protection, or Education and Awareness)	Structure and Infrastructure

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Dam Failure, Flood, Hail, Hurricane, Lightning, Thunderstorm Wind, Tornado, Wildfire, Winter Storm
Effect on new/existing buildings:	Reduce risk to existing structures and infrastructure
Priority (High, Moderate, Low):	Moderate
Estimated Cost:	$1,000,000
Potential Funding Sources:	Operating Budget; HMA Grants
Lead Agency/Department Responsible:	GBRA Operations Manager
Implementation Schedule:	Within 24-36 months of plan adoption
Incorporation into Existing Plans:	Strategic Plan

COMMENTS:
ADDITIONAL CONSIDERATIONS: (Rate action as indicated below) The following STAPLEE criteria were evaluated on a scale of 1 to 5 indicating the extent to which this action satisfies each consideration. (1= Does Not Satisfy 3 = Moderately Satisfies 5 = Strongly Satisfies)
Socially Acceptable = 5; Technically Feasible = 4; Administratively Possible = 5; Politically Acceptable = 5; Legal = 5; Economically Sound = 4; and Environmentally Sound = 4

GBRA – Action #7	
Proposed Action:	Implement education and awareness program utilizing media, social media, bulletins, flyers, etc. to educate employees and customers of hazards that can threaten the area and mitigation measures to reduce injuries, fatalities, and property damages.
BACKGROUND INFORMATION	
Site and Location:	GBRA service area
Risk Reduction Benefit (Current Cost/Losses Avoided)**:**	Reduce risk of damages and injuries through education and awareness.
Type of Action: (Local Plans and Regulations, Structure and Infrastructure Projects, Natural Systems Protection, or Education and Awareness)	Education and Awareness

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Dam Failure, Drought, Extreme Heat, Flood, Hail, Hurricane, Lightning, Thunderstorm Wind, Tornado, Wildfire, Winter Storm
Effect on new/existing buildings:	N/A
Priority (High, Moderate, Low):	High
Estimated Cost:	$2,500
Potential Funding Sources:	Operating Budget; HMA Grants
Lead Agency/Department Responsible:	Strategic Communications and Education Manager
Implementation Schedule:	Within 24 months of plan adoption
Incorporation into Existing Plans:	Strategic Plan

COMMENTS:
ADDITIONAL CONSIDERATIONS: (Rate action as indicated below) The following STAPLEE criteria were evaluated on a scale of 1 to 5 indicating the extent to which this action satisfies each consideration. (1= Does Not Satisfy 3 = Moderately Satisfies 5 = Strongly Satisfies)
Socially Acceptable = 5; Technically Feasible = 5; Administratively Possible = 5; Politically Acceptable = 5; Legal = 5; Economically Sound = 5; and Environmentally Sound = 5

GBRA – Action #8	
Proposed Action:	Install flood warning/telemetry system at lift stations.
BACKGROUND INFORMATION	
Site and Location:	GBRA service area
Risk Reduction Benefit (Current Cost/Losses Avoided)**:**	Continue essential utility service during severe weather events.
Type of Action: (Local Plans and Regulations, Structure and Infrastructure Projects, Natural Systems Protection, or Education and Awareness)	Structure and Infrastructure

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Dam Failure, Flood, Hurricane, Thunderstorm Wind
Effect on new/existing buildings:	Reduce risk to existing infrastructure
Priority (High, Moderate, Low):	Moderate
Estimated Cost:	$250,000
Potential Funding Sources:	Operating Budget; HMA Grants
Lead Agency/Department Responsible:	Operations Manager
Implementation Schedule:	Within 24-36 months of plan adoption
Incorporation into Existing Plans:	Strategic Plan

COMMENTS:
ADDITIONAL CONSIDERATIONS: (Rate action as indicated below) The following STAPLEE criteria were evaluated on a scale of 1 to 5 indicating the extent to which this action satisfies each consideration. (1= Does Not Satisfy 3 = Moderately Satisfies 5 = Strongly Satisfies)
Socially Acceptable = 5; Technically Feasible = 4; Administratively Possible = 5; Politically Acceptable = 5; Legal = 5; Economically Sound = 4; and Environmentally Sound = 4

GBRA – Action #9	
Proposed Action:	Repair/upgrade levees along diversion canals between diversion gates at Guadalupe River mile 10 and Victoria Barge Canal.
BACKGROUND INFORMATION	
Site and Location:	Calhoun County diversion system
Risk Reduction Benefit (Current Cost/Losses Avoided)**:**	Reduce risk of saltwater intrusion into municipal industrial and agricultural water supply.
Type of Action: (Local Plans and Regulations, Structure and Infrastructure Projects, Natural Systems Protection, or Education and Awareness)	Structure and Infrastructure

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flood, Hurricane
Effect on new/existing buildings:	Reduce risk to existing infrastructure
Priority (High, Moderate, Low):	Moderate
Estimated Cost:	$10,000,000
Potential Funding Sources:	HMA Grants, TWDB, Low interest loans, Bonds
Lead Agency/Department Responsible:	Operations Manager
Implementation Schedule:	Within 24-36 months of plan adoption
Incorporation into Existing Plans:	Strategic Plan

COMMENTS:
ADDITIONAL CONSIDERATIONS: (Rate action as indicated below) The following STAPLEE criteria were evaluated on a scale of 1 to 5 indicating the extent to which this action satisfies each consideration. (1= Does Not Satisfy 3 = Moderately Satisfies 5 = Strongly Satisfies)
Socially Acceptable = 5; Technically Feasible = 5; Administratively Possible = 5; Politically Acceptable = 5; Legal = 5; Economically Sound = 4; and Environmentally Sound = 4

GBRA – Action #10	
Proposed Action:	Implement a fuels reduction program on GBRA owned property to reduce wildfire risk; Cut firebreaks into GBRA owned or managed public wooded areas according to risk factors.
BACKGROUND INFORMATION	
Site and Location:	GBRA owned and managed property
Risk Reduction Benefit (Current Cost/Losses Avoided)**:**	Reduce risk of wildfire through fuels reduction in high risk areas.
Type of Action: (Local Plans and Regulations, Structure and Infrastructure Projects, Natural Systems Protection, or Education and Awareness)	Natural Systems Protection

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Wildfire
Effect on new/existing buildings:	Reduce risk to existing structures and infrastructure
Priority (High, Moderate, Low):	High
Estimated Cost:	$10,000
Potential Funding Sources:	Operating Budget, HMA Grants
Lead Agency/Department Responsible:	Operations Manager
Implementation Schedule:	Within 12-24 months of plan adoption
Incorporation into Existing Plans:	Strategic Plan

COMMENTS:
ADDITIONAL CONSIDERATIONS: (Rate action as indicated below) The following STAPLEE criteria were evaluated on a scale of 1 to 5 indicating the extent to which this action satisfies each consideration. (1= Does Not Satisfy 3 = Moderately Satisfies 5 = Strongly Satisfies)
Socially Acceptable = 4; Technically Feasible = 5; Administratively Possible = 5; Politically Acceptable = 5; Legal = 5; Economically Sound = 4; and Environmentally Sound = 4

		GBRA – Action #11
	Proposed Action:	Equip sewer manholes with watertight covers and require watertight manholes on all future GBRA owned collection systems.
	BACKGROUND INFORMATION	
	Site and Location:	GBRA service area
	Risk Reduction Benefit (Current Cost/Losses Avoided)**:**	Reduce risk of inflow/infiltration to treatment plants; Reduce operating costs; Reduce damages.
	Type of Action: (Local Plans and Regulations, Structure and Infrastructure Projects, Natural Systems Protection, or Education and Awareness)	Local Plans and Regulations; Structure and Infrastructure

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flood
Effect on new/existing buildings:	Reduce risk to existing structures and infrastructure
Priority (High, Moderate, Low):	High
Estimated Cost:	$100,000
Potential Funding Sources:	Operating Budget (staff time); Utility District Owners
Lead Agency/Department Responsible:	Operations Manager
Implementation Schedule:	Within 12-24 months of plan adoption
Incorporation into Existing Plans:	Strategic Plan

COMMENTS:
ADDITIONAL CONSIDERATIONS: (Rate action as indicated below) The following STAPLEE criteria were evaluated on a scale of 1 to 5 indicating the extent to which this action satisfies each consideration. (1= Does Not Satisfy 3 = Moderately Satisfies 5 = Strongly Satisfies)
Socially Acceptable = 5; Technically Feasible = 5; Administratively Possible = 5; Politically Acceptable = 5; Legal = 5; Economically Sound = 5; and Environmentally Sound = 5

		GBRA – Action #12
	Proposed Action:	Elevate critical equipment above BFE.
	BACKGROUND INFORMATION	
	Site and Location:	GBRA service area critical equipment
	Risk Reduction Benefit (Current Cost/Losses Avoided)**:**	Reduce risk of flood damages to critical equipment; Ensure continuity of services.
	Type of Action: (Local Plans and Regulations, Structure and Infrastructure Projects, Natural Systems Protection, or Education and Awareness)	Structure and Infrastructure

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flood
Effect on new/existing buildings:	Reduce risk to existing equipment and infrastructure
Priority (High, Moderate, Low):	Moderate
Estimated Cost:	$1,000,000
Potential Funding Sources:	Operating Budget; HMA Grants
Lead Agency/Department Responsible:	Operations Manager
Implementation Schedule:	Within 24 months of plan adoption
Incorporation into Existing Plans:	Strategic Plan

COMMENTS:
ADDITIONAL CONSIDERATIONS: (Rate action as indicated below) The following STAPLEE criteria were evaluated on a scale of 1 to 5 indicating the extent to which this action satisfies each consideration. (1= Does Not Satisfy 3 = Moderately Satisfies 5 = Strongly Satisfies)
Socially Acceptable = 5; Technically Feasible = 4; Administratively Possible = 5; Politically Acceptable = 5; Legal = 5; Economically Sound = 5; and Environmentally Sound = 5

		GBRA – Action #13
	Proposed Action:	Provide educational information to river front residents and ranchers on internet links to gage heights, weather alerts and rain totals. Teach area residents to record the flood level at their location and record the gage readings upstream.
	BACKGROUND INFORMATION	
	Site and Location:	GBRA service area along the Guadalupe River
	Risk Reduction Benefit (Current Cost/Losses Avoided)**:**	Reduce risk of fatalities, injuries and damages during extreme flood events; Enhance risk assessment; Provide valuable data for early evacuation.
	Type of Action: (Local Plans and Regulations, Structure and Infrastructure Projects, Natural Systems Protection, or Education and Awareness)	Education and Awareness

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flood
Effect on new/existing buildings:	N/A
Priority (High, Moderate, Low):	High
Estimated Cost:	$2,500
Potential Funding Sources:	Operating Budget (staff time)
Lead Agency/Department Responsible:	Strategic Communications and Education Manager
Implementation Schedule:	Within 12 months of plan adoption
Incorporation into Existing Plans:	Strategic Plan

COMMENTS:
ADDITIONAL CONSIDERATIONS: (Rate action as indicated below) The following STAPLEE criteria were evaluated on a scale of 1 to 5 indicating the extent to which this action satisfies each consideration. (1= Does Not Satisfy 3 = Moderately Satisfies 5 = Strongly Satisfies)
Socially Acceptable = 5; Technically Feasible = 5; Administratively Possible = 5; Politically Acceptable = 5; Legal = 5; Economically Sound = 5; and Environmentally Sound = 5

GBRA – Action #14	
Proposed Action:	Elevate existing rental cabins above the BFE; Require all future rental cabins to be elevate above the BFE.
BACKGROUND INFORMATION	
Site and Location:	Coleto Creek Recreation area
Risk Reduction Benefit (Current Cost/Losses Avoided)**:**	Eliminate repetitive flood losses to existing and future structures; Reduce losses in revenue.
Type of Action: (Local Plans and Regulations, Structure and Infrastructure Projects, Natural Systems Protection, or Education and Awareness)	Structure and Infrastructure

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flood
Effect on new/existing buildings:	Reduce risk to existing and future structures
Priority (High, Moderate, Low):	Moderate
Estimated Cost:	$1,000,000
Potential Funding Sources:	Operating Budget; HMA Grants
Lead Agency/Department Responsible:	Operations Manager
Implementation Schedule:	Within 24-36 months of plan adoption
Incorporation into Existing Plans:	Strategic Plan

COMMENTS:
ADDITIONAL CONSIDERATIONS: (Rate action as indicated below) The following STAPLEE criteria were evaluated on a scale of 1 to 5 indicating the extent to which this action satisfies each consideration. (1= Does Not Satisfy 3 = Moderately Satisfies 5 = Strongly Satisfies)
Socially Acceptable = 4; Technically Feasible = 4; Administratively Possible = 5; Politically Acceptable = 5; Legal = 5; Economically Sound = 4; and Environmentally Sound = 4

		GBRA – Action #15
	Proposed Action:	Harden existing rental cabins to withstand extreme weather events.
	BACKGROUND INFORMATION	
	Site and Location:	Coleto Creek Recreation area
	Risk Reduction Benefit (Current Cost/Losses Avoided)**:**	Reduce damages through improved construction techniques; Reduce losses in revenue.
	Type of Action: (Local Plans and Regulations, Structure and Infrastructure Projects, Natural Systems Protection, or Education and Awareness)	Structure and Infrastructure

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Thunderstorm Wind, Hail, Hurricane, Lightning, Tornado
Effect on new/existing buildings:	Reduce risk to existing structures
Priority (High, Moderate, Low):	Moderate
Estimated Cost:	$1,000,000
Potential Funding Sources:	Operating Budget; HMA Grants
Lead Agency/Department Responsible:	Operations Manager
Implementation Schedule:	Within 24-36 months of plan adoption
Incorporation into Existing Plans:	Strategic Plan

COMMENTS:
ADDITIONAL CONSIDERATIONS: (Rate action as indicated below) The following STAPLEE criteria were evaluated on a scale of 1 to 5 indicating the extent to which this action satisfies each consideration. (1= Does Not Satisfy 3 = Moderately Satisfies 5 = Strongly Satisfies)
Socially Acceptable = 5; Technically Feasible = 4; Administratively Possible = 5; Politically Acceptable = 5; Legal = 5; Economically Sound = 4; and Environmentally Sound = 4

	GBRA – Action #16
Proposed Action:	Addition of second power feed.
BACKGROUND INFORMATION	
Site and Location:	Port Lavaca Water Treatment Plant
Risk Reduction Benefit (Current Cost/Losses Avoided)**:**	Reduce risk of damages to drives, controls, etc., by limiting dirty power events.
Type of Action: (Local Plans and Regulations, Structure and Infrastructure Projects, Natural Systems Protection, or Education and Awareness)	Structure and Infrastructure

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Thunderstorm Wind
Effect on new/existing buildings:	Reduce risk to existing structures and infrastructure
Priority (High, Moderate, Low):	Moderate
Estimated Cost:	$100,000
Potential Funding Sources:	Operating Budget; HMA Grants
Lead Agency/Department Responsible:	Port Lavaca WTP Operations Manager
Implementation Schedule:	Within 24-36 months of plan adoption
Incorporation into Existing Plans:	Strategic Plan

COMMENTS:
ADDITIONAL CONSIDERATIONS: (Rate action as indicated below) The following STAPLEE criteria were evaluated on a scale of 1 to 5 indicating the extent to which this action satisfies each consideration. (1= Does Not Satisfy 3 = Moderately Satisfies 5 = Strongly Satisfies)
Socially Acceptable = 5; Technically Feasible = 4; Administratively Possible = 5; Politically Acceptable = 5; Legal = 5; Economically Sound = 4; and Environmentally Sound = 4

GBRA – Action #17	
Proposed Action:	Install fusible links for all vital equipment required for operations of I-35 pipeline system.
BACKGROUND INFORMATION	
Site and Location:	I-35 pipeline system
Risk Reduction Benefit (Current Cost/Losses Avoided)**:**	Reduce risk of communications outages; Reduce systems equipment losses; Reduce loss of revenue.
Type of Action: (Local Plans and Regulations, Structure and Infrastructure Projects, Natural Systems Protection, or Education and Awareness)	Structure and Infrastructure

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Thunderstorm Wind, Hurricane, Lightning
Effect on new/existing buildings:	Reduce risk to existing structures and infrastructure
Priority (High, Moderate, Low):	High
Estimated Cost:	$50,000
Potential Funding Sources:	Operating Budget; HMA Grants; Customer Base
Lead Agency/Department Responsible:	Operations Manager
Implementation Schedule:	Within 12-36 months of plan adoption
Incorporation into Existing Plans:	Strategic Plan

COMMENTS:
ADDITIONAL CONSIDERATIONS: (Rate action as indicated below) The following STAPLEE criteria were evaluated on a scale of 1 to 5 indicating the extent to which this action satisfies each consideration. (1= Does Not Satisfy 3 = Moderately Satisfies 5 = Strongly Satisfies)
Socially Acceptable = 5; Technically Feasible = 4; Administratively Possible = 5; Politically Acceptable = 5; Legal = 5; Economically Sound = 5; and Environmentally Sound = 5

		GBRA – Action #18
	Proposed Action:	Construct new ingress/egress route for Nolte Island.
	BACKGROUND INFORMATION	
	Site and Location:	Nolte Island
	Risk Reduction Benefit (Current Cost/Losses Avoided)**:**	Reduce risk of injury or damages; ensure continuity of services.
	Type of Action: (Local Plans and Regulations, Structure and Infrastructure Projects, Natural Systems Protection, or Education and Awareness)	Structure and Infrastructure

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Dam Failure, Flood, Hurricane, Thunderstorm Wind, Tornado, Wildfire
Effect on new/existing buildings:	N/A
Priority (High, Moderate, Low):	Moderate
Estimated Cost:	$2,000,000
Potential Funding Sources:	Operating Budget; HMA Grants
Lead Agency/Department Responsible:	Operations Manager
Implementation Schedule:	Within 24-36 months of plan adoption
Incorporation into Existing Plans:	Strategic Plan

COMMENTS:
ADDITIONAL CONSIDERATIONS: (Rate action as indicated below) The following STAPLEE criteria were evaluated on a scale of 1 to 5 indicating the extent to which this action satisfies each consideration. (1= Does Not Satisfy 3 = Moderately Satisfies 5 = Strongly Satisfies)
Socially Acceptable = 5; Technically Feasible = 4; Administratively Possible = 5; Politically Acceptable = 4; Legal = 4; Economically Sound = 4; and Environmentally Sound = 4

GBRA – Action #19	
Proposed Action:	Expand signage in all areas of public access.
BACKGROUND INFORMATION	
Site and Location:	GBRA owned or managed lands with public access
Risk Reduction Benefit (Current Cost/Losses Avoided)**:**	Reduce risk of injury or damages.
Type of Action: (Local Plans and Regulations, Structure and Infrastructure Projects, Natural Systems Protection, or Education and Awareness)	Education and Awareness

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Dam Failure, Flood, Hurricane, Thunderstorm Wind, Tornado, Wildfire
Effect on new/existing buildings:	N/A
Priority (High, Moderate, Low):	Moderate
Estimated Cost:	$100,000
Potential Funding Sources:	Operating Budget; HMA Grants
Lead Agency/Department Responsible:	Operations Manager
Implementation Schedule:	Within 24-36 months of plan adoption
Incorporation into Existing Plans:	Strategic Plan

COMMENTS:
ADDITIONAL CONSIDERATIONS: (Rate action as indicated below) The following STAPLEE criteria were evaluated on a scale of 1 to 5 indicating the extent to which this action satisfies each consideration. (1= Does Not Satisfy 3 = Moderately Satisfies 5 = Strongly Satisfies)
Socially Acceptable = 5; Technically Feasible = 5; Administratively Possible = 5; Politically Acceptable = 5; Legal = 5; Economically Sound = 4; and Environmentally Sound = 4

		GBRA – Action #20
	Proposed Action:	Periodically review GBRA insurance coverages to verify all infrastructures are listed properties on the property policy.
	BACKGROUND INFORMATION	
	Site and Location:	N/A
	Risk Reduction Benefit (Current Cost/Losses Avoided)**:**	Ensure coverage of all infrastructure.
	Type of Action: (Local Plans and Regulations, Structure and Infrastructure Projects, Natural Systems Protection, or Education and Awareness)	Local Plans and Regulations – Preparedness

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Dam Failure, Flood, Hail, Hurricane, Lightning, Thunderstorm Wind, Tornado, Wildfire, Winter Storm
Effect on new/existing buildings:	N/A
Priority (High, Moderate, Low):	Moderate
Estimated Cost:	$1,000
Potential Funding Sources:	Operating Budget (staff time)
Lead Agency/Department Responsible:	Operations Manager
Implementation Schedule:	Within 24 months of plan adoption
Incorporation into Existing Plans:	Strategic Plan

COMMENTS:
ADDITIONAL CONSIDERATIONS: (Rate action as indicated below) The following STAPLEE criteria were evaluated on a scale of 1 to 5 indicating the extent to which this action satisfies each consideration. (1= Does Not Satisfy 3 = Moderately Satisfies 5 = Strongly Satisfies)
Socially Acceptable = 5; Technically Feasible = 5; Administratively Possible = 5; Politically Acceptable = 5; Legal = 5; Economically Sound = 5; and Environmentally Sound = 5

GBRA – Action #21	
Proposed Action:	Develop park operating policies and procedures related to park closures due to extreme weather events.
BACKGROUND INFORMATION	
Site and Location:	N/A
Risk Reduction Benefit (Current Cost/Losses Avoided)**:**	Reduce risk of fatality or injury to employees and customers.
Type of Action: (Local Plans and Regulations, Structure and Infrastructure Projects, Natural Systems Protection, or Education and Awareness)	Local Plans and Regulations – Preparedness

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Dam Failure, Flood, Hail, Hurricane, Lightning, Thunderstorm Wind, Tornado, Wildfire, Winter Storm
Effect on new/existing buildings:	N/A
Priority (High, Moderate, Low):	Moderate
Estimated Cost:	$5,000
Potential Funding Sources:	Operating Budget (staff time)
Lead Agency/Department Responsible:	Operations Manager
Implementation Schedule:	Within 24 months of plan adoption
Incorporation into Existing Plans:	Strategic Plan

COMMENTS:
ADDITIONAL CONSIDERATIONS: (Rate action as indicated below) The following STAPLEE criteria were evaluated on a scale of 1 to 5 indicating the extent to which this action satisfies each consideration. (1= Does Not Satisfy 3 = Moderately Satisfies 5 = Strongly Satisfies)
Socially Acceptable = 5; Technically Feasible = 5; Administratively Possible = 5; Politically Acceptable = 5; Legal = 5; Economically Sound = 5; and Environmentally Sound = 5

		GBRA – Action #22
	Proposed Action:	Update procurement procedures to clarify contracting options immediately prior and after extreme events.
	BACKGROUND INFORMATION	
	Site and Location:	N/A
	Risk Reduction Benefit (Current Cost/Losses Avoided)**:**	Reduce costs associated with recovery.
	Type of Action: (Local Plans and Regulations, Structure and Infrastructure Projects, Natural Systems Protection, or Education and Awareness)	Local Plans and Regulations – Preparedness

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Dam Failure, Flood, Hail, Hurricane, Lightning, Thunderstorm Wind, Tornado, Wildfire, Winter Storm
Effect on new/existing buildings:	N/A
Priority (High, Moderate, Low):	Moderate
Estimated Cost:	$5,000
Potential Funding Sources:	Operating Budget (staff time)
Lead Agency/Department Responsible:	Operations Manager
Implementation Schedule:	Within 24 months of plan adoption
Incorporation into Existing Plans:	Strategic Plan

COMMENTS:
ADDITIONAL CONSIDERATIONS: (Rate action as indicated below) The following STAPLEE criteria were evaluated on a scale of 1 to 5 indicating the extent to which this action satisfies each consideration. (1= Does Not Satisfy 3 = Moderately Satisfies 5 = Strongly Satisfies)
Socially Acceptable = 5; Technically Feasible = 5; Administratively Possible = 5; Politically Acceptable = 5; Legal = 5; Economically Sound = 5; and Environmentally Sound = 5

		GBRA – Action #23
	Proposed Action:	Procure surplus safety gear for use by staff following extreme events.
	BACKGROUND INFORMATION	
	Site and Location:	GBRA facilities (as necessary)
	Risk Reduction Benefit (Current Cost/Losses Avoided)**:**	Reduce risk of employee injuries or fatalities.
	Type of Action: (Local Plans and Regulations, Structure and Infrastructure Projects, Natural Systems Protection, or Education and Awareness)	Local Plans and Regulations – Preparedness

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Dam Failure, Flood, Hail, Hurricane, Lightning, Thunderstorm Wind, Tornado, Wildfire, Winter Storm
Effect on new/existing buildings:	N/A
Priority (High, Moderate, Low):	Moderate
Estimated Cost:	$25,000
Potential Funding Sources:	Operating Budget
Lead Agency/Department Responsible:	Operations Manager
Implementation Schedule:	Within 24 months of plan adoption
Incorporation into Existing Plans:	Strategic Plan

COMMENTS:
ADDITIONAL CONSIDERATIONS: (Rate action as indicated below) The following STAPLEE criteria were evaluated on a scale of 1 to 5 indicating the extent to which this action satisfies each consideration. (1= Does Not Satisfy 3 = Moderately Satisfies 5 = Strongly Satisfies)
Socially Acceptable = 5; Technically Feasible = 5; Administratively Possible = 5; Politically Acceptable = 5; Legal = 5; Economically Sound = 4; and Environmentally Sound = 5

GBRA – Action #24	
Proposed Action:	Develop and implement an aggressive annual power pole inspection and replacement program.
BACKGROUND INFORMATION	
Site and Location:	GBRA service area
Risk Reduction Benefit (Current Cost/Losses Avoided)**:**	Reduce risk of power outages; Reduce damages; Reduce revenue losses.
Type of Action: (Local Plans and Regulations, Structure and Infrastructure Projects, Natural Systems Protection, or Education and Awareness)	Structure and Infrastructure

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Dam Failure, Flood, Hurricane, Thunderstorm Wind, Tornado, Winter Storm
Effect on new/existing buildings:	Reduce risk to infrastructure
Priority (High, Moderate, Low):	Moderate
Estimated Cost:	$250,000
Potential Funding Sources:	Operating Budget
Lead Agency/Department Responsible:	Operations Manager
Implementation Schedule:	Within 24 months of plan adoption
Incorporation into Existing Plans:	Strategic Plan

COMMENTS:
ADDITIONAL CONSIDERATIONS: (Rate action as indicated below) The following STAPLEE criteria were evaluated on a scale of 1 to 5 indicating the extent to which this action satisfies each consideration. (1= Does Not Satisfy 3 = Moderately Satisfies 5 = Strongly Satisfies)
Socially Acceptable = 5; Technically Feasible = 5; Administratively Possible = 5; Politically Acceptable = 5; Legal = 5; Economically Sound = 4; and Environmentally Sound = 4

GBRA – Action #25	
Proposed Action:	Identify and install stream and rain gages at critical sites, upgrade gages at established sites where necessary, coordinate installation requests.
BACKGROUND INFORMATION	
Site and Location:	GBRA service area
Risk Reduction Benefit (Current Cost/Losses Avoided)**:**	Reduce damages; Reduce risk of injuries and fatalities; Improve early warning times.
Type of Action: (Local Plans and Regulations, Structure and Infrastructure Projects, Natural Systems Protection, or Education and Awareness)	Structure and Infrastructure

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flood
Effect on new/existing buildings:	N/A
Priority (High, Moderate, Low):	Moderate
Estimated Cost:	$100,000
Potential Funding Sources:	Operating Budget
Lead Agency/Department Responsible:	Operations Manager
Implementation Schedule:	Within 24 months of plan adoption
Incorporation into Existing Plans:	Strategic Plan

COMMENTS:
ADDITIONAL CONSIDERATIONS: (Rate action as indicated below) The following STAPLEE criteria were evaluated on a scale of 1 to 5 indicating the extent to which this action satisfies each consideration. (1= Does Not Satisfy 3 = Moderately Satisfies 5 = Strongly Satisfies)
Socially Acceptable = 5; Technically Feasible = 5; Administratively Possible = 5; Politically Acceptable = 5; Legal = 5; Economically Sound = 5; and Environmentally Sound = 4

	GBRA – Action #26
Proposed Action:	Undertake a comprehensive study of flood risk and reduction alternatives, with the assistance of the US Army Corps of Engineers and local sponsors. Implement feasible alternative for flood reduction.
BACKGROUND INFORMATION	
Site and Location:	GBRA service area
Risk Reduction Benefit (Current Cost/Losses Avoided)**:**	Reduce flood damages; Reduce risk of injuries and fatalities.
Type of Action: (Local Plans and Regulations, Structure and Infrastructure Projects, Natural Systems Protection, or Education and Awareness)	Structure and Infrastructure

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flood
Effect on new/existing buildings:	Reduce risk to new and existing structures
Priority (High, Moderate, Low):	Moderate
Estimated Cost:	$10,000,000
Potential Funding Sources:	State and Federal Grants; Bonds
Lead Agency/Department Responsible:	Operations Manager
Implementation Schedule:	Within 24-36 months of plan adoption
Incorporation into Existing Plans:	Strategic Plan

COMMENTS:
ADDITIONAL CONSIDERATIONS: (Rate action as indicated below) The following STAPLEE criteria were evaluated on a scale of 1 to 5 indicating the extent to which this action satisfies each consideration. (1= Does Not Satisfy 3 = Moderately Satisfies 5 = Strongly Satisfies)
Socially Acceptable = 5; Technically Feasible = 5; Administratively Possible = 5; Politically Acceptable = 5; Legal = 5; Economically Sound = 5; and Environmentally Sound = 5

		GBRA – Action #27
	Proposed Action:	Develop severe weather action plans for GBRA facilities/employees and identify/harden designated shelter areas. Educate employees on plans and shelter locations.
	BACKGROUND INFORMATION	
	Site and Location:	GBRA service area
	Risk Reduction Benefit (Current Cost/Losses Avoided)**:**	Reduce risk of injuries and fatalities
	Type of Action: (Local Plans and Regulations, Structure and Infrastructure Projects, Natural Systems Protection, or Education and Awareness)	Education and Awareness

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Hurricane, Thunderstorm Wind, Tornado
Effect on new/existing buildings:	N/A
Priority (High, Moderate, Low):	Moderate
Estimated Cost:	$3,000
Potential Funding Sources:	Operating Budget
Lead Agency/Department Responsible:	Operations Manager
Implementation Schedule:	Within 24-36 months of plan adoption
Incorporation into Existing Plans:	Strategic Plan

COMMENTS:
ADDITIONAL CONSIDERATIONS: (Rate action as indicated below) The following STAPLEE criteria were evaluated on a scale of 1 to 5 indicating the extent to which this action satisfies each consideration. (1= Does Not Satisfy 3 = Moderately Satisfies 5 = Strongly Satisfies)
Socially Acceptable = 5; Technically Feasible = 5; Administratively Possible = 5; Politically Acceptable = 5; Legal = 5; Economically Sound = 5; and Environmentally Sound = 5

GBRA – Action #28	
Proposed Action:	Implement a tree trimming program that routinely clears tree limbs hanging in right-of-way for above ground infrastructure.
BACKGROUND INFORMATION	
Site and Location:	GBRA service area
Risk Reduction Benefit (Current Cost/Losses Avoided)**:**	Reduce risk of power outages.
Type of Action: (Local Plans and Regulations, Structure and Infrastructure Projects, Natural Systems Protection, or Education and Awareness)	Structure and Infrastructure

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Hurricane, Thunderstorm Wind, Tornado
Effect on new/existing buildings:	Reduce risk to existing structures and infrastructure
Priority (High, Moderate, Low):	Moderate
Estimated Cost:	$250,000
Potential Funding Sources:	Operating Budget; State and Federal Grants
Lead Agency/Department Responsible:	Operations Manager
Implementation Schedule:	Within 24-36 months of plan adoption
Incorporation into Existing Plans:	Strategic Plan

COMMENTS:
ADDITIONAL CONSIDERATIONS: (Rate action as indicated below) The following STAPLEE criteria were evaluated on a scale of 1 to 5 indicating the extent to which this action satisfies each consideration. (1= Does Not Satisfy 3 = Moderately Satisfies 5 = Strongly Satisfies)
Socially Acceptable = 5; Technically Feasible = 5; Administratively Possible = 5; Politically Acceptable = 5; Legal = 4; Economically Sound = 4; and Environmentally Sound = 4

GBRA – Action #29	
Proposed Action:	Require "safe rooms" to be added when constructing GBRA facilities.
BACKGROUND INFORMATION	
Site and Location:	GBRA service area
Risk Reduction Benefit (Current Cost/Losses Avoided)**:**	Reduce risk of fatalities or injuries to GBRA employees.
Type of Action: (Local Plans and Regulations, Structure and Infrastructure Projects, Natural Systems Protection, or Education and Awareness)	Local Plans and Regulations

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Hurricane, Thunderstorm Wind, Tornado
Effect on new/existing buildings:	N/A
Priority (High, Moderate, Low):	Moderate
Estimated Cost:	$1,000
Potential Funding Sources:	Operating Budget (staff time)
Lead Agency/Department Responsible:	Operations Manager
Implementation Schedule:	Within 24-36 months of plan adoption
Incorporation into Existing Plans:	Strategic Plan

COMMENTS:
ADDITIONAL CONSIDERATIONS: (Rate action as indicated below) The following STAPLEE criteria were evaluated on a scale of 1 to 5 indicating the extent to which this action satisfies each consideration. (1= Does Not Satisfy 3 = Moderately Satisfies 5 = Strongly Satisfies)
Socially Acceptable = 5; Technically Feasible = 5; Administratively Possible = 5; Politically Acceptable = 5; Legal = 5; Economically Sound = 5; and Environmentally Sound = 5

GBRA – Action #30	
Proposed Action:	Purchase NOAA “All Hazards” radios for early warning and post-event information and place in all employee manned facilities.
BACKGROUND INFORMATION	
Site and Location:	GBRA employee manned facilities
Risk Reduction Benefit (Current Cost/Losses Avoided)**:**	Reduce risk of fatalities or injuries to GBRA employees.
Type of Action: (Local Plans and Regulations, Structure and Infrastructure Projects, Natural Systems Protection, or Education and Awareness)	Education and Awareness

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Dam Failure, Drought, Extreme Heat, Flood, Hail, Hurricane, Lightning, Thunderstorm Wind, Tornado, Wildfire, Winter Storm
Effect on new/existing buildings:	N/A
Priority (High, Moderate, Low):	Moderate
Estimated Cost:	$5,000
Potential Funding Sources:	Operating Budget
Lead Agency/Department Responsible:	Operations Manager
Implementation Schedule:	Within 24-36 months of plan adoption
Incorporation into Existing Plans:	Strategic Plan

COMMENTS:
ADDITIONAL CONSIDERATIONS: (Rate action as indicated below) The following STAPLEE criteria were evaluated on a scale of 1 to 5 indicating the extent to which this action satisfies each consideration. (1= Does Not Satisfy 3 = Moderately Satisfies 5 = Strongly Satisfies)
Socially Acceptable = 5; Technically Feasible = 5; Administratively Possible = 5; Politically Acceptable = 5; Legal = 5; Economically Sound = 5; and Environmentally Sound = 5

GBRA – Action #31	
Proposed Action:	Conduct public/employee education program on fire risks and wildland fire mitigation, with the assistance of the Texas Forest Service.
BACKGROUND INFORMATION	
Site and Location:	GBRA service area
Risk Reduction Benefit (Current Cost/Losses Avoided)**:**	Reduce risk of fatalities or injuries; Reduce risk of wildfires and associated damages through education.
Type of Action: (Local Plans and Regulations, Structure and Infrastructure Projects, Natural Systems Protection, or Education and Awareness)	Education and Awareness

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Wildfire
Effect on new/existing buildings:	N/A
Priority (High, Moderate, Low):	Moderate
Estimated Cost:	$2,000
Potential Funding Sources:	Operating Budget (staff time)
Lead Agency/Department Responsible:	Operations Manager
Implementation Schedule:	Within 24-36 months of plan adoption
Incorporation into Existing Plans:	Strategic Plan

COMMENTS:
ADDITIONAL CONSIDERATIONS: (Rate action as indicated below) The following STAPLEE criteria were evaluated on a scale of 1 to 5 indicating the extent to which this action satisfies each consideration. (1= Does Not Satisfy 3 = Moderately Satisfies 5 = Strongly Satisfies)
Socially Acceptable = 5; Technically Feasible = 5; Administratively Possible = 5; Politically Acceptable = 5; Legal = 5; Economically Sound = 5; and Environmentally Sound = 5

GBRA – Action #32	
Proposed Action:	Evaluate access and road conditions at all GBRA facilities or assets for response vehicles and formulate/implement options to improve access.
BACKGROUND INFORMATION	
Site and Location:	GBRA facilities and assets
Risk Reduction Benefit (Current Cost/Losses Avoided)**:**	Reduce risk of injury or damages; ensure continuity of services.
Type of Action: (Local Plans and Regulations, Structure and Infrastructure Projects, Natural Systems Protection, or Education and Awareness)	Structure and Infrastructure

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Dam Failure, Flood, Hurricane, Thunderstorm Wind, Tornado, Wildfire
Effect on new/existing buildings:	N/A
Priority (High, Moderate, Low):	Moderate
Estimated Cost:	$5,000,000
Potential Funding Sources:	Operating Budget; HMA Grants
Lead Agency/Department Responsible:	Operations Manager
Implementation Schedule:	Within 24-36 months of plan adoption
Incorporation into Existing Plans:	Strategic Plan

COMMENTS:
ADDITIONAL CONSIDERATIONS: (Rate action as indicated below) The following STAPLEE criteria were evaluated on a scale of 1 to 5 indicating the extent to which this action satisfies each consideration. (1= Does Not Satisfy 3 = Moderately Satisfies 5 = Strongly Satisfies)
Socially Acceptable = 5; Technically Feasible = 5; Administratively Possible = 5; Politically Acceptable = 5; Legal = 5; Economically Sound = 4; and Environmentally Sound = 4

		GBRA – Action #33
	Proposed Action:	Restrict vegetation or require fire-resistant landscaping in GBRA owned or managed easements.
	BACKGROUND INFORMATION	
	Site and Location:	GBRA owned or managed easements
	Risk Reduction Benefit (Current Cost/Losses Avoided)**:**	Reduce risk of injury or damages; ensure continuity of services.
	Type of Action: (Local Plans and Regulations, Structure and Infrastructure Projects, Natural Systems Protection, or Education and Awareness)	Local Plans and Regulations

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Wildfire
Effect on new/existing buildings:	N/A
Priority (High, Moderate, Low):	Moderate
Estimated Cost:	$1,000
Potential Funding Sources:	Operating Budget (staff time)
Lead Agency/Department Responsible:	Operations Manager
Implementation Schedule:	Within 24-36 months of plan adoption
Incorporation into Existing Plans:	Strategic Plan

COMMENTS:
ADDITIONAL CONSIDERATIONS: (Rate action as indicated below) The following STAPLEE criteria were evaluated on a scale of 1 to 5 indicating the extent to which this action satisfies each consideration. (1= Does Not Satisfy 3 = Moderately Satisfies 5 = Strongly Satisfies)
Socially Acceptable = 4; Technically Feasible = 5; Administratively Possible = 5; Politically Acceptable = 5; Legal = 5; Economically Sound = 5; and Environmentally Sound = 4

GBRA – Action #34	
Proposed Action:	Adopt construction regulations for fire-resistant roofing materials, smoke alarm systems, sprinkler systems, cisterns, escape roads, fuels management requirements, and boxing of eaves, overhangs, and decks for all future GBRA structures.
BACKGROUND INFORMATION	
Site and Location:	GBRA new structures
Risk Reduction Benefit (Current Cost/Losses Avoided)**:**	Reduce risk of injury or damages; ensure continuity of services; Reduce losses in revenue.
Type of Action: (Local Plans and Regulations, Structure and Infrastructure Projects, Natural Systems Protection, or Education and Awareness)	Local Plans and Regulations

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Wildfire
Effect on new/existing buildings:	Reduce risk to new structures
Priority (High, Moderate, Low):	Moderate
Estimated Cost:	$1,000
Potential Funding Sources:	Operating Budget (staff time)
Lead Agency/Department Responsible:	Operations Manager
Implementation Schedule:	Within 24-36 months of plan adoption
Incorporation into Existing Plans:	Strategic Plan

COMMENTS:
ADDITIONAL CONSIDERATIONS: (Rate action as indicated below) The following STAPLEE criteria were evaluated on a scale of 1 to 5 indicating the extent to which this action satisfies each consideration. (1= Does Not Satisfy 3 = Moderately Satisfies 5 = Strongly Satisfies)
Socially Acceptable = 5; Technically Feasible = 5; Administratively Possible = 5; Politically Acceptable = 5; Legal = 5; Economically Sound = 4; and Environmentally Sound = 5

	GBRA – Action #35
Proposed Action:	Adopt and implement program to insulate outdoor pipes at all GBRA buildings.
BACKGROUND INFORMATION	
Site and Location:	GBRA facilities
Risk Reduction Benefit (Current Cost/Losses Avoided)**:**	Reduce risk of damages; ensure continuity of services; Reduce losses in revenue.
Type of Action: (Local Plans and Regulations, Structure and Infrastructure Projects, Natural Systems Protection, or Education and Awareness)	Local Plans and Regulations; Structure and Infrastructure

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Winter Storm
Effect on new/existing buildings:	Reduce risk to new and existing structures
Priority (High, Moderate, Low):	Moderate
Estimated Cost:	$50,000
Potential Funding Sources:	Operating Budget
Lead Agency/Department Responsible:	Operations Manager
Implementation Schedule:	Within 24-36 months of plan adoption
Incorporation into Existing Plans:	Strategic Plan

COMMENTS:
ADDITIONAL CONSIDERATIONS: (Rate action as indicated below) The following STAPLEE criteria were evaluated on a scale of 1 to 5 indicating the extent to which this action satisfies each consideration. (1= Does Not Satisfy 3 = Moderately Satisfies 5 = Strongly Satisfies)
Socially Acceptable = 5; Technically Feasible = 5; Administratively Possible = 5; Politically Acceptable = 5; Legal = 5; Economically Sound = 4; and Environmentally Sound = 4

GBRA – Action #36	
Proposed Action:	Acquire, conserve and utilize easements to prevent development of known hazard areas.
BACKGROUND INFORMATION	
Site and Location:	GBRA service area
Risk Reduction Benefit (Current Cost/Losses Avoided)**:**	Reduce risk of damages; ensure continuity of services; Reduce losses in revenue.
Type of Action: (Local Plans and Regulations, Structure and Infrastructure Projects, Natural Systems Protection, or Education and Awareness)	Natural Systems Protection

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flood, Hurricane, Wildfire
Effect on new/existing buildings:	Reduce risk to new and existing structures
Priority (High, Moderate, Low):	Moderate
Estimated Cost:	$500,000
Potential Funding Sources:	State and Federal Grants
Lead Agency/Department Responsible:	Operations Manager
Implementation Schedule:	Within 24-36 months of plan adoption
Incorporation into Existing Plans:	Strategic Plan

COMMENTS:
ADDITIONAL CONSIDERATIONS: (Rate action as indicated below) The following STAPLEE criteria were evaluated on a scale of 1 to 5 indicating the extent to which this action satisfies each consideration. (1= Does Not Satisfy 3 = Moderately Satisfies 5 = Strongly Satisfies)
Socially Acceptable = 4; Technically Feasible = 5; Administratively Possible = 5; Politically Acceptable = 5; Legal = 5; Economically Sound = 4; and Environmentally Sound = 5

GBRA – Action #37	
Proposed Action:	Implement landscape requirements (selection and planting guidelines) at all GBRA facilities.
BACKGROUND INFORMATION	
Site and Location:	GBRA facilities
Risk Reduction Benefit (Current Cost/Losses Avoided)**:**	Reduce risk of damages; Reduce water usage.
Type of Action: (Local Plans and Regulations, Structure and Infrastructure Projects, Natural Systems Protection, or Education and Awareness)	Local Plans and Regulations

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flood, Drought, Wildfire
Effect on new/existing buildings:	Reduce risk to new and existing structures
Priority (High, Moderate, Low):	Moderate
Estimated Cost:	$1,000
Potential Funding Sources:	Operating Budget (staff time)
Lead Agency/Department Responsible:	Operations Manager
Implementation Schedule:	Within 24-36 months of plan adoption
Incorporation into Existing Plans:	Strategic Plan

COMMENTS:
ADDITIONAL CONSIDERATIONS: (Rate action as indicated below) The following STAPLEE criteria were evaluated on a scale of 1 to 5 indicating the extent to which this action satisfies each consideration. (1= Does Not Satisfy 3 = Moderately Satisfies 5 = Strongly Satisfies)
Socially Acceptable = 5; Technically Feasible = 5; Administratively Possible = 5; Politically Acceptable = 5; Legal = 5; Economically Sound = 4; and Environmentally Sound = 5

GBRA – Action #38	
Proposed Action:	Install roller compacted concrete overtopping protection.
BACKGROUND INFORMATION	
Site and Location:	Dunlap Dam on Guadalupe River in Guadalupe County, Texas. Dam forms Lake Dunlap.
Risk Reduction Benefit (Current Cost/Losses Avoided)**:**	Reduce flood risk to private property, roads, intakes for regional water systems, and electrical generation facilities. Reduce life and safety risk.
Type of Action: (Local Plans and Regulations, Structure and Infrastructure Projects, Natural Systems Protection, or Education and Awareness)	Structure and Infrastructure

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Dam Failure, Flood
Effect on new/existing buildings:	Reduce risk to existing buildings and infrastructure.
Priority (High, Moderate, Low):	High
Estimated Cost:	$3,300,000
Potential Funding Sources:	Grants
Lead Agency/Department Responsible:	Engineering
Implementation Schedule:	Within 24-36 months of plan adoption.
Incorporation into Existing Plans:	Strategic Plan

COMMENTS:
Preliminary engineering has been completed.
ADDITIONAL CONSIDERATIONS: (Rate action as indicated below) The following STAPLEE criteria were evaluated on a scale of 1 to 5 indicating the extent to which this action satisfies each consideration. (1= Does Not Satisfy 3 = Moderately Satisfies 5 = Strongly Satisfies)
Socially Acceptable = 5; Technically Feasible = 5; Administratively Possible = 5; Politically Acceptable = 5; Legal = 5; Economically Sound = 4; and Environmentally Sound = 5

GBRA – Action #39	
Proposed Action:	Install roller compacted concrete overtopping protection.
BACKGROUND INFORMATION	
Site and Location:	McQueeney Dam on Guadalupe River in Guadalupe County, Texas. Dam forms Lake McQueeney.
Risk Reduction Benefit (Current Cost/Losses Avoided)**:**	Reduce flood risk to property, roadways, and electrical generation facilities. Reduce life and safety risk.
Type of Action: (Local Plans and Regulations, Structure and Infrastructure Projects, Natural Systems Protection, or Education and Awareness)	Structure and Infrastructure

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Dam Failure, Flood
Effect on new/existing buildings:	Reduce risk to existing buildings and infrastructure.
Priority (High, Moderate, Low):	High
Estimated Cost:	$4,000,000
Potential Funding Sources:	Grants
Lead Agency/Department Responsible:	Engineering
Implementation Schedule:	Within 24-36 months of plan adoption.
Incorporation into Existing Plans:	Strategic Plan

COMMENTS:
Preliminary engineering has been completed.
ADDITIONAL CONSIDERATIONS: (Rate action as indicated below) The following STAPLEE criteria were evaluated on a scale of 1 to 5 indicating the extent to which this action satisfies each consideration. (1= Does Not Satisfy 3 = Moderately Satisfies 5 = Strongly Satisfies)
Socially Acceptable = 5; Technically Feasible = 5; Administratively Possible = 5; Politically Acceptable = 5; Legal = 5; Economically Sound = 4; and Environmentally Sound = 5

GBRA – Action #40	
Proposed Action:	Install roller compacted concrete overtopping protection.
BACKGROUND INFORMATION	
Site and Location:	TP-4 Dam on Guadalupe River in Guadalupe County, Texas. Dam forms Lake Placid.
Risk Reduction Benefit (Current Cost/Losses Avoided)**:**	Reduce flood risk to private property, roads, intakes for regional water systems, and electrical generation facilities.
Type of Action: (Local Plans and Regulations, Structure and Infrastructure Projects, Natural Systems Protection, or Education and Awareness)	Structure and Infrastructure

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Dam Failure, Flood
Effect on new/existing buildings:	Reduce risk to existing buildings and infrastructure.
Priority (High, Moderate, Low):	High
Estimated Cost:	$4,700,000
Potential Funding Sources:	Grants
Lead Agency/Department Responsible:	Engineering
Implementation Schedule:	Within 24-36 months of plan adoption.
Incorporation into Existing Plans:	Strategic Plan

COMMENTS:
Preliminary engineering has been completed.
ADDITIONAL CONSIDERATIONS: (Rate action as indicated below) The following STAPLEE criteria were evaluated on a scale of 1 to 5 indicating the extent to which this action satisfies each consideration. (1= Does Not Satisfy 3 = Moderately Satisfies 5 = Strongly Satisfies)
Socially Acceptable = 5; Technically Feasible = 5; Administratively Possible = 5; Politically Acceptable = 5; Legal = 5; Economically Sound = 4; and Environmentally Sound = 5

GBRA – Action #41	
Proposed Action:	Install roller compacted concrete overtopping protection.
BACKGROUND INFORMATION	
Site and Location:	Nolte Dam on Guadalupe River in Guadalupe County, Texas. Dam forms Meadow Lake.
Risk Reduction Benefit (Current Cost/Losses Avoided)**:**	Reduce flood risk to private property, roads, and electrical generation facilities.
Type of Action: (Local Plans and Regulations, Structure and Infrastructure Projects, Natural Systems Protection, or Education and Awareness)	Structure and Infrastructure

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Dam Failure, Flood
Effect on new/existing buildings:	Reduce risk to existing buildings and infrastructure.
Priority (High, Moderate, Low):	High
Estimated Cost:	$4,700,000
Potential Funding Sources:	Grants
Lead Agency/Department Responsible:	Engineering
Implementation Schedule:	Within 24-36 months of plan adoption.
Incorporation into Existing Plans:	Strategic Plan

COMMENTS:
Preliminary engineering has been completed.
ADDITIONAL CONSIDERATIONS: (Rate action as indicated below) The following STAPLEE criteria were evaluated on a scale of 1 to 5 indicating the extent to which this action satisfies each consideration. (1= Does Not Satisfy 3 = Moderately Satisfies 5 = Strongly Satisfies)
Socially Acceptable = 5; Technically Feasible = 5; Administratively Possible = 5; Politically Acceptable = 5; Legal = 5; Economically Sound = 4; and Environmentally Sound = 5

GBRA – Action #42	
Proposed Action:	Install roller compacted concrete overtopping protection.
BACKGROUND INFORMATION	
Site and Location:	H-4 Dam on Guadalupe River in Gonzales County, Texas. Dam forms Lake Gonzales.
Risk Reduction Benefit (Current Cost/Losses Avoided)**:**	Reduce flood risk to private property, roads, and electrical generation facilities.
Type of Action: (Local Plans and Regulations, Structure and Infrastructure Projects, Natural Systems Protection, or Education and Awareness)	Structure and Infrastructure

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Dam Failure, Flood
Effect on new/existing buildings:	Reduce risk to existing buildings and infrastructure.
Priority (High, Moderate, Low):	High
Estimated Cost:	$6,400,000
Potential Funding Sources:	Grants
Lead Agency/Department Responsible:	Engineering
Implementation Schedule:	Within 24-36 months of plan adoption.
Incorporation into Existing Plans:	Strategic Plan

COMMENTS:
Preliminary engineering has been completed.
ADDITIONAL CONSIDERATIONS: (Rate action as indicated below) The following STAPLEE criteria were evaluated on a scale of 1 to 5 indicating the extent to which this action satisfies each consideration. (1= Does Not Satisfy 3 = Moderately Satisfies 5 = Strongly Satisfies)
Socially Acceptable = 5; Technically Feasible = 5; Administratively Possible = 5; Politically Acceptable = 5; Legal = 5; Economically Sound = 4; and Environmentally Sound = 5

GBRA – Action #43	
Proposed Action:	Install roller compacted concrete overtopping protection.
BACKGROUND INFORMATION	
Site and Location:	H-5 Dam on Guadalupe River in Gonzales County, Texas. Dam forms Lake Wood.
Risk Reduction Benefit (Current Cost/Losses Avoided)**:**	Reduce flood risk to private property, roads, intakes for regional water systems, and electrical generation facilities.
Type of Action: (Local Plans and Regulations, Structure and Infrastructure Projects, Natural Systems Protection, or Education and Awareness)	Structure and Infrastructure

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Dam Failure, Flood
Effect on new/existing buildings:	Reduce risk to existing buildings and infrastructure.
Priority (High, Moderate, Low):	High
Estimated Cost:	$7,500,000
Potential Funding Sources:	Grants
Lead Agency/Department Responsible:	Engineering
Implementation Schedule:	Within 24-36 months of plan adoption.
Incorporation into Existing Plans:	Strategic Plan

COMMENTS:
Preliminary engineering has been completed.
ADDITIONAL CONSIDERATIONS: (Rate action as indicated below) The following STAPLEE criteria were evaluated on a scale of 1 to 5 indicating the extent to which this action satisfies each consideration. (1= Does Not Satisfy 3 = Moderately Satisfies 5 = Strongly Satisfies)
Socially Acceptable = 5; Technically Feasible = 5; Administratively Possible = 5; Politically Acceptable = 5; Legal = 5; Economically Sound = 4; and Environmentally Sound = 5

GBRA – Action #44	
Proposed Action:	Existing flood gates have reached the end of their useful life and are a historic design utilizing wooden construction. Upgrade the spillway using a modern hydraulic crest gate design.
BACKGROUND INFORMATION	
Site and Location:	Dunlap Dam on Guadalupe River in Guadalupe County, Texas. Dam forms Lake Dunlap.
Risk Reduction Benefit (Current Cost/Losses Avoided)**:**	Reduce flood risk to private property, roads, intakes for regional water systems, and electrical generation facilities.
Type of Action: (Local Plans and Regulations, Structure and Infrastructure Projects, Natural Systems Protection, or Education and Awareness)	Structure and Infrastructure

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Dam Failure, Flood
Effect on new/existing buildings:	Reduce risk to existing buildings and infrastructure.
Priority (High, Moderate, Low):	High
Estimated Cost:	$11,300,000
Potential Funding Sources:	Grants
Lead Agency/Department Responsible:	Engineering
Implementation Schedule:	Within 24-36 months of plan adoption.
Incorporation into Existing Plans:	Strategic Plan

COMMENTS:
Preliminary engineering has been completed.
ADDITIONAL CONSIDERATIONS: (Rate action as indicated below) The following STAPLEE criteria were evaluated on a scale of 1 to 5 indicating the extent to which this action satisfies each consideration. (1= Does Not Satisfy 3 = Moderately Satisfies 5 = Strongly Satisfies)
Socially Acceptable = 5; Technically Feasible = 5; Administratively Possible = 5; Politically Acceptable = 5; Legal = 5; Economically Sound = 4; and Environmentally Sound = 5

GBRA – Action #45	
Proposed Action:	Existing flood gates have reached the end of their useful life and are a historic design utilizing wooden construction. Upgrade the spillway using a modern hydraulic crest gate design.
BACKGROUND INFORMATION	
Site and Location:	McQueeney Dam on Guadalupe River in Guadalupe County, Texas. Dam forms Lake McQueeney.
Risk Reduction Benefit (Current Cost/Losses Avoided)**:**	Reduce flood risk to private property, roads, intakes for regional water systems, and electrical generation facilities.
Type of Action: (Local Plans and Regulations, Structure and Infrastructure Projects, Natural Systems Protection, or Education and Awareness)	Structure and Infrastructure

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Dam Failure, Flood
Effect on new/existing buildings:	Reduce risk to existing buildings and infrastructure.
Priority (High, Moderate, Low):	High
Estimated Cost:	$11,300,000
Potential Funding Sources:	Grants
Lead Agency/Department Responsible:	Engineering
Implementation Schedule:	Within 24-36 months of plan adoption.
Incorporation into Existing Plans:	Strategic Plan

COMMENTS:
Preliminary engineering has been completed.
ADDITIONAL CONSIDERATIONS: (Rate action as indicated below) The following STAPLEE criteria were evaluated on a scale of 1 to 5 indicating the extent to which this action satisfies each consideration. (1= Does Not Satisfy 3 = Moderately Satisfies 5 = Strongly Satisfies)
Socially Acceptable = 5; Technically Feasible = 5; Administratively Possible = 5; Politically Acceptable = 5; Legal = 5; Economically Sound = 4; and Environmentally Sound = 5

	GBRA – Action #46
Proposed Action:	Existing flood gates have reached the end of their useful life and are a historic design utilizing wooden construction. Upgrade the spillway using a modern hydraulic crest gate design.
BACKGROUND INFORMATION	
Site and Location:	TP-4 Dam on Guadalupe River in Guadalupe County, Texas. Dam forms Lake Placid.
Risk Reduction Benefit (Current Cost/Losses Avoided)**:**	Reduce flood risk to private property, roads, intakes for regional water systems, and electrical generation facilities.
Type of Action: (Local Plans and Regulations, Structure and Infrastructure Projects, Natural Systems Protection, or Education and Awareness)	Structure and Infrastructure

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Dam Failure, Flood
Effect on new/existing buildings:	Reduce risk to existing buildings and infrastructure.
Priority (High, Moderate, Low):	High
Estimated Cost:	$8,600,000
Potential Funding Sources:	Grants
Lead Agency/Department Responsible:	Engineering
Implementation Schedule:	Within 24-36 months of plan adoption.
Incorporation into Existing Plans:	Strategic Plan

COMMENTS:
Preliminary engineering has been completed.
ADDITIONAL CONSIDERATIONS: (Rate action as indicated below) The following STAPLEE criteria were evaluated on a scale of 1 to 5 indicating the extent to which this action satisfies each consideration. (1= Does Not Satisfy 3 = Moderately Satisfies 5 = Strongly Satisfies)
Socially Acceptable = 5; Technically Feasible = 5; Administratively Possible = 5; Politically Acceptable = 5; Legal = 5; Economically Sound = 4; and Environmentally Sound = 5

GBRA – Action #47	
Proposed Action:	Existing flood gates have reached the end of their useful life and are a historic design utilizing wooden construction. Upgrade the spillway using a modern hydraulic crest gate design.
BACKGROUND INFORMATION	
Site and Location:	Nolte Dam on Guadalupe River in Guadalupe County, Texas. Dam forms Meadow Lake.
Risk Reduction Benefit (Current Cost/Losses Avoided)**:**	Reduce flood risk to private property, roads, intakes for regional water systems, and electrical generation facilities.
Type of Action: (Local Plans and Regulations, Structure and Infrastructure Projects, Natural Systems Protection, or Education and Awareness)	Structure and Infrastructure

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Dam Failure, Flood
Effect on new/existing buildings:	Reduce risk to existing buildings and infrastructure.
Priority (High, Moderate, Low):	High
Estimated Cost:	$11,300,000
Potential Funding Sources:	Grants
Lead Agency/Department Responsible:	Engineering
Implementation Schedule:	Within 24-36 months of plan adoption.
Incorporation into Existing Plans:	Strategic Plan

COMMENTS:
Preliminary engineering has been completed.
ADDITIONAL CONSIDERATIONS: (Rate action as indicated below) The following STAPLEE criteria were evaluated on a scale of 1 to 5 indicating the extent to which this action satisfies each consideration. (1= Does Not Satisfy 3 = Moderately Satisfies 5 = Strongly Satisfies)
Socially Acceptable = 5; Technically Feasible = 5; Administratively Possible = 5; Politically Acceptable = 5; Legal = 5; Economically Sound = 4; and Environmentally Sound = 5

GBRA – Action #48	
Proposed Action:	Existing flood gates have reached the end of their useful life and are a historic design utilizing wooden construction. Upgrade the spillway using a modern hydraulic crest gate design.
BACKGROUND INFORMATION	
Site and Location:	H-4 Dam on Guadalupe River in Guadalupe County, Texas. Dam forms Lake Gonzales.
Risk Reduction Benefit (Current Cost/Losses Avoided)**:**	Reduce flood risk to private property, roads, intakes for regional water systems, and electrical generation facilities.
Type of Action: (Local Plans and Regulations, Structure and Infrastructure Projects, Natural Systems Protection, or Education and Awareness)	Structure and Infrastructure

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Dam Failure, Flood
Effect on new/existing buildings:	Reduce risk to existing buildings and infrastructure.
Priority (High, Moderate, Low):	High
Estimated Cost:	$7,500,000
Potential Funding Sources:	Grants
Lead Agency/Department Responsible:	Engineering
Implementation Schedule:	Within 24-36 months of plan adoption.
Incorporation into Existing Plans:	Strategic Plan

COMMENTS:
Preliminary engineering has been completed.
ADDITIONAL CONSIDERATIONS: (Rate action as indicated below) The following STAPLEE criteria were evaluated on a scale of 1 to 5 indicating the extent to which this action satisfies each consideration. (1= Does Not Satisfy 3 = Moderately Satisfies 5 = Strongly Satisfies)
Socially Acceptable = 5; Technically Feasible = 5; Administratively Possible = 5; Politically Acceptable = 5; Legal = 5; Economically Sound = 4; and Environmentally Sound = 5

GBRA – Action #49	
Proposed Action:	Existing flood gates have reached the end of their useful life and are a historic design utilizing wooden construction. Upgrade the spillway using a modern hydraulic crest gate design.
BACKGROUND INFORMATION	
Site and Location:	H-5 Dam on Guadalupe River in Guadalupe County, Texas. Dam forms Lake Wood.
Risk Reduction Benefit (Current Cost/Losses Avoided)**:**	Reduce flood risk to private property, roads, intakes for regional water systems, and electrical generation facilities.
Type of Action: (Local Plans and Regulations, Structure and Infrastructure Projects, Natural Systems Protection, or Education and Awareness)	Structure and Infrastructure

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Dam Failure, Flood
Effect on new/existing buildings:	Reduce risk to existing buildings and infrastructure.
Priority (High, Moderate, Low):	High
Estimated Cost:	$7,500,000
Potential Funding Sources:	Grants
Lead Agency/Department Responsible:	Engineering
Implementation Schedule:	Within 24-36 months of plan adoption.
Incorporation into Existing Plans:	Strategic Plan

COMMENTS:
Preliminary engineering has been completed.
ADDITIONAL CONSIDERATIONS: (Rate action as indicated below) The following STAPLEE criteria were evaluated on a scale of 1 to 5 indicating the extent to which this action satisfies each consideration. (1= Does Not Satisfy 3 = Moderately Satisfies 5 = Strongly Satisfies)
Socially Acceptable = 5; Technically Feasible = 5; Administratively Possible = 5; Politically Acceptable = 5; Legal = 5; Economically Sound = 4; and Environmentally Sound = 5

GBRA – Action #50	
Proposed Action:	Harden spillways and embankments to handle extreme flood events. Earthen embankments need to be hardened in the event of possible dam failure.
BACKGROUND INFORMATION	
Site and Location:	The six hydroelectric dams and plants were constructed in the 1920's. Increased development upstream may increase the magnitude and frequency of flood events.
Risk Reduction Benefit (Current Cost/Losses Avoided)**:**	Reduce flood risk to private property, roads, intakes for regional water systems, and electrical generation facilities.
Type of Action: (Local Plans and Regulations, Structure and Infrastructure Projects, Natural Systems Protection, or Education and Awareness)	Structure and Infrastructure

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Dam Failure
Effect on new/existing buildings:	Reduce risk to existing buildings and infrastructure.
Priority (High, Moderate, Low):	High
Estimated Cost:	$15,000,000
Potential Funding Sources:	Grants, Bonds
Lead Agency/Department Responsible:	Hydro Electric Division
Implementation Schedule:	Within 24-36 months of plan adoption.
Incorporation into Existing Plans:	Strategic Plan

COMMENTS:
ADDITIONAL CONSIDERATIONS: (Rate action as indicated below) The following STAPLEE criteria were evaluated on a scale of 1 to 5 indicating the extent to which this action satisfies each consideration. (1= Does Not Satisfy 3 = Moderately Satisfies 5 = Strongly Satisfies)
Socially Acceptable = 5; Technically Feasible = 5; Administratively Possible = 5; Politically Acceptable = 5; Legal = 5; Economically Sound = 4; and Environmentally Sound = 5

GBRA – Action #51	
Proposed Action:	Review and update drought contingency plans annually and provide public information regarding drought awareness and conservation measures.
BACKGROUND INFORMATION	
Site and Location:	GBRA has developed a drought contingency plan for Canyon Lake, the only water supply reservoir within the river basin.
Risk Reduction Benefit (Current Cost/Losses Avoided)**:**	Reduce water consumption during periods of drought.
Type of Action: (Local Plans and Regulations, Structure and Infrastructure Projects, Natural Systems Protection, or Education and Awareness)	Education and Awareness

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Drought
Effect on new/existing buildings:	N/A
Priority (High, Moderate, Low):	High
Estimated Cost:	$10,000
Potential Funding Sources:	Operating Budget
Lead Agency/Department Responsible:	Engineering Department
Implementation Schedule:	Within 12-24 months of plan adoption.
Incorporation into Existing Plans:	Strategic Plan

COMMENTS:
ADDITIONAL CONSIDERATIONS: (Rate action as indicated below) The following STAPLEE criteria were evaluated on a scale of 1 to 5 indicating the extent to which this action satisfies each consideration. (1= Does Not Satisfy 3 = Moderately Satisfies 5 = Strongly Satisfies)
Socially Acceptable = 5; Technically Feasible = 5; Administratively Possible = 5; Politically Acceptable = 5; Legal = 5; Economically Sound = 4; and Environmentally Sound = 5

GBRA – Action #53	
Proposed Action:	Develop new water supply projects and initiatives working with colleagues in Region L.
BACKGROUND INFORMATION	
Site and Location:	The State of Texas updates the state Water Plan every 5 years. This water planning effort divides the state into 16 regions. The Guadalupe Basin is covered by Region L.
Risk Reduction Benefit (Current Cost/Losses Avoided)**:**	Reduce water consumption during periods of drought.
Type of Action: (Local Plans and Regulations, Structure and Infrastructure Projects, Natural Systems Protection, or Education and Awareness)	Preparedness

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Drought
Effect on new/existing buildings:	N/A
Priority (High, Moderate, Low):	High
Estimated Cost:	$10,000
Potential Funding Sources:	Operating Budget
Lead Agency/Department Responsible:	Engineering Department
Implementation Schedule:	Within 12-24 months of plan adoption.
Incorporation into Existing Plans:	Strategic Plan

COMMENTS:
ADDITIONAL CONSIDERATIONS: (Rate action as indicated below) The following STAPLEE criteria were evaluated on a scale of 1 to 5 indicating the extent to which this action satisfies each consideration. (1= Does Not Satisfy 3 = Moderately Satisfies 5 = Strongly Satisfies)
Socially Acceptable = 5; Technically Feasible = 5; Administratively Possible = 5; Politically Acceptable = 5; Legal = 5; Economically Sound = 4; and Environmentally Sound = 5

GBRA – Action #54	
Proposed Action:	Develop hydrologic forecast models for the Guadalupe Basin. The headwaters of the Guadalupe Basin are located in a region known as “Flash Flood Alley”. These intense rain events are difficult to forecast. Improved tools are needed.
BACKGROUND INFORMATION	
Site and Location:	Model the entire watershed.
Risk Reduction Benefit (Current Cost/Losses Avoided)**:**	Reduce flood damages through improved mapping to guide future planning decisions; Improve forecasting; Improve risk assessment.
Type of Action: (Local Plans and Regulations, Structure and Infrastructure Projects, Natural Systems Protection, or Education and Awareness)	Preparedness

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flood
Effect on new/existing buildings:	N/A
Priority (High, Moderate, Low):	High
Estimated Cost:	$2,000,000
Potential Funding Sources:	Operating Budget
Lead Agency/Department Responsible:	Engineering Department
Implementation Schedule:	Within 24-36 months of plan adoption.
Incorporation into Existing Plans:	Strategic Plan

COMMENTS:
ADDITIONAL CONSIDERATIONS: (Rate action as indicated below) The following STAPLEE criteria were evaluated on a scale of 1 to 5 indicating the extent to which this action satisfies each consideration. (1= Does Not Satisfy 3 = Moderately Satisfies 5 = Strongly Satisfies)
Socially Acceptable = 5; Technically Feasible = 5; Administratively Possible = 5; Politically Acceptable = 5; Legal = 5; Economically Sound = 4; and Environmentally Sound = 5

		GBRA – Action #55
	Proposed Action:	Upgrade lightening protection equipment and critical equipment at all GBRA facilities.
	BACKGROUND INFORMATION	
	Site and Location:	All GBRA facilities.
	Risk Reduction Benefit (Current Cost/Losses Avoided)**:**	Lightning from severe thunderstorms can result in major electronic damage to water and wastewater plants, shutting down service for days.
	Type of Action: (Local Plans and Regulations, Structure and Infrastructure Projects, Natural Systems Protection, or Education and Awareness)	Structure and Infrastructure

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Lightning
Effect on new/existing buildings:	Reduce risk to existing structure and infrastructure
Priority (High, Moderate, Low):	High
Estimated Cost:	$300,000
Potential Funding Sources:	Operating Budget, Grants
Lead Agency/Department Responsible:	Operations Manager
Implementation Schedule:	Within 12-24 months of plan adoption.
Incorporation into Existing Plans:	Strategic Plan

COMMENTS:
ADDITIONAL CONSIDERATIONS: (Rate action as indicated below) The following STAPLEE criteria were evaluated on a scale of 1 to 5 indicating the extent to which this action satisfies each consideration. (1= Does Not Satisfy 3 = Moderately Satisfies 5 = Strongly Satisfies)
Socially Acceptable = 5; Technically Feasible = 5; Administratively Possible = 5; Politically Acceptable = 5; Legal = 5; Economically Sound = 4; and Environmentally Sound = 5

GBRA – Action #56	
Proposed Action:	Develop a delta model for the lower basin area.
BACKGROUND INFORMATION	
Site and Location:	Lower basin
Risk Reduction Benefit (Current Cost/Losses Avoided)**:**	Reduce flood damages through improved mapping to guide future planning decisions; Improve forecasting; Improve risk assessment.
Type of Action: (Local Plans and Regulations, Structure and Infrastructure Projects, Natural Systems Protection, or Education and Awareness)	Preparedness

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flood
Effect on new/existing buildings:	N/A
Priority (High, Moderate, Low):	High
Estimated Cost:	$1,200,000
Potential Funding Sources:	Operating Budget, Grants, Bonds
Lead Agency/Department Responsible:	Engineering Department
Implementation Schedule:	Within 24-36 months of plan adoption.
Incorporation into Existing Plans:	Strategic Plan

COMMENTS:
ADDITIONAL CONSIDERATIONS: (Rate action as indicated below) The following STAPLEE criteria were evaluated on a scale of 1 to 5 indicating the extent to which this action satisfies each consideration. (1= Does Not Satisfy 3 = Moderately Satisfies 5 = Strongly Satisfies)
Socially Acceptable = 5; Technically Feasible = 5; Administratively Possible = 5; Politically Acceptable = 5; Legal = 5; Economically Sound = 4; and Environmentally Sound = 5

GBRA – Action #57	
Proposed Action:	Upgrade diversion levees in the Calhoun Canal System.
BACKGROUND INFORMATION	
Site and Location:	Calhoun Canal System
Risk Reduction Benefit (Current Cost/Losses Avoided)**:**	Reduce flood damages; Reduce risk of additional breaches and associated repair costs.
Type of Action: (Local Plans and Regulations, Structure and Infrastructure Projects, Natural Systems Protection, or Education and Awareness)	Structure and Infrastructure

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flood
Effect on new/existing buildings:	Reduce risk to existing structures and infrastructure
Priority (High, Moderate, Low):	High
Estimated Cost:	$5,000,000
Potential Funding Sources:	Operating Budget, Grants, Bonds
Lead Agency/Department Responsible:	GBRA Operations Department
Implementation Schedule:	Within 24-48 months of plan adoption.
Incorporation into Existing Plans:	Strategic Plan

COMMENTS:
ADDITIONAL CONSIDERATIONS: (Rate action as indicated below) The following STAPLEE criteria were evaluated on a scale of 1 to 5 indicating the extent to which this action satisfies each consideration. (1= Does Not Satisfy 3 = Moderately Satisfies 5 = Strongly Satisfies)
Socially Acceptable = 5; Technically Feasible = 5; Administratively Possible = 5; Politically Acceptable = 5; Legal = 5; Economically Sound = 4; and Environmentally Sound = 4

GBRA – Action #58	
Proposed Action:	Hardened generator and fuel storage tank at Port Lavaca Water Treatment Plant.
BACKGROUND INFORMATION	
Site and Location:	Port Lavaca WTP
Risk Reduction Benefit (Current Cost/Losses Avoided)**:**	Reduce risk of damages; Ensure continuity of services.
Type of Action: (Local Plans and Regulations, Structure and Infrastructure Projects, Natural Systems Protection, or Education and Awareness)	Structure and Infrastructure

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flood, Hail, Thunderstorm Wind, Hurricane, Lightning, Extreme Heat, Tornado, Winter Storm
Effect on new/existing buildings:	N/A
Priority (High, Moderate, Low):	High
Estimated Cost:	$250,000
Potential Funding Sources:	Operating Budget, Grants, Bonds
Lead Agency/Department Responsible:	GBRA Operations Department
Implementation Schedule:	Within 12 months of plan adoption.
Incorporation into Existing Plans:	Strategic Plan

COMMENTS:
ADDITIONAL CONSIDERATIONS: (Rate action as indicated below) The following STAPLEE criteria were evaluated on a scale of 1 to 5 indicating the extent to which this action satisfies each consideration. (1= Does Not Satisfy 3 = Moderately Satisfies 5 = Strongly Satisfies)
Socially Acceptable = 5; Technically Feasible = 5; Administratively Possible = 5; Politically Acceptable = 5; Legal = 5; Economically Sound = 4; and Environmentally Sound = 5

GBRA – Action #59	
Proposed Action:	Hardened building to provide shelter to personnel and critical infrastructure (SCADA) at PLWTP.
BACKGROUND INFORMATION	
Site and Location:	PLWTP
Risk Reduction Benefit (Current Cost/Losses Avoided)**:**	Reduce structural damages; Protect employees; Ensure continuity of services.
Type of Action: (Local Plans and Regulations, Structure and Infrastructure Projects, Natural Systems Protection, or Education and Awareness)	Structure and Infrastructure

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flood, Hail, Thunderstorm Wind, Hurricane, Lightning, Tornado
Effect on new/existing buildings:	Reduce risk to existing structure and infrastructure
Priority (High, Moderate, Low):	High
Estimated Cost:	$500,000
Potential Funding Sources:	Operating Budget, Grants, Bonds
Lead Agency/Department Responsible:	GBRA Operations Department
Implementation Schedule:	Within 12-36 months of plan adoption.
Incorporation into Existing Plans:	Strategic Plan

COMMENTS:
ADDITIONAL CONSIDERATIONS: (Rate action as indicated below) The following STAPLEE criteria were evaluated on a scale of 1 to 5 indicating the extent to which this action satisfies each consideration. (1= Does Not Satisfy 3 = Moderately Satisfies 5 = Strongly Satisfies)
Socially Acceptable = 5; Technically Feasible = 5; Administratively Possible = 5; Politically Acceptable = 5; Legal = 5; Economically Sound = 4; and Environmentally Sound = 5

		GBRA – Action #60
	Proposed Action:	Hardened pre-stressed concrete water storage tank (1MG) at PLWTP.
	BACKGROUND INFORMATION	
	Site and Location:	PLWTP
	Risk Reduction Benefit (Current Cost/Losses Avoided)**:**	Reduce structural damages; Ensure continuity of services.
	Type of Action: (Local Plans and Regulations, Structure and Infrastructure Projects, Natural Systems Protection, or Education and Awareness)	Structure and infrastructure

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flood, Hail, Thunderstorm Wind, Hurricane, Lightning, Tornado
Effect on new/existing buildings:	Reduce risk to existing infrastructure
Priority (High, Moderate, Low):	High
Estimated Cost:	$2,500,000
Potential Funding Sources:	Operating Budget, Grants, Bonds
Lead Agency/Department Responsible:	GBRA Operations Department
Implementation Schedule:	Within 12-36 months of plan adoption.
Incorporation into Existing Plans:	Strategic Plan

COMMENTS:
ADDITIONAL CONSIDERATIONS: (Rate action as indicated below) The following STAPLEE criteria were evaluated on a scale of 1 to 5 indicating the extent to which this action satisfies each consideration. (1= Does Not Satisfy 3 = Moderately Satisfies 5 = Strongly Satisfies)
Socially Acceptable = 5; Technically Feasible = 5; Administratively Possible = 5; Politically Acceptable = 5; Legal = 5; Economically Sound = 4; and Environmentally Sound = 5

	GBRA – Action #61
Proposed Action:	Hardened treated water pump station at PLWTP.
BACKGROUND INFORMATION	
Site and Location:	PLWTP
Risk Reduction Benefit (Current Cost/Losses Avoided)**:**	Reduce structural damages; Ensure continuity of services.
Type of Action: (Local Plans and Regulations, Structure and Infrastructure Projects, Natural Systems Protection, or Education and Awareness)	Structure and Infrastructure

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flood, Hail, Thunderstorm Wind, Hurricane, Lightning, Tornado
Effect on new/existing buildings:	Reduce risk to existing infrastructure
Priority (High, Moderate, Low):	High
Estimated Cost:	$2,500,000
Potential Funding Sources:	Operating Budget, Grants, Bonds
Lead Agency/Department Responsible:	GBRA Operations Department
Implementation Schedule:	Within 12-36 months of plan adoption.
Incorporation into Existing Plans:	Strategic Plan

COMMENTS:
ADDITIONAL CONSIDERATIONS: (Rate action as indicated below) The following STAPLEE criteria were evaluated on a scale of 1 to 5 indicating the extent to which this action satisfies each consideration. (1= Does Not Satisfy 3 = Moderately Satisfies 5 = Strongly Satisfies)
Socially Acceptable = 5; Technically Feasible = 5; Administratively Possible = 5; Politically Acceptable = 5; Legal = 5; Economically Sound = 4; and Environmentally Sound = 5

GBRA – Action #62	
Proposed Action:	Install stream gauges and citizen monitors where needed in the basin and develop software to allow general public to view gauges and anticipated flood events.
BACKGROUND INFORMATION	
Site and Location:	Key streams in basin.
Risk Reduction Benefit (Current Cost/Losses Avoided)**:**	River flow gauges provide invaluable information to the NWS during a flood event.
Type of Action: (Local Plans and Regulations, Structure and Infrastructure Projects, Natural Systems Protection, or Education and Awareness)	Structure and Infrastructure

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flood
Effect on new/existing buildings:	N/A
Priority (High, Moderate, Low):	High
Estimated Cost:	$100,000
Potential Funding Sources:	Grants, Bonds
Lead Agency/Department Responsible:	Engineering Department
Implementation Schedule:	Within 12-36 months of plan adoption.
Incorporation into Existing Plans:	Strategic Plan

COMMENTS:
ADDITIONAL CONSIDERATIONS: (Rate action as indicated below) The following STAPLEE criteria were evaluated on a scale of 1 to 5 indicating the extent to which this action satisfies each consideration. (1= Does Not Satisfy 3 = Moderately Satisfies 5 = Strongly Satisfies)
Socially Acceptable = 5; Technically Feasible = 5; Administratively Possible = 5; Politically Acceptable = 5; Legal = 5; Economically Sound = 4; and Environmentally Sound = 5

GBRA – Action #63	
Proposed Action:	Add back-up SCADA control room at alternate locations in the basin.
BACKGROUND INFORMATION	
Site and Location:	Hydroelectric room is the central point for all river flow information.
Risk Reduction Benefit (Current Cost/Losses Avoided)**:**	Reduce structural damages; Ensure continuity of services
Type of Action: (Local Plans and Regulations, Structure and Infrastructure Projects, Natural Systems Protection, or Education and Awareness)	Structure and Infrastructure

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Tornado
Effect on new/existing buildings:	N/A
Priority (High, Moderate, Low):	High
Estimated Cost:	$300,000
Potential Funding Sources:	Grants
Lead Agency/Department Responsible:	Hydro Electric Division
Implementation Schedule:	Within 12-36 months of plan adoption.
Incorporation into Existing Plans:	Strategic Plan

COMMENTS:
ADDITIONAL CONSIDERATIONS: (Rate action as indicated below) The following STAPLEE criteria were evaluated on a scale of 1 to 5 indicating the extent to which this action satisfies each consideration. (1= Does Not Satisfy 3 = Moderately Satisfies 5 = Strongly Satisfies)
Socially Acceptable = 5; Technically Feasible = 5; Administratively Possible = 5; Politically Acceptable = 5; Legal = 5; Economically Sound = 4; and Environmentally Sound = 5

		GBRA – Action #64
	Proposed Action:	Develop detailed Dam Failure (Breach) Model for the H4 and H5 Dams in the basin in order to harden the dam structure so that it will pass PMF.
	BACKGROUND INFORMATION	
	Site and Location:	Two low head hydroelectric dams constructed in the 1920s within Gonzales County upstream of City of Gonzales
	Risk Reduction Benefit (Current Cost/Losses Avoided)**:**	Reduce structural damages
	Type of Action: (Local Plans and Regulations, Structure and Infrastructure Projects, Natural Systems Protection, or Education and Awareness)	Structure and Infrastructure

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Dam Failure
Effect on new/existing buildings:	N/A
Priority (High, Moderate, Low):	High
Estimated Cost:	$150,000
Potential Funding Sources:	Operating Budget, Grants
Lead Agency/Department Responsible:	Hydro Electric Division
Implementation Schedule:	Within 12-36 months of plan adoption.
Incorporation into Existing Plans:	Strategic Plan

COMMENTS:
ADDITIONAL CONSIDERATIONS: (Rate action as indicated below) The following STAPLEE criteria were evaluated on a scale of 1 to 5 indicating the extent to which this action satisfies each consideration. (1= Does Not Satisfy 3 = Moderately Satisfies 5 = Strongly Satisfies)
Socially Acceptable = 5; Technically Feasible = 5; Administratively Possible = 5; Politically Acceptable = 5; Legal = 5; Economically Sound = 4; and Environmentally Sound = 5

GBRA – Action #65	
Proposed Action:	Improve communication with GBRA staff and County EMC's regarding Emergency Action Plan for Dam Failure and Safety.
BACKGROUND INFORMATION	
Site and Location:	Basin-wide
Risk Reduction Benefit (Current Cost/Losses Avoided)**:**	Reduce structural damages and loss of life.
Type of Action: (Local Plans and Regulations, Structure and Infrastructure Projects, Natural Systems Protection, or Education and Awareness)	Education and Awareness

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Dam Failure
Effect on new/existing buildings:	N/A
Priority (High, Moderate, Low):	High
Estimated Cost:	$5,000
Potential Funding Sources:	Operating Budget
Lead Agency/Department Responsible:	Hydro Electric Division
Implementation Schedule:	Within 12-36 months of plan adoption.
Incorporation into Existing Plans:	Strategic Plan

COMMENTS:
ADDITIONAL CONSIDERATIONS: (Rate action as indicated below) The following STAPLEE criteria were evaluated on a scale of 1 to 5 indicating the extent to which this action satisfies each consideration. (1= Does Not Satisfy 3 = Moderately Satisfies 5 = Strongly Satisfies)
Socially Acceptable = 5; Technically Feasible = 5; Administratively Possible = 5; Politically Acceptable = 5; Legal = 5; Economically Sound = 4; and Environmentally Sound = 5

SECTION 19: PLAN MAINTENANCE

Plan Maintenance Procedures

The following is an explanation of how the Guadalupe-Blanco River Authority will be involved in implementing, evaluating, and enhancing the Hazard Mitigation Action Plan Update (Plan or Plan Update) over time. The sustained hazard mitigation planning process consists of four main parts:

- Incorporation
- Monitoring and Evaluation
- Updating
- Continued Public Involvement

Incorporation

The Guadalupe-Blanco River Authority will be responsible for further development and implementation of mitigation actions. Each action has been assigned to a specific department within the GBRA. The following describes the process by which the GBRA will incorporate elements of the mitigation plan into other planning mechanisms.

Process of Incorporation

Once the Plan Update is adopted, the Guadalupe-Blanco River Authority will implement actions based on priority and the availability of funding. The GBRA currently implements policies and programs to reduce loss of life and property damages from hazards. The mitigation actions developed for this Plan Update enhance this ongoing effort and will be implemented through other program mechanisms where possible.

The potential funding sources listed for each identified action may be used when the GBRA seeks funds to implement actions. An implementation time period or a specific implementation date has been assigned to each action as an incentive for completing each task and gauging whether actions are implemented in a timely manner.

The GBRA will integrate implementation of their mitigation actions with other plans and policies such as construction standards and emergency management plans, and ensure that these actions, or proposed projects, are reflected in other planning efforts. Coordinating and integrating components of other plans and policies into goals and objectives of the Plan will further maximize funding and provide possible cost-sharing of key projects, thereby reducing loss of lives and property, and mitigation hazards affecting the area.

Upon formal adoption of the Plan, Planning Team members will work to integrate the hazard mitigation strategies into other planning mechanisms for the GBRA. Planning Team members will conduct periodic reviews of plans and policies (once per year at a minimum) and analyze the need for amendments in light of the approved Plan. The Planning Team will review all annual budget reviews, emergency operations or management plans, evacuation plans, and any other internal plans related to water supply and quality. They will ensure that capital improvement planning in the future will also contribute to the goals of this Hazard Mitigation Plan to reduce the long-term risk to life and property from all hazards. Within one year of formal adoption of the Hazard Mitigation Action Plan, existing planning mechanisms will be reviewed.

The GBRA will review and revise, as necessary, the long-range goals and objectives in strategic plan and budgets to ensure that they are consistent with this mitigation action plan. Additionally, the GBRA will work to advance the goals of this hazard mitigation plan through its routine, ongoing, long-range planning, budgeting, and work process.

Table 19-1. Methods of Incorporation of the Plan

PLANNING MECHANISM	TITLE RESPONSIBLE	METHOD OF INCORPORATION
Grant Applications	Grant Administrator	The GBRA will consult the Plan whenever there are yearly grant funding cycles available through FEMA, including the Pre-Disaster Mitigation (PDM) cycle, and when there is a Disaster Declaration for Texas triggering Hazard Mitigation Grant Program (HMGP) funds. Mitigation actions for each jurisdiction will be reviewed by the planning team members and information will be updated for completing applications, such as maps and risk assessment data. If a project is not in the Plan, an amendment may be developed.
Annual Budget Review	Accounting Assistant	The GBRA will review the Plan and mitigation actions therein when conducting its annual budget review. When allocating funds for upcoming operating and construction budgets, high priority mitigation actions will be reviewed during Board meetings. Each identified staff member/ planning team member will be responsible for bringing mitigation actions to the meeting to discuss feasibility of the potential project in terms of the availability of funds, grant assistance, and preliminary cost benefit review.

PLANNING MECHANISM	TITLE RESPONSIBLE	METHOD OF INCORPORATION
Emergency Planning	Deputy Assistant – GBRA Headquarters	The Plan will be consulted during updates to the emergency operations and/or disaster recovery plan. Risk assessment and vulnerability data will be pulled from the plan and analyzed in conjunction with the review, renewal, or re-writing of an Emergency Operations or Management Plan. This data will either be included within the new emergency planning mechanism or included as an appendix. Mitigation projects that relate to prevention and protection will also be reviewed for relevance to determine if they should be included.
Continuity of Operations Plan	Executive Manager of Project Engineering and Development	Before any updates to the Continuity of Operations Plan are conducted, the GBRA will review the risk assessment and mitigation strategy sections of the Plan, as continuity of services is a priority during a hazard event. Mitigation projects that improve the continuity of operations will be reviewed to ensure that all facilities and services are discussed within the plan.
Evacuation Plan	Deputy Assistant – GBRA Headquarters	The Plan will be consulted during updates to the evacuation plan. Mitigation projects that assist the evacuation process or improve evacuation routes will be reviewed to ensure the most up-to-date information is included in the evacuation plan.
Other Plans	Executive Manager Operations and Water Quality	The Plan will be utilized in updating and maintaining other internal plans that are related to water supply and quality. In updating or maintaining these plans, the Plan will be consulted for Risk Assessment and vulnerability data, along with flood risk and extent. In addition, mitigation projects will be reviewed for inclusion.

Monitoring and Evaluation

Periodic revisions of the Plan are required to ensure that goals, objectives, and mitigation actions are kept current. Revisions may be required to ensure the Plan Update is in compliance with federal and state statutes and regulations. This section outlines the procedures for completing Plan revisions, updates, and review. Table 19-2 indicates the department and title responsible for Plan monitoring, evaluating updating and review of the Plan. When the plan is discussed that includes the planning process, risk assessment, mitigation goals and strategies, and mitigation actions that are written into the plan.

Table 19-2. Team Members Responsible for Plan Monitoring, Evaluating, Updating, and Review of the Plan

ORGANIZATION	TITLE
Guadalupe-Blanco River Authority	Executive Manager of Project Engineering and Development
Guadalupe-Blanco River Authority	Project and Community Representative
Guadalupe-Blanco River Authority	Accounting Assistant
Guadalupe-Blanco River Authority	Deputy Assistant - GBRA Headquarters
Guadalupe-Blanco River Authority	Deputy FCO
Guadalupe-Blanco River Authority	Grant Administrator - Seguin
Guadalupe-Blanco River Authority	Water Quality Protection Manager
Guadalupe-Blanco River Authority	Senior Advisor to the General Manager

Monitoring

Designated Planning Team members are responsible for monitoring, evaluating, updating, and reviewing the Plan, as shown in Table 19-2. Individuals holding the title listed in Table 19-2 will be responsible for monitoring the Plan on an annual basis. Plan monitoring includes reviewing and incorporating into the Plan other existing planning mechanisms that relate or support goals and objectives of the Plan; monitoring the incorporation of the Plan into future updates of other existing planning mechanisms as appropriate; reviewing mitigation actions submitted and coordinating with various departments to determine if mitigation actions need to be re-evaluated and updated; evaluating and updating the Plan as necessary; and monitoring plan maintenance to ensure that the process described is being followed, on an annual basis, throughout the life of the plan. The Planning Team will develop a brief report that identifies if changes to the Plan are needed, such as recommending an action for funding. A summary of meeting notes will report the particulars involved in developing an action into a project.

Evaluation

As part of the evaluation process, the Planning Team will assess changes in risk; determine whether the implementation of mitigation actions is on schedule; determine whether there are any implementation problems, such as technical, political, legal, or coordination issues; and identify changes in land development or programs that affect mitigation priorities for each respective department or organization.

The Planning Team will meet on an annual basis to evaluate the Plan Update and identify any needed changes. The annual evaluation process will help to determine if any changes are necessary.

Updating

Plan Amendments

At any time, minor technical changes may be made to update the Guadalupe-Blanco River Authority Hazard Mitigation Plan Update. Material changes to mitigation actions or major changes in the overall direction of the Plan or the policies contained within it must be subject to formal adoption by the GBRA.

The GBRA will review proposed amendments and vote to accept, reject, or amend the proposed change. Upon ratification, the amendment will be transmitted to TDEM.

In determining whether to recommend approval or denial of a Plan amendment request, the GBRA will consider the following factors:

- Errors or omissions made in the identification of issues or needs during the preparation of the Plan;
- New issues or needs that were not adequately addressed in the Plan; and
- Changes in information, data, or assumptions from those on which the Plan was based.

Five Year Review

The Plan Update will be thoroughly reviewed by the Planning Team at the end of three years from the approval date to determine whether there have been significant changes in the planning area that necessitate changes in the types of mitigation actions proposed. Factors that may affect the content of the Plan include new development in identified hazard areas, increased exposure to hazards, disaster declarations, increase or decrease in capability to address hazards, and changes to federal or state legislation.

The Plan review process provides the GBRA an opportunity to evaluate mitigation actions that have been successful, identify losses avoided due to the implementation of specific mitigation measures, and address mitigation actions that may not have been successfully implemented as assigned.

It is recommended that the full Planning Team (Section 2, Table 2-1) meet to review the Plan Update at the end of three years because grant funds may be necessary for the development of a five-year update. Reviewing planning grant options in advance of the five-year Plan update deadline is recommended considering the timelines for grant and planning cycles can be in excess of a year.

Following the Plan review, any revisions deemed necessary will be summarized and implemented according to the reporting procedures and Plan amendment process outlined herein. Upon completion of the review, update, and amendment process the revised Plan will be submitted to TDEM for final review and approval in coordination with FEMA.

Continued Public Involvement

Public input was an integral part of the preparation of this Plan Update and will continue to be essential for Plan updates. The Guadalupe-Blanco River Authority considered its employees as part of the public and will continue to directly involve them in the annual review and cyclical updates. Changes or suggestions to improve or update the Plan will provide opportunities for additional public input.

The public can review the Plan, of which a copy will be kept at the Guadalupe-Blanco River Authority's office where officials and the public are invited to provide ongoing feedback.

The Planning Team may also designate willing stakeholder members that were involved in the Plan's development, to provide feedback on an annual basis. It is important that stakeholders and the community maintain a vested interest in preserving the functionality of the planning area as it pertains to the overall goals of the mitigation plan. The Planning Team is responsible for notifying stakeholders and community members on an annual basis and maintaining the Plan.

APPENDIX A: PLANNING TEAM

Planning Team Members

The Guadalupe-Blanco River Authority Hazard Mitigation Action Plan Update (Plan or Plan Update), was organized using a direct representative model. An Executive Planning Team from GBRA, shown in Table A-1, was formed to coordinate planning efforts, and request input and participation in the planning process. Table A-2 is comprised of stakeholders (area organizations and departments) who were invited to provide Plan input.

Table A-1. Planning Team

ORGANIZATION	TITLE
Guadalupe-Blanco River Authority	Accounting Assistant
Guadalupe-Blanco River Authority	Assistant Chief Ranger - Lake Wood Park
Guadalupe-Blanco River Authority	Chief District Operator - WCWTP
Guadalupe-Blanco River Authority	Chief Operator - Luling WTP
Guadalupe-Blanco River Authority	Chief Operator - Port Lavaca WTP
Guadalupe-Blanco River Authority	Chief Operator - San Marcos WTP
Guadalupe-Blanco River Authority	Chief Operator-Western Canyon
Guadalupe-Blanco River Authority	Chief Ranger - Coleto Creek Park
Guadalupe-Blanco River Authority	Deputy Assistant - GBRA Headquarters
Guadalupe-Blanco River Authority	Deputy Division Manager - Hydro/RUD
Guadalupe-Blanco River Authority	Deputy FCO
Guadalupe-Blanco River Authority	Deputy General Manager
Guadalupe-Blanco River Authority	Deputy General Manager
Guadalupe-Blanco River Authority	Distribution Operator - Western Canyon
Guadalupe-Blanco River Authority	Division Manager - Calhoun & Refugio County
Guadalupe-Blanco River Authority	Division Manager - Hays & Caldwell County
Guadalupe-Blanco River Authority	Division Manager - Hydro/RUD
Guadalupe-Blanco River Authority	Division Manager - Western Canyon

Appendix A: Planning Team

ORGANIZATION	TITLE
Guadalupe-Blanco River Authority	Executive Manager of Project Engineering and Development
Guadalupe-Blanco River Authority	Executive Manager Operations and Water Quality
Guadalupe-Blanco River Authority	Grant Administrator - Seguin
Guadalupe-Blanco River Authority	Lab Director
Guadalupe-Blanco River Authority	Lockhart - Wastewater
Guadalupe-Blanco River Authority	Operator - Buda
Guadalupe-Blanco River Authority	Plant Manager - San Marcos WTP
Guadalupe-Blanco River Authority	Project and Community Representative
Guadalupe-Blanco River Authority	Project Coordinator
Guadalupe-Blanco River Authority	Reservoir Manager - Coleto Creek
Guadalupe-Blanco River Authority	RUD
Guadalupe-Blanco River Authority	RUD
Guadalupe-Blanco River Authority	Senior Advisor to the General Manager
Guadalupe-Blanco River Authority	Water Quality Project Manager

Stakeholders

The following groups listed in Table A-2 represent a list of organizations invited to stakeholder meetings throughout the planning process and include key planning staff of various jurisdictions. The invited organizations and stakeholders were given an opportunity to provide comments and data for the Plan Update. For a list of attendees at meetings, please see Appendix E[1].

Table A-2. Stakeholders

AGENCY	TITLE
Caldwell County	Emergency Management Coordinator
Caldwell County	Public Works Administrator
Calhoun County	Emergency Management Coordinator
Calhoun Count	Public Works Administrator
Comal County	Emergency Management Coordinator

[1] Information contained in Appendix E is exempt from public release under the Freedom of Information Act (FOIA).

Appendix A: Planning Team

AGENCY	TITLE
Comal County	Public Works Administrator
DeWitt County	Emergency Management Coordinator
DeWitt County	Public Works Administrator
Gonzales County	Emergency Management Coordinator
Gonzales County	Public Works Administrator
Guadalupe County	Emergency Management Coordinator
Guadalupe County	Public Works Administrator
Hays County	Emergency Management Coordinator
Hays County	Public Works Administrator
Kendall County	Emergency Management Coordinator
Kendall County	Public Works Administrator
Refugio County	Emergency Management Coordinator
Refugio County	Public Works Administrator
Victoria County	Emergency Management Coordinator
Victoria County	Public Works Administrator
Texas A&M - Agrilife Extension	County Extension Agent
Guadalupe-Blanco River Trust	Trustee
Gonzales ISD	Superintendent
New Braunfels ISD	Superintendent
San Marcos ISD	Superintendent

APPENDIX B: PUBLIC SURVEY RESULTS

Overview

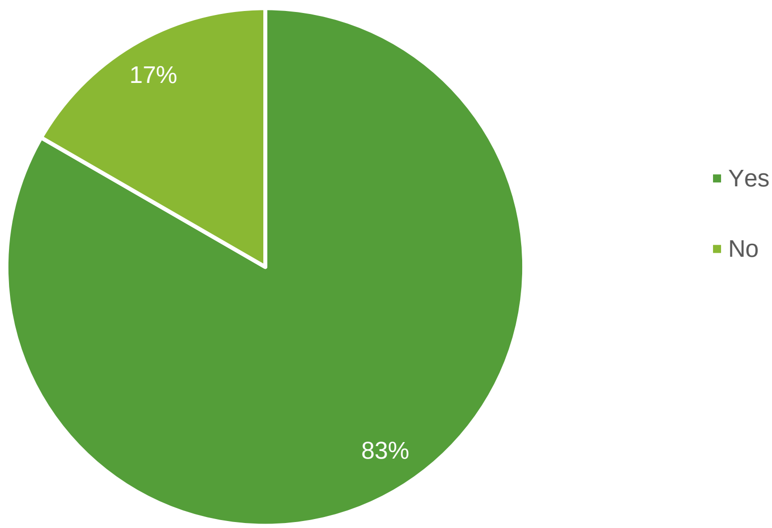
The Guadalupe-Blanco River Authority prepared a public survey that requested public opinion on a wide range of questions relating to natural hazards. The survey available to the public via a link that was emailed out and distributed at meetings throughout the planning process.

A total of 12 surveys were collected, the results of which are analyzed in Appendix B. The purpose of the survey was twofold: 1) to solicit input during the planning process, and 2) to help the GBRA identify any potential actions or problem areas.

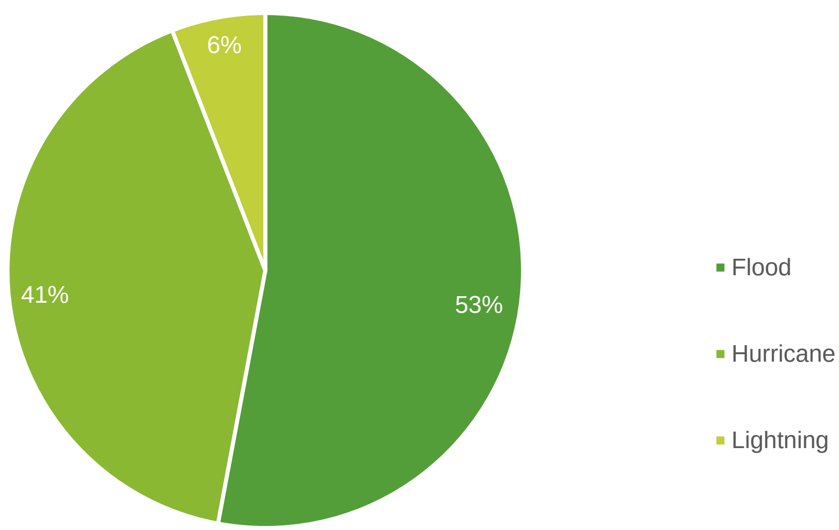
The following survey results depict the percentage of responses for each answer. Similar responses have been summarized for questions that did not provide a multiple-choice answer or that required an explanation.

Public Survey Results

1. A. Have you ever experienced or been impacted by a disaster?

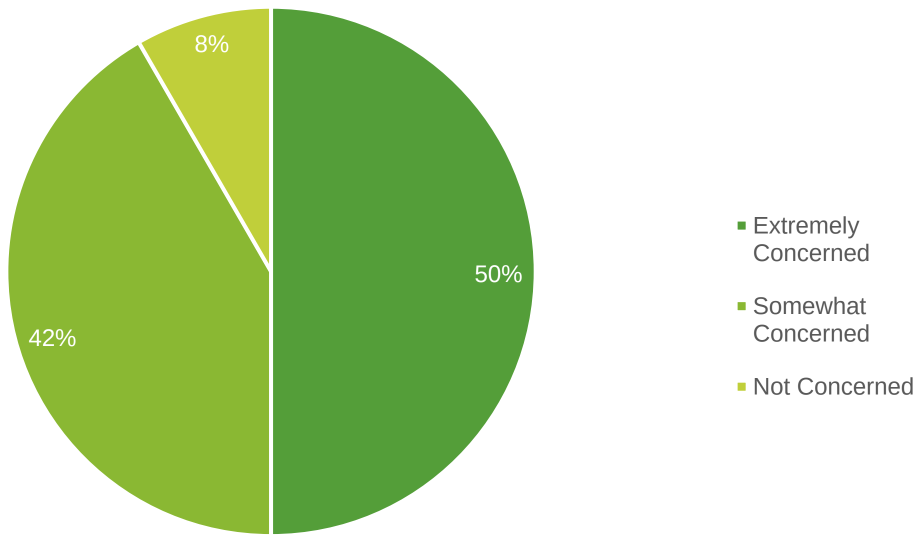


1. B. If "Yes", please explain:

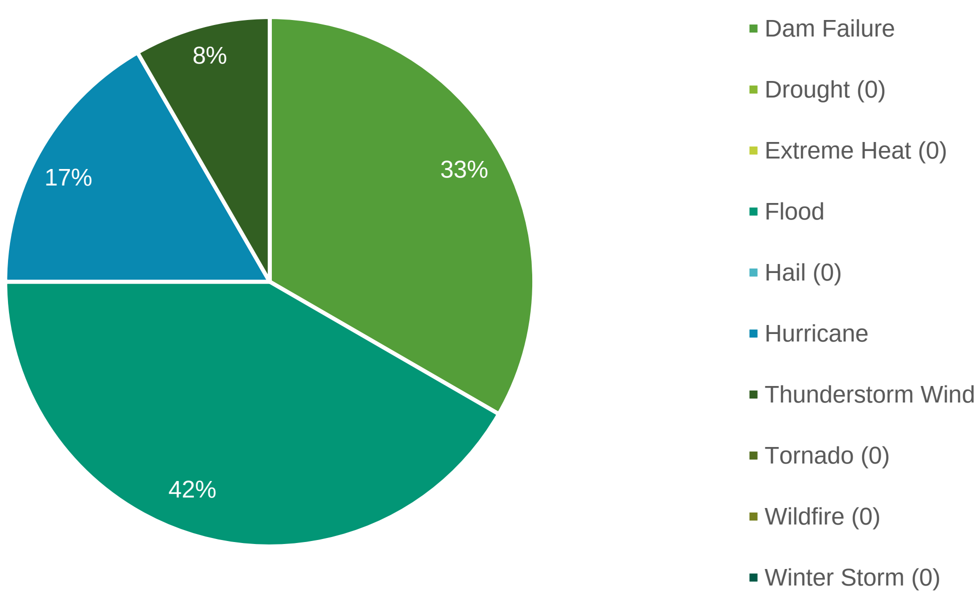


Appendix B: Public Survey Results

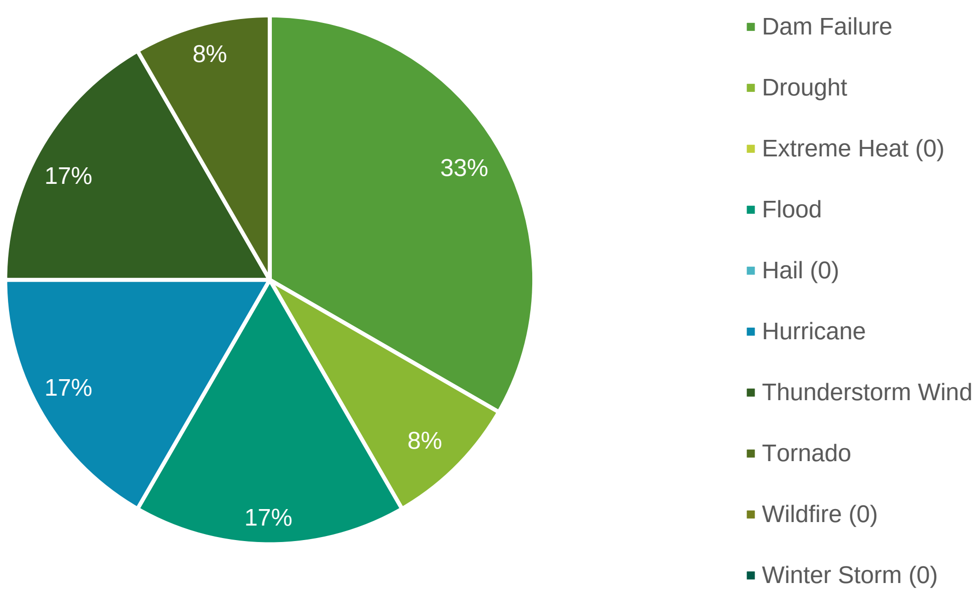
2. How concerned are you about the possibility of the GBRA being impacted by a disaster?



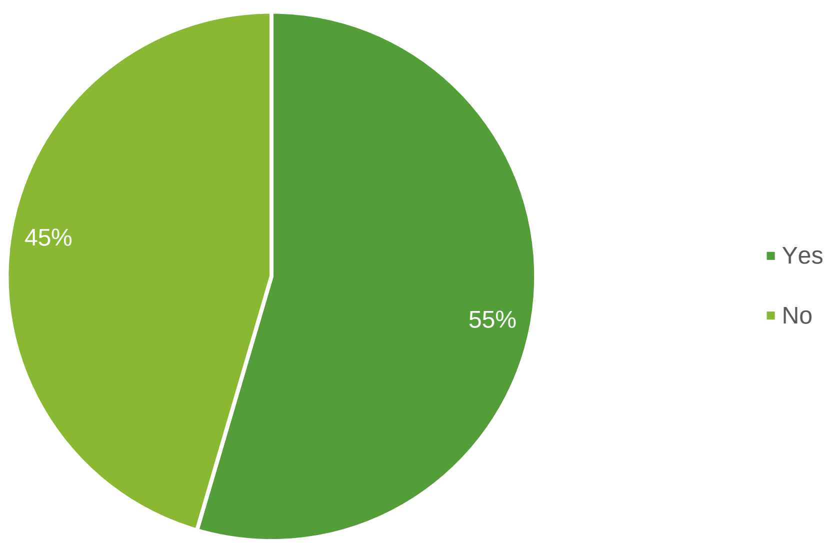
3. Please select the one hazard you think is the highest threat to the GBRA:



4. Please select the one hazard you think is the second highest threat to the GBRA:

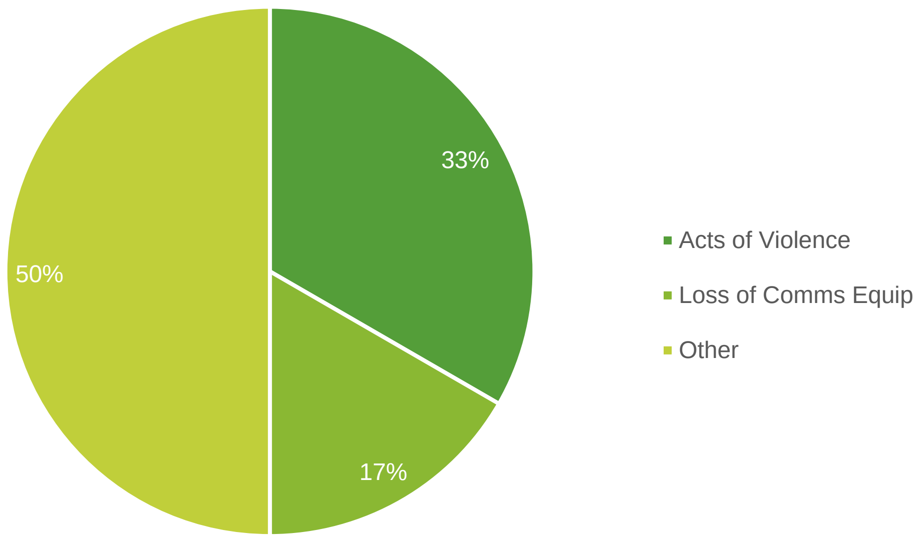


5. A. Are there hazards not listed above that you think is a wide-scale threat to GBRA?

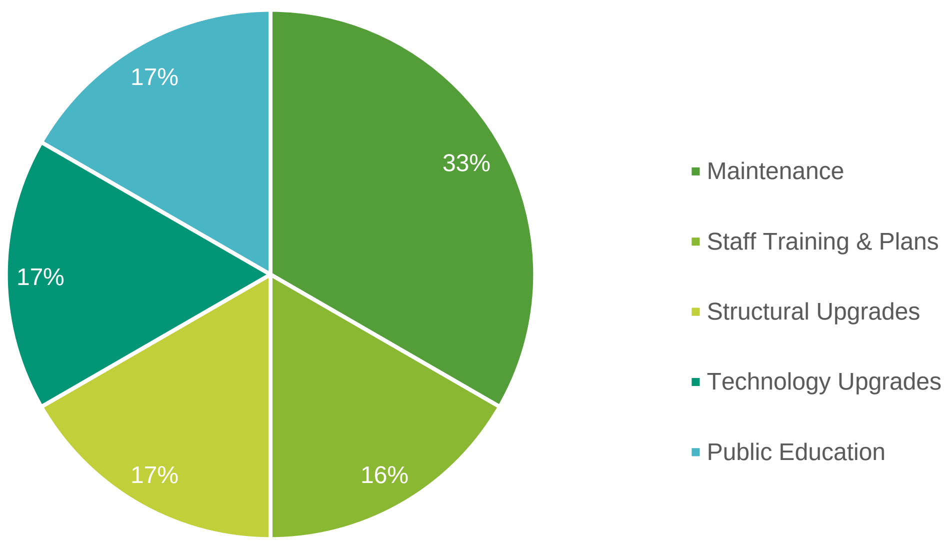


Appendix B: Public Survey Results

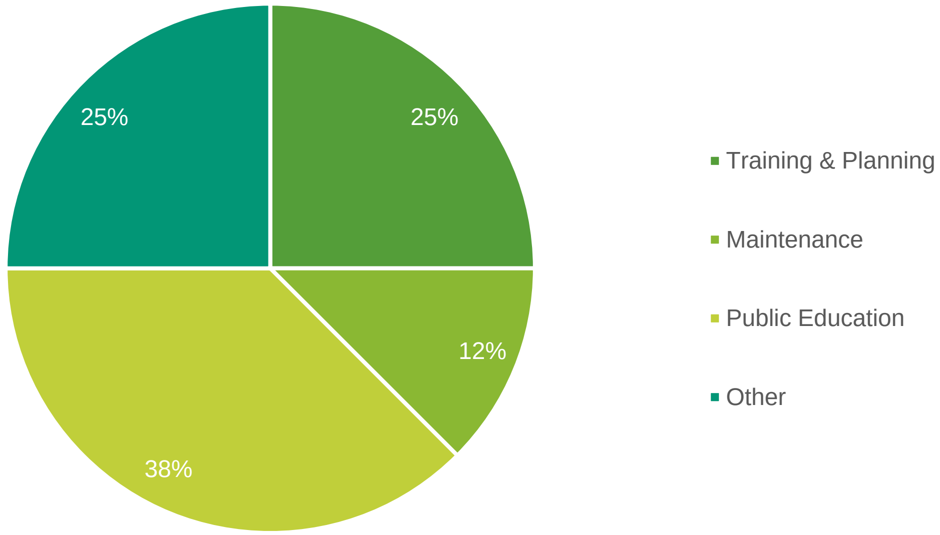
5. B. If “Yes”, please explain:



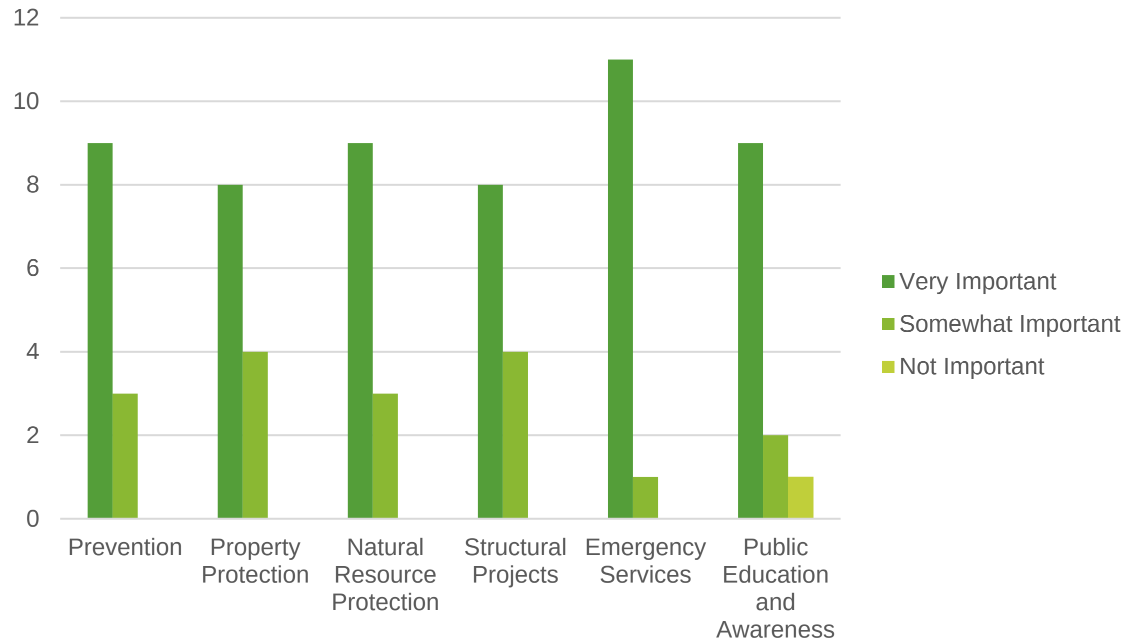
6. In your opinion, what are some steps GBRA could take to reduce or eliminate the risk of future hazard damages in your neighborhood?



7. Are there any other issues regarding the reduction of risk and loss associated with hazards or disasters in the community that you think are important?



8. A number of GBRA-wide activities can reduce our risk from hazards. In general, these activities fall into one of the following six broad categories. Please tell us how important you think each one is for your community to consider pursuing.



Prevention / Local Plans & Regulations - Administrative or regulatory actions that influence the way land is developed and buildings are built. Examples include planning and zoning, building codes, open space preservation, and floodplain regulations.

Property Protection - Actions that involve the modification of existing buildings to protect them from a hazard or removal from the hazard area. Examples include acquisition, relocation, elevation, structural retrofits, and storm shutters.

Natural Resource Protection - Actions that in addition to minimizing hazard losses also preserve or restore the functions of natural systems. Examples include: floodplain protection, habitat preservation, slope stabilization, riparian buffers, and forest management.

Structural Projects - Actions intended to lessen the impact of a hazard by modifying the natural progression of the hazard. Examples include dams, levees, seawalls detention / retention basins, channel modification, retaining walls and storm sewers.

Emergency Services - Actions that protect people and property during and immediately after a hazard event. Examples include warning systems, evacuation planning, emergency response training, and protection of critical facilities or systems.

Public Education and Awareness - Actions to inform citizens about hazards and techniques they can use to protect themselves and their property. Examples include outreach projects, school education programs, library materials, and demonstration events.

APPENDIX C: CRITICAL FACILITIES

Overview

This Appendix is **For Official Use Only (FOUO)** and may be exempt from public release under FOIA. Table C-1 lists the critical facilities owned by GBRA and Table C-2 is a summary table of critical facilities by type.

Critical Facilities

Table C-1. List of GBRA Critical Facilities by Type

NAME	TYPE
306 Repeater Tower	Communication
Buda Wastewater Treatment Plant	Waste Water
Calhoun County Rural Water System	Water
Canyon Dam	Dam
Canyon Hydro	Hydroelectric
Canyon Park Estates Wastewater Treatment Plant	Waste Water
Coleto Creek Dam	Dam
Coleto Creek Park and Reservoir	Water
Comal Trace Water Distribution System	Water
Cordillera Ranch WDS & Wastewater Treatment Plant	Waste Water
Crestview Subdivision Wastewater Treatment Plant	Waste Water
Diversion Dam & Salt Water Barrier	Dam
Dunlap Dam	Dam
Dunlap Regional Lift Station	Lift Station
Dunlap Wastewater Treatment Plant	Hydroelectric
GBRA Main Business Office	Administration
Guadalupe Power Partners	Electric

Appendix C: Critical Facilities

NAME	TYPE
GVEC Cost Tower	Water
H-4 Dam	Dam
H-5 Dam	Dam
Hillside Terrace	Water
Lake Dunlap (TP-1) Hydroelectric Plant	Hydroelectric
Lake Gonzales (H-4) Hydroelectric Plant	Hydroelectric
Lake McQueeney (TP-3) Hydroelectric Plant	Hydroelectric
Lake Wood Park (H-5) Hydroelectric Power Plant	Hydroelectric
Lake Wood Sub Station	Electric
Legends Pond	Water
Lockhart Raw Water Pump Station	Water
Lockhart Wastewater Treatment Plant #1	Waste Water
Lockhart Wastewater Treatment Plant FM20	Waste Water
Lockhart Water Treatment Plant	Waste Water
Long Creek #1 Lift Station	Lift Station
Long Creek #2 Lift Station	Lift Station
Long Creek #3 Lift Station	Lift Station
Luling Water Treatment Plant	Waste Water
McQueeney Dam	Dam
McQueeney Sub-Station	Electric
New Braunfels River Gage	Water
Nolte Dam	Dam
Nolte Hydro	Hydroelectric
North Cliffe Wastewater Treatment Plant	Waste Water
Port Lavaca Water Treatment Plant, Canal System	Waste Water
Regional Raw Water Pump Stations 1 and 2	Water
Rivers Bend Lift Station	Lift Station
Roland Water Tower	Water

Appendix C: Critical Facilities

NAME	TYPE
RRWS #3 PS	Water
San Marcos Water Treatment Plant	Waste Water
Shadow Creek Wastewater Treatment Plant	Waste Water
South Bank	Lift Station
Springs Hill Wastewater Treatment Plant	Waste Water
Sunfield Wastewater Treatment Plant	Waste Water
TP-4 Dam	Dam
TP-4 Hydroelectric Plant	Hydroelectric
Western Canyon Raw Water Pump Station	Water
Western Canyon Water Treatment Plant	Waste Water

Table C-2. Summary of GBRA Critical Facilities by Type

TYPE	NUMBER
Administration	1
Communication	1
Dam	9
Electric	3
Hydroelectric	8
Lift Station	6
Waste Water	15
Water	13
Total	**56**

APPENDIX D: DAM LOCATIONS

Overview

Appendix D is **For Official Use Only (FOUO)** and may be exempt from public release under the Freedom of Information Act (FOIA).

Dam Locations

Table D-1 below reflects the dams that are owned and operated by the Guadalupe-Blanco River Authority that are profiled in the dam failure section.

Table D-1. Listing of GBRA Dam Locations and Storage Capacities

Dam	LATITUDE	LONGITUDE	HEIGHT (Ft.)	STORAGE (Acre Feet)
Coleto Creek Dam	28.72333	-97.16667	65	132,536
Lake Dunlap Dam	29.653992	-98.066285	41	14,330
Lake Gonzales Dam	29.495815	-97.624491	42	28,070
Lake Meadow Dam	29.528826	-97.93947	43.6	3,210
Lake McQueeney Dam	29.594357	-98.040702	42	6,170
Lake Placid Dam	29.548446	-97.999636	46.8	5,650
Lake Wood Dam	29.468355	-97.492067	42	27,450

APPENDIX E: MEETING DOCUMENTATION

Workshop Documentation

Appendix E is **For Official Use Only (FOUO)** and may be exempt from public release under the Freedom of Information Act (FOIA).

GBRA held a series of Planning Team workshops: a Kickoff Workshop on December 8, 2016, a Risk Assessment Workshop on June 26, 2016 and a Mitigation Strategy Workshop on October 25, 2017. At each of these workshops members of the Planning Team were informed of the planning process, expressed opinions, and volunteered information. GBRA hosted and participated in two stakeholder meetings. The sign-in sheets for each workshop are included below. For more details on the workshops and planning process, see Section 2.

Figure E-1. GBRA Kickoff Workshop, 12.08.16

GBRA

H2O PARTNERS

GUADALUPE-BLANCO RIVER AUTHORITY
HAZARD MITIGATION PLAN KICKOFF WORKSHOP
GBRA River Annex, Seguin, TX
December 8, 2016

Please print clearly.

Name	Title	Department	Phone	Email
Rachel Andrews	Mitigation Specialist	H20 Partners	512-983-0092	rachel@h2opartnersusa.
Eduardo Montana	GBRA		512-398-6391	emontana@gbra.org
Jerry Sharp	GBRA	San Marcos WTP	512-353-3888	JSharp@GBRA.org
Jesi Mann	GBRA Operator		512-757-6524	jmann@gbra.org
Joe Downey	GBRA Luling		830-875-2132	jdowney@gbra.org
Joel Heidecke	GBRA	RUD	830 660 1808	jheideke@gbra.org
Brian Lyssy	Operator	RUD	830-660-2402	BLYSSY@GBRA.ORG
Darel Ball	Exec. MGR - Water Resources & Utility Ops.		830-379-5822	dball@gbra.org
Jeff McKee	Asst. Division Manager	Hydroelectric/Rural Utilities	830-379-5822	jmckee@gbra.org
Allen Lawson	Chief Dist. Operator	WCWTP	830-560-0023	alawson@gbra.org
Cecil Holliday	Operator	WCWTP	830-560-0446	cholliday@gbra.org

GBRA

H2O PARTNERS

GUADALUPE-BLANCO RIVER AUTHORITY
HAZARD MITIGATION PLAN KICKOFF WORKSHOP
GBRA River Annex, Seguin, TX
December 8, 2016

Please print clearly.

Name	Title	Department	Phone	Email
JORGE ROJAS		Western Canyon	830-313-0606	JROJAS@gbra.org ~~Jeedaaa yahoo~~
Wilfred Korth	Chief Ranger	Coleto Creek Park	361-575-6366	wkorth@gbra.org
Mark Henneke	Asst. Chief Ranger	Lake Wood Park	1830672-2779	mhenneke@gbra.org
Alan Schneider	Chief Operator	Coleto Creek Reservoir	361-575-6366	aschneider@gbra.org
STEPHANIE SHELLY	DIVISION MANAGER	CALHOUN/REFUGIO COUNTIES	361-552-9751	sshelly@gbra.org
Jason Eeds	System Operator	Lockhart W.W.	512-398-6391	jeeds@gbra.org
Yolanda Pierce	Op. Assistant	GBRA Headquarters	830-379-5822	ypierce@gbra.org
Thomas D. Hill	Chief Engineer	Seguin	830-379-5822	thill@gbra.org
Tim Dusek	Grants Administrator	Seguin	830-660-9193	tdusek@gbra.org

Figure E-2. GBRA Risk Assessment Workshop, 06.28.17

GBRA

H2O PARTNERS

GUADALUPE-BLANCO RIVER AUTHORITY
HAZARD MITIGATION PLAN RISK ASSESSMENT WORKSHOP
GBRA River Annex, Seguin, TX
June 28, 2017

Please print clearly.

Name	Title	Department	Phone	Email
Erin Capps		H2O	512-769-5483	ecapps@h2opartnersusa.com
Teresa VanBooven	Project/Comm. Rep.	Eng - GBRA	830-379-5822	tvanbooven@gbra.org
Alan Schneider	Chief Op.	Coleto Creek Res.	361-575-6366	aschneider@gbra.org
Wilfred Korth	Chief Ranger	Coleto Creek	361-575-6366	wkorth@gbra.org
Allen Ognoskie	Division Mgr.	Hydro/RUD	830-379-5822	aognoskie@gbra.org
Lee Gudgell	Water Quality Project Manager	041 - Water Supply	830-379-5822	lgudgell@gbra.org
Edwardo Montana	Division MGR, Hays/Caldwell Counties		512-398-6391	emontana@gbra.org
Raymond Casteline	Lab Director	LAB	830-379-5822	rcasteline@gbra.org
Darel Ball	Ex Mgr Ops & Water Supply	041	830-379-5822	dball@gbra.org
Jonathan Stinson	Dep. GM	GM		
Susan Hubbert	Deputy CFO	General - Acctg	830-379-5822	shubbert@gbra.org

GBRA

H2O PARTNERS

GUADALUPE-BLANCO RIVER AUTHORITY
HAZARD MITIGATION PLAN RISK ASSESSMENT WORKSHOP
GBRA River Annex, Seguin, TX
June 28, 2017

Please print clearly.

Name	Title	Department	Phone	Email
Jeannine Herrmann,	Accounting Asst. II,	General Accounting	830-379-5822 x229	jherrmann@gbra.org
Darrell Nichols.	Deputy. GM	GM	830.379.5822	dnichols@gbra.org
Alvin Schuerg	Advisor To GM	GM	830/379-5822	~~aschuerg~~ aschuerg@gbra.org
Thomas D. Hill	Chief Engineer	Water Supply	830/379-5822	thill@gbra.org
Mary Newman	Project Coordinator	Engineering	830 379 5822	mnewman@GBRA.org

Appendix E: Meeting Documentation

Figure E-3. Mitigation Strategy Workshop Sign-In, 10.25.17

GBRA

H2O PARTNERS

GUADALUPE-BLANCO RIVER AUTHORITY
HAZARD MITIGATION PLAN MITIGATION STRATEGY WORKSHOP
GBRA River Annex, Seguin, TX
October 25, 2017

Please print clearly.

Name	Title	Department	Phone	Email
JONATHAN STINSON	DEPT GM	GENERAL		jstinson@gbra.org
Ronnie Parenica	Chief Operator	PL WTP	361-552-9751	rparenica@gbra.org
Alan Schneider	Reservoir Manager	Coleto Creek	361-575-6366	aschneider@gbra.org
Mark Henneke	Asst Chief Ranger	Lake Wood Park	8306722779	mhenneke@gbra
Joe Downey	Chief Operator	Luling WTP	830-875-2132	jdowney@gbra.org
RAY Casteline	Lab Director	LAB	830-379-5822	rcastelino@gbra.org
Jeff McKee	Deputy Division Manager	Hydro/RUD	830-379-5822	jmckee@gbra.org
John Gerland	Chief Operator	San Marcos WTP	512.353.3888	jgerland@gbra.org
Jerry Sharp	Plant Manager	SMWTP	512-353-3888	jsharp@gbra.org
Allen Ognoskie	Division Mgr.	Hydro/RUD	830-379-5822	aognoskie@gbra.org
Alvin Schuerg	Adv. to G.M.	General	ξ	ASCHUERG@GBRA.ORG

GBRA

H2O PARTNERS

GUADALUPE-BLANCO RIVER AUTHORITY
HAZARD MITIGATION PLAN MITIGATION STRATEGY WORKSHOP
GBRA River Annex, Seguin, TX
October 25, 2017

Please print clearly.

Name	Title	Department	Phone	Email
Cecil Holiday	Distribution Operator	Western Canyon	830-560-0446	cholliday@gbra.org
Hunter Duncan	Chief Operator	Western Canyon	830-560-6159	hduncan@gbra.org
Jorge Rojas	Division Mngr	Western Canyon	830-313-0606	JROJAS@gbra.org
Jesi Mann	Operator	Buda	512-757-6524	jmann@gbra.org
Eduardo Martinez	Division Mgr	Hays/Caldwell County	512-356-6351	emartinez@gbra.org
Darel Ball	Exec. Mgr Ops & Water Quality	Water Resources	830-379-5822	dball@gbra.org
Teresa Van Booven	Project + Comm. Rep.	Water Supply	830-379-5822	tvanbooven@gbra.org
Rhonda Murphy	Mitigation Planner	H2O Partners	512 571-2088	RMurphy@H2OpartnersUSA.com

Stakeholder Meeting Documentation

As discussed in Section 2, two stakeholder meetings were held to discuss the Plan Update. Documentation in the form of the agendas and sign-in sheets for each of the meetings follows.

Figure E-4. Public Stakeholders Meeting Agenda, 09.28.17

Agenda

Operations Group Meeting
September 28, 2017
10:00 AM to 12:00 PM
River Annex

Facilitator:	Allen Ognoskie
Scribe:	Cecil Holiday
Timekeeper:	Ed Boettner
Attendees Required:	Alan Schneider, Allen Ognoskie, Cecil Holiday, Ed Boettner, Eduardo Montana, Hunter Duncan, Jason Eeds, Jeff McKee, Jerry Sharp, Joe Downey, Joel Heideke, John Gerland, Jorge Rojas, Mark Henneke, Mike Urrutia, Ray Casteline, Stephanie Shelly (note: above is the rotation of duties, alphabetized by first name)

Agenda topics

10:00	Review Agenda	All
10:05	GBRA Hazard Mitigation	Teresa
10:20	Grants	Tim Dusek
10:35	Accounting Department Info.	Susan/Oscar/Gynna
10:50	Review Minutes of Previous Meeting	All
10:55	Suspense Calendar	All
11:00	Lab Updates	Mike/Ray
11:10	Safety Concerns/Review Accidents & Incidents	Darel
11:20	Develop 2018 Work Plan	All
11:35	TCEQ Inspections (Regulatory Issues	All
11:45	Meetings & Dates, Next Meeting & Assign Roles	All
11:50	Items of Concern	All
12:00	New Projects / Lunch	All
	Delta/Plus	All
	SCADA Work Shop	Jim/All

Figure E-5. Public Stakeholders Meeting Minutes, 09.28.17

Operations Group
Minutes of the Meeting
September 28, 2017
10:00 A.M.

The Operations Group meeting was held September 28, 2017 in the Board Room at the Bill West Annex.

Members Present: Alan Schneider, Joe Downey, Cecil Holliday, Hunter Duncan, Eduardo Montana, Jason Eeds, Jeff McKee, John Gerland, Jorge Rojas, Mark Henneke, Allen Ognoskie, Jorge Rojas, Stephanie Shelly, Mike Urrutia, Ray Casteline, Alan Schneider, Ed Boettner, Jerry Sharp

Others present: Alvin Schuerg, Tim Dusek, Cindy Demers, Oscar Ramirez, Gynna Hernandez, Jim Wyatt, Teresa VanBooven

Rotation Duties:

Facilitator – Allen Ognoskie
Scribe – Cecil Holliday
Time Keeper – Ed Boettner

Review Agenda:

- Stephanie reviewed the meeting agenda.

GBRA Hazard Mitigation:

- Teresa handed out Annualized Loss Methodology worksheets to be completed on each facility and turned in by October 13th for the October 25th meeting.

Grants:

- Tim D. presented us with information for the GBRA grant program and went over the request form and key parts of the GBRA Grant Policy.
- Due to the complexity of the grant process we need to initiate process at least 45 days before deadline.
- Try to utilize HUB (Historically Underutilized Businesses) for contracts/purchases.
- Tim is open to hearing all ideas and "wish list" items for possible grants.

Accounting Department:

- Cindy introduced Oscar Ramirez the new Accounting Manager.
- Need to work on moving the "Bill To" address on all invoices and accounts to 933 E. Court Street, Seguin, TX 78155.
- Gynna to send out received invoices to appropriate managers on every Tuesday. Please return in a timely matter so end of month balance sheets are not off.

Reviewed Minutes:

- Reviewed minutes and action items from last meeting.

Suspense calendar

- Reviewed suspense calendar for October.
- Question was brought up if we need to update/add/remove items on suspense calendars.

Action Items:

- Hazard mitigation, Annualized Loss Methodology paperwork needs to be filled out for each area and information is due by 10/13/17 for the 10/25/17 meeting.
- In efforts to stream line accounting invoice payment process please work on changing "Bill to" address to Seguin address for your various contractor/vendors.
- Susan H. to check on the uniform contract (new charges on bills).
- Jeff McKee to research cost effectiveness/need for in house generator maintenance.
- Ray Casteline to set up a point of contact person to sign for uniform deliveries.
- Review suspense calendars and do we need to add/remove items?
- Investigate and identify dangers around WWTP clarifiers and possible work arounds for maintenance activities.
- Brainstorm and bring 2018 work plan ideas for next meeting.
- Start process of making contact with power company customer reps for GBRA for emergencies.
- All involved with Hurricane Harvey to preform round table discussion to memorialize the good, bad, and learned.
- Identify all critical operation items at facilities for SCADA resources. Jim Wyatt to preform site visits to evaluate needs.

Lab Updates:

- Ray Casteline wants to do site visits at facilities to get familiar with assets and to make sure lab procedures are up to date and followed correctly.
- Regional Lab is due for TCEQ audit in 2018.
- Ray informed us of the mobile lab that is available in emergency situations.

Safety Concerns:

- Reviewed broken ankle accident and the importance of not having anyone on top of concrete walls without fall protection.
- Managers to investigate possible dangers of cleaning weirs and clarifiers.
- Reviewed two other incidents; rolled ankle and puncture wound.
- Safety Boot Policy still under review.

2018 Work Plan:

- This item was moved to next meeting.

Regulatory Issues:

- Joe Downey had an TCEQ inspections with no violations.
- Stephanie gave a Hurricane Harvey update.
- We spoke about the importance of having a working relationship with the power company customer account representative that can be a vital contact in emergency situations.

Next Meeting:

- **The next meeting has been scheduled for October 25, 2017 after the Hazard Mitigation workshop**.
- Responsibilities for the next meeting are:
  - Facilitator – Cecil Holliday
  - Scribe – Ed Boettner
  - Time Keeper – Eduardo Montana

Items of Concern:

- Mike U. distributed new Worker's Compensation info cards from Barbra.

New Projects:

- New projects were discussed: 4-S Ranch WWTP, Park Village WWTP, Lockhart Hoist.
- Alvin gave a brief update/overview of the mid basin project(s).

Delta/Plus:

- The overall consensus was that this was a really good meeting.

SCADA:

- Jim went over the 5 year outlook and needs that are on the horizon.
- Standardize equipment where possible on new projects or repairs.
- Jim to visit sites to identify critical items and make sure we have stock for repairs.
- Discussed response trailer with repair parts.
- Succession planning is vital. What happens when Jim is not here?
- Discussed possibly getting people some PLC training to help with the basics.

Appendix F: Capability Assessment

Overview

The Planning Team completed a Capability Assessment Survey at the beginning of the planning process. The completed Capability Assessment Checklist, included in Appendix F, provides information on existing policies and plans for GBRA.

A Capability Assessment is an integral component of the plan development process. The Capability Assessment serves to evaluate the existing planning capabilities to support implementation of the Plan's Mitigation Strategy Objectives.

GBRA has a unique set of capabilities including policies, programs, staff, funding, and other resources available to accomplish hazard mitigation objectives and reduce long-term vulnerability. The Planning Team identified existing capabilities in each jurisdiction that currently reduce disaster losses or could be used to reduce losses in the future and capabilities that inadvertently increase risks in the community.

GBRA Capability Assessment

COMMUNITY CAPABILITY CHECKLIST		
Planning/Regulatory Tool	**In Place**	**Under Development**
Hazard Mitigation Plan		X
Fiscal Year Business Plan		
Stormwater Management Plan/Ordinance		
Emergency Operations Plan	X	
Capital Improvements Plan		X
Floodplain Management Plan		
Flood Response Plan	X	
Water Master Plan	X	
Continuity of Operations Plan		X
Evacuation Plan	X	
Wastewater Master Plan	X	
Administrative and Technical Capability	**Yes**	**No**
Planners		X
Engineers	X	
Emergency Manager		X
Floodplain Manager	X	
Personnel skilled in Geographic Information Systems (GIS)	X	
Resource development staff	X	

COMMUNITY CAPABILITY CHECKLIST			
CAPABILITY	DEGREE OF CAPABILITY		
	Limited	Moderate	High
Planning and Regulatory Capability		X	
Administrative and Technical Capability		X	
Fiscal Capability	X		
Political Capability		X	